



DEPARTMENT OF PAPER AND BIOPROCESS
ENGINEERING

State University of New York
College of Environmental Science and Forestry

Graduate Student Handbook
2010 Fall Edition

Preface

This booklet has been compiled for graduate students in the department of paper and bioprocess engineering. The content is derived from the "Handbook of Graduate Studies" published by the Office of Instruction and Graduate Studies at ESF and from various documents drafted by previous PSE graduate study committees. The current version was accepted by the Faculty of Paper and Bioprocess Engineering.

B. V. RAMARAO

GRADUATE STUDIES AND RESEARCH COMMITTEE

DEPARTMENT OF PAPER AND BIOPROCESS ENGINEERING

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MS Programs in Paper and BioProcess Engineering

ADMISSIONS TO THE GRADUATE PROGRAM

The information about procedures involved in the admission process for graduate students is available with downloadable application form, instructions, and letter of recommendation form on the internet.

<http://www.esf.edu/admissions/graduate/graduate.htm>.
<http://infostu.suny.edu/interstu/supform.htm>

MS PROGRAM

Student is accepted into a degree program or shortly after matriculation. For a student accepted into the MS program without a major professor, a *temporary advisor* may be appointed by the PSE Faculty Chair. However, every effort should be made to expedite the appointment of a major professor as soon as possible. It is recommended that the MS student contact all the professors / research associates to find out mutual research interests and look for possible financial support before reaching final decision of her/his major professor. It is the duty of the major professor to fulfill a primary role as the student's mentor. Aided by other members of the steering committee, the major professor guides the student in the development and implementation of the Program of Study (**Form 3B (MS)**), including course selection, facilitation of the appointment of the steering committee and examiner(s), examination schedule and reviews of thesis, including a complete review of the thesis before the final draft is presented for defense. The major professor provides the steering committee with the **student's audit form** with adequate updates.

STEERING COMMITTEE

The Steering Committee for the MS student is composed of the major professor and at least two faculty members or other qualified persons with a PhD degree. Other qualified persons include faculty at other institutions, or other recognized professionals. The student's steering committee is appointed by the Dean of Instruction and Graduate Studies (**Form 2B**), upon the recommendation of the Faculty Chair (**Form 2A**). The steering committee should *be appointed within the first*

semester. For all students, the steering committee must be established *and must have met by the end of the third semester of graduate study.* The steering committee assists the student in the development of the **Program of Study**, including the development of the research or academic/professional experience. The steering committee guides the development of the thesis or dissertation, including a review of the draft before the final copy is presented for defense.

CREDITS

Grade Evaluation

For each graduate course completed, one of the following grades may be awarded:

GRADE	DEFINITION	Grade Points
A	Excellent	4.000
A-		3.7
B+		3.3
B	Satisfactory	3.000
B-		2.7
C+		2.3
C	Average	2.0
C-		1.7
F	Fail	0.000
I/F	Incomplete Fail	
I/U	Incomplete, Unresolved	
W	Withdrawn	
WP	Withdrawn Passing	
WF	Withdrawn Failing	
S	Satisfactory	
U	Unsatisfactory	
SAU	Satisfactory Audit	
UAU	Unsatisfactory Audit	
I	Incomplete	

Academic Performance

All graduate students are required to maintain at least a 3.000 cumulative grade point average, GPA for graduate level courses. Students who do not maintain this average, or who receive two or more grades of Unsatisfactory (U) for work on thesis, will be placed on probation or dismissed from ESF by the Dean of Instruction and Graduate Studies upon the recommendation of the College Subcommittee on Academic Standards. Students who have been dismissed may appeal the decision to the Faculty Subcommittee on Academic Standards. A guide to submitting an appeal is included in the APPENDICES of this document (cf. P 59).

GPA

Semester and cumulative grade point averages are based on graduate level courses only and are computed by dividing the grade points earned by the credit hours completed in all courses grades "A to F". A temporary grade of "I" may be assigned by an instructor only when the student is passing and has nearly completed the

courses, but because of circumstances beyond the student's control, the work is not completed. The Incomplete grade must be resolved *prior to the end of the semester* following that in which the incomplete was received. At the request of the instructor (via petition) under extraordinary conditions, the incomplete may be extended for one additional semester. If the incomplete is not resolved by the appropriate deadline, it will be changed to a grade of "I/F" or "I/U".

Credit Hour Load

To meet academic requirements, MS students must be registered for at least one credit each semester, *excluding summers*, from the first semester of matriculation until all degree requirements have been completed. Students are required to register for at least one credit in the summer if they will complete all requirements during that time. There is *no full-time credit hour load* to meet academic requirements. To qualify for various forms of *financial support*, however, the following credit hour loads are defined:

MS students who hold an *assistantship* must be registered for at least nine credits each semester while holding such an award.

MS students *not holding an assistantship* are considered full-time if they are registered for at least 12 credits each semester.

MS students, holding an assistantship or not, in their *last semester* of study who have met all academic requirements, except for the completion of their thesis, may be considered full-time if registered for at least one credit and have their major professor verify they are working full-time on the completion of degree requirements.

REGISTRATION DEADLINE

The day following the deadline to add courses, students who did not register will be withdrawn from the graduate program.

TIME LIMITS

MS students must complete all requirements for the Master of Science within three years of the first date of matriculation. If not, O.I.G.S. will provide the necessary consultation.

CREDITS AND COURSES

CREDIT HOUR REQUIREMENTS

The minimum credit hour requirement is the successful completion of 30 credits distributed between coursework and thesis. The applicable distributions will be determined by the steering committee to suit program objectives, with the understanding that a minimum of 18 credits are awarded for graduate level coursework, and a minimum of 6 credits are awarded for the thesis.

Numbering System for Graduate Courses and Shared Resource Courses

- ◆ 100-499 are undergraduate courses for which no graduate credit may be given.
- ◆ 500-599 are graduate courses designed expressly for areas of specialization in post-baccalaureate programs. Qualified undergraduates may enroll by permission of the instructor.
- ◆ 600-699 are graduate courses designed expressly for advanced levels of specialization. Undergraduates with a GPA of 3.000 or better may enroll with an approved petition.
- ◆ 700-999 are advanced graduate level courses. No undergraduate students may register for these courses.
- ◆ Shared resource courses, designated as 4XX/5XX or 4XX/6XX (*cf.* Required courses), are designed when the topic coverage of both courses is the same. Separate course syllabi are developed expressly differentiating the requirements and evaluative criteria between the undergraduate course and graduate *course*. No type of cross listing may be offered unless approved by the faculty.

PROGRAM OF STUDY

The MS **Program of Study (Form 3B(MS))**, includes an individualized sequence of courses and a plan for research or academic/professional experience. The Program of Study, developed by the student with the advice and approval of the major professor and other members of the steering committee, *must be submitted to the Faculty Chair for approval*, and forwarded to the Dean of Instruction and Graduate Studies at least *by the end of the third semester*.

The Program of Study can be *changed* during the course of each student's studies and must be approved by the major professor, Faculty Chair, and the Dean of Instruction and Graduate Studies. (See **Form 3A** for *policies* specific to the graduate program).

AREAS OF STUDY

The general area of study for each master's student is implied by the title of the program in which the degree is awarded. The student's area of study is listed on the student's transcript as identified in the study plan.

The areas of study are given in Chapter 3, pages 19- 27.

Ancillary areas

Each Faculty may offer **minors** identifying ancillary areas of study that may be appropriate for the degree program (e.g. Management, Process Control). *A minor is equivalent to 12 or more graduate credits*, earned in the minor area. Courses in the minor area must be taken outside of the student's major area of study. *A Minor Professor must be appointed to the student's steering committee* for each minor elected, in addition to the minimum complement of steering committee members. Each Minor professor can replace an additional examiner.

COURSES

Students planning to obtain an advanced degree in Paper Science and Engineering must present evidence of having completed the following courses in undergraduate work prior to arrival or make up deficiencies in these offerings without graduate credit.

- ◆ Mathematics: A minimum of one year of calculus.
- ◆ Physics: A minimum of one year of physics with laboratory and mathematics emphasis.
- ◆ Inorganic and General Chemistry: Two semesters with laboratory, which may include qualitative analysis.
- ◆ Computer Programming: Competence to be determined by passing an acceptable course with a grade of "B" or better or an equivalency examination.
- ◆ Three out of the following six courses:
 - *Analytical Chemistry*: One semester with laboratory, including quantitative analysis.
 - *Physical Chemistry*: Two semesters. Calculus must be used in the presentation.
 - *Organic Chemistry*: Two semesters with laboratory.
 - *Engineering Mechanics*: (Statics and Dynamics): Two semesters.
 - Mechanics of Materials: One semester.
 - Mathematics Beyond Integral Calculus: Two semesters (one course can be statistics).
- ◆ *Communication Skills*: All MS students are expected to be proficient in communication skills, including technical writing and library skills. Students are required to have completed at least *one course in technical writing* and *one course in library usage*, either as an undergraduate or as a graduate student. Credits for such courses taken during the graduate program are not counted towards degree requirements. Alternatively, MS students can meet the requirement by demonstrating the equivalent in experience in writing and library skills, as determined by the steering committee.

Transfer Credits

Up to **six credits of graduate coursework** in which a minimum grade of "B" was earned from an accredited institution and not used to complete another degree may be accepted towards completion of a Master's degree as approved by the steering committee and by the professor teaching the course at PSE.

Foundation Courses

PSE Option

The student is expected to be knowledgeable in the areas of pulping and bleaching, paper properties, and papermaking, either through having passed these as an undergraduate (UG) at this College or by passing, with a grade of "B" or better, the corresponding graduate level courses (G). (Undergraduate level course credits may not be applied toward graduate degree course requirements).

Course	UG/G
Pulping Technology	PSE 461/ERE 670
Paper Properties	PSE 465/ERE 677

Papermaking Processes	PSE 468/ERE 679
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BPE Option

All graduate students will be required to take 9 credits of coursework from the following 3 groups. At least 3 credits must be taken from each of A, B and C. Students may obtain credit for equivalent courses taken elsewhere upon approval of the steering committee and appropriate petition procedures.

Option	Core Course Groups		
	Group A	Group B	Group C
PSE	Pulping & Bleaching Wood Chemistry	Papermaking Processes	Paper Properties
BPE	Biochemistry Wood Chemistry Microbiology Pulping & Bleaching	Transport Phenomena Bioseparations Colloidal Science	Bioprocess Kinetics Reaction engineering Process Design Advanced Thermodynamics Catalysis

Elective Courses

Additional courses will be selected in consultation with the student's major professor with the aim of supporting the student's thesis research and/or to further a particular career objective. The courses may be selected from those offered by Paper & BioProcess Engineering, other units within the College or at neighboring Syracuse University, as appropriate (*cf.* Minor).

Seminars

Participation in seminars, including the preparation and presentation of technical material, is vital to the student's graduate education. The MS students are required to participate in graduate seminars, as follows: Each MS student is expected to participate in topic seminars, including presentations, as determined by the Faculty. This requirement can be fulfilled, with appropriate approval, by seminars offered at Syracuse University or the SUNY Health Sciences Center.

Research Credit

A Master's degree candidate is required to complete a research-oriented thesis (Option 1 in "Handbook") for which will be awarded at least 6 but no more than 12 credits toward the total of 30 required for the degree. Options 2 and 3 in the "Handbook" are not recognized by Paper Science and Engineering.

THESIS

To complete this degree, in addition to completion of necessary coursework, students

prepare a thesis, which investigates a problem that initiates, expands or clarifies knowledge in the field. Students are required to define an appropriate problem for investigation; review relevant information; develop a study plan incorporating investigative techniques appropriate to the problem; implement the plan; and relate the results to theory or body of knowledge in the field. The student must successfully defend the thesis for degree completion. The thesis is prepared and bound according to College standards and deposited in Moon Memorial Library, and submitted for microfilming to UMI (*cf.* APPENDICES).

Thesis Seminar

Students completing the Master's degree are required to present a "*Capstone Seminar*" on their thesis. The purpose of the capstone seminar is to provide an opportunity for the graduate student to present technical information to a critical body of professionals and peers. This seminar will be presented at least *three weeks* before the defense-of-thesis examination and should be attended by the student's steering committee. Each seminar is open to the College community and will be announced *one week* prior to presentation College-wide to encourage attendance by students and faculty. Students will formally register for Seminar (ERE 797, section 4, 1 credit hour) during their final semester and will be graded "S" or "U" ("satisfactory or "unsatisfactory") by a committee comprised of the major professor, three faculty, and one graduate student. A grade of "unsatisfactory" will require the seminar being repeated.

Thesis Defense Examination

Form 5A describes the procedures for the defense. **Form 5B** has to be sent to the Faculty Chair, who forwards it to the Dean of Instruction and Graduate Studies at least *one month prior to defense* to appoint the examination chair.

FLOWSHEET OF PROCEDURES

	FORMS	TIMING
Student is accepted to M.S. program		
Major professor is appointed	Forms 2A+B	End of Sem 1
Program of study	Form 3B (MS)	End of Sem 1
Semester plans	Form 4	End of Sem 1
Steering committee is appointed	Forms 2A+B	End of Sem 1
Request chair for thesis exam	Form 5B	
CAPSTONE seminar		
Defense of thesis exam	Form 5E	
Academic requirements completed	Form 9	
Student submits 4+ completed, signed theses	Microfilm. Diploma form, and fees	
Commencement and convocation		

Ph D Programs in Paper and BioProcess Engineering

ADMISSIONS TO THE GRADUATE PROGRAM

The information about procedures involved in the admission process for graduate students is available with downloadable application form, instructions, and letter of recommendation form on the internet.

<http://www.esf.edu/admissions/graduate/graduate.htm>.

<http://infostu.suny.edu/interstu/suppform.htm>

Ph D PROGRAM

Student is accepted into a degree program or shortly after matriculation. For a student accepted into the Ph D program without a major professor, a *temporary advisor* may be appointed by the PSE Faculty Chair. However, every effort should be made to expedite the appointment of a major professor as soon as possible. It is recommended that the student contact all the professors / research associates to find out mutual research interests and look for possible financial support before reaching final decision of her/his major professor.

It is the duty of the major professor to fulfill a primary role as the student's mentor. Aided by other members of the steering committee, the major professor guides the

student in the development and implementation of the Program of Study (**Form 3B (Ph D)**), including course selection, facilitation of the appointment of the steering committee and examiner(s), examination schedule and reviews of thesis, including a complete review of the thesis before the final draft is presented for defense. Students usually *meet with their major professor at least once each semester* for signatures on the **Form 4** (S.C.O.R.E.) for courses agreed upon on the **3B Form**. The major professor provides the steering committee with the **student's audit form** with adequate updates.

MAJOR PROFESSOR

The student's major professor is appointed by the Dean of Instruction and Graduate Studies (**Form 2B**, cf. APPENDICES) upon the recommendation of the Faculty Chair (**Form 2A**). Unless the student is accepted specifically to a grant, the major professor is usually identified during the initial application process and is appointed at the time the student is accepted into a degree program or shortly after matriculation. For doctoral students accepted into the doctoral program without a major professor, a *temporary advisor* may be appointed by the PSE Faculty Chair. However, every effort should be made to expedite the appointment of a major professor as soon as possible. It is recommended that the doctoral student contact several professors / research associates to find out mutual research interests and look for possible financial support before reaching final decision of her/his major professor. It is the duty of the major professor to fulfill a primary role as the student's mentor. Aided by other members of the steering committee, the major professor guides the student in the development and implementation of the Program of Study (**Form 3B (PhD)**), including course selection, facilitation of the appointment of the steering committee and examiner(s), examination schedule and reviews of thesis, including a complete review of the thesis before the final draft is presented for defense.

STEERING COMMITTEE

The Steering Committee for the doctoral student is composed of the major professor with a doctoral degree and at least two faculty members or other qualified persons with similar degrees. Other qualified persons include faculty at other institutions, or other recognized professionals with a PhD. The student's steering committee is appointed by the Dean of Instruction and Graduate Studies (**Form 2B**), upon the recommendation of the Faculty Chair (**Form 2A**).

The steering committee should *be appointed within the first semester*. For all students, the steering committee must be established *and must have met by the end of the third semester of graduate study*. The steering committee assists the student in the development of the Program of Study, including the development of the research or academic/professional experience. The steering committee guides the development of the thesis or dissertation, including a review of the draft before the final copy is presented for defense.

The Steering Committee for the Ph D student is composed of the major professor and at least two faculty members or other qualified persons with a PhD degree. Other qualified persons include faculty at other institutions, or other recognized professionals. The student's steering committee is appointed by the Dean of Instruction and Graduate Studies (**Form 2B**), upon the recommendation of the Faculty Chair (**Form 2A**). The steering committee should *be appointed within the first semester*. For all students, the steering committee must be established *and must*

have met by the end of the third semester of graduate study. The steering committee assists the student in the development of the **Program of Study**, including the development of the research or academic/professional experience.

The steering committee guides the development of the thesis or dissertation, including a review of the draft before the final copy is presented for defense.

CREDITS

Grade Evaluation

For each graduate course completed, one of the following grades may be awarded:

GRADE	DEFINITION	Grade Points
A	Excellent	4.000
A-		3.7
B+		3.3
B	Satisfactory	3.000
B-		2.7
C+		2.3
C	Average	2.0
C-		1.7
F	Fail	0.000
I/F	Incomplete Fail	
I/U	Incomplete, Unresolved	
W	Withdrawn	
WP	Withdrawn Passing	
WF	Withdrawn Failing	
S	Satisfactory	
U	Unsatisfactory	
SAU	Satisfactory Audit	
UAU	Unsatisfactory Audit	
I	Incomplete	

Academic Performance

All graduate students are required to maintain at least a 3.000 cumulative grade point average, GPA for graduate level courses. Students who do not maintain this average, or who receive two or more grades of Unsatisfactory (U) for work on thesis, will be placed on probation or dismissed from ESF by the Dean of Instruction and Graduate Studies upon the recommendation of the College Subcommittee on Academic Standards. Students who have been dismissed may appeal the decision to the Faculty Subcommittee on Academic Standards. A guide to submitting an appeal is included in the APPENDICES of this document (cf. P 59).

GPA

Semester and cumulative grade point averages are based on graduate level courses only and are computed by dividing the grade points earned by the credit hours completed in all courses grades "A to F". A temporary grade of "I" may be assigned by an instructor only when the student is passing and has nearly completed the

courses, but because of circumstances beyond the student's control, the work is not completed. The Incomplete grade must be resolved *prior to the end of the semester* following that in which the incomplete was received. At the request of the instructor (via petition) under extraordinary conditions, the incomplete may be extended for one additional semester. If the incomplete is not resolved by the appropriate deadline, it will be changed to a grade of "I/F" or "I/U".

Credit Hour Load

To meet academic requirements, students must be registered for at least one credit each semester, *excluding summers*, from the first semester of matriculation until all degree requirements have been completed. Students are required to register for at least one credit in the summer if they will complete all requirements during that time. There is *no full-time credit hour load* to meet academic requirements. To qualify for various forms of *financial support*, however, the following credit hour loads are defined:

Students who hold an *assistantship* must be registered for at least nine credits each semester while holding such an award.

Students *not holding an assistantship* are considered full-time if they are registered for at least 12 credits each semester.

Students, holding an assistantship or not, in their *last semester* of study who have met all academic requirements, except for the completion of their thesis, may be considered full-time if registered for at least one credit and have their major professor verify they are working full-time on the completion of degree requirements.

REGISTRATION DEADLINE

The day following the deadline to add courses, students who did not register will be withdrawn from the graduate program.

TIME LIMITS

Ph D students must complete all requirements for the degree within three years of the first date of matriculation. If not, O.I.G.S. will provide the necessary consultation.

CREDITS AND COURSES

CREDIT HOUR REQUIREMENTS

The minimum credit hour requirement is the successful completion of 90 credits distributed between coursework and thesis (60 excluding credits for a candidate entering the program with an MS or equivalent). The applicable distributions will be determined by the steering committee to suit program objectives, with the understanding that 30 to 48 credits are awarded for graduate level coursework, and 12 to 30 credits are awarded for the thesis (cf. p. 24). The minimum credit hour requirement is the successful completion of 90 credits distributed between coursework and thesis. The applicable distributions will be determined by the steering committee to suit program objectives, with the understanding that a minimum of 18 credits are

awarded for graduate level coursework, and a minimum of 6 credits are awarded for the thesis.

Numbering System for Graduate Courses and Shared Resource Courses

- ◆ 100-499 are undergraduate courses for which no graduate credit may be given.
- ◆ 500-599 are graduate courses designed expressly for areas of specialization in post-baccalaureate programs. Qualified undergraduates may enroll by permission of the instructor.
- ◆ 600-699 are graduate courses designed expressly for advanced levels of specialization. Undergraduates with a GPA of 3.000 or better may enroll with an approved petition.
- ◆ 700-999 are advanced graduate level courses. No undergraduate students may register for these courses.
- ◆ Shared resource courses, designated as 4XX/5XX or 4XX/6XX (*cf.* Required courses), are designed when the topic coverage of both courses is the same. Separate course syllabi are developed expressly differentiating the requirements and evaluative criteria between the undergraduate course and graduate *course*. No type of cross listing may be offered unless approved by the faculty.

PROGRAM OF STUDY

The **Program of Study (Form 3B(PhD))**, includes an individualized sequence of courses and a plan for research or academic/professional experience. The Program of Study, developed by the student with the advice and approval of the major professor and other members of the steering committee, *must be submitted to the Faculty Chair for approval*, and forwarded to the Dean of Instruction and Graduate Studies at least *by the end of the third semester*.

The Program of Study can be *changed* during the course of each student's studies and must be approved by the major professor, Faculty Chair, and the Dean of Instruction and Graduate Studies. (See **Form 3A** for *policies* specific to the graduate program).

Ancillary areas

Each Faculty may offer **minors** identifying ancillary areas of study that may be appropriate for the degree program (e.g. Management, Process Control). *A minor is equivalent to 12 or more graduate credits*, earned in the minor area. Courses in the minor area must be taken outside of the student's major area of study. *A Minor Professor must be appointed to the student's steering committee* for each minor elected, in addition to the minimum complement of steering committee members. Each Minor professor can replace an additional examiner.

COURSES

Students planning to obtain an advanced degree in Paper Science and Engineering

must present evidence of having completed the following courses in undergraduate work prior to arrival or make up deficiencies in these offerings without graduate credit.

- ◆ Mathematics: A minimum of one year of calculus.
- ◆ Physics: A minimum of one year of physics with laboratory and mathematics emphasis.
- ◆ Inorganic and General Chemistry: Two semesters with laboratory, which may include qualitative analysis.
- ◆ Computer Programming: Competence to be determined by passing an acceptable course with a grade of "B" or better or an equivalency examination.
- ◆ Three out of the following six courses:
 - *Analytical Chemistry*: One semester with laboratory, including quantitative analysis.
 - *Physical Chemistry*: Two semesters. Calculus must be used in the presentation.
 - *Organic Chemistry*: Two semesters with laboratory.
 - *Engineering Mechanics*: (Statics and Dynamics): Two semesters.
 - Mechanics of Materials: One semester.
 - Mathematics Beyond Integral Calculus: Two semesters (one course can be statistics).
- ◆ *Communication Skills*: All MS students are expected to be proficient in communication skills, including technical writing and library skills. Students are required to have completed at least *one course in technical writing* and *one course in library usage*, either as an undergraduate or as a graduate student. Credits for such courses taken during the graduate program are not counted towards degree requirements. Alternatively, MS students can meet the requirement by demonstrating the equivalent in experience in writing and library skills, as determined by the steering committee.

Transfer Credits

Up to **six credits of graduate coursework** in which a minimum grade of "B" was earned from an accredited institution and not used to complete another degree may be accepted towards completion of a doctoral degree as approved by the steering committee and by the professor teaching the course at PBE.

Foundation Courses

PSE Option

The student is expected to be knowledgeable in the areas of pulping and bleaching, paper properties, and papermaking, either through having passed these as an undergraduate (UG) at this College or by passing, with a grade of "B" or better, the corresponding graduate level courses (G). (Undergraduate level course credits may not be applied toward graduate degree course requirements).

Course	UG/G
Pulping Technology	PSE 550
Paper Properties	PSE 668
Papermaking Processes	PSE 665

and at least *one* of the following:
 a. transport processes ERE 682

- b. transport phenomena CEN 645
- c. chemical engineering thermodynamics CEN 657
- d. advanced thermodynamics I MEE 651
- e. chemical thermodynamics I CHE 656
- f. chemical reaction engineering CEN 587
- g. polymer properties and technology FCH 552
- h. materials and processes in manufacturing MEE 636
- i. colloid and interfacial science applications in papermaking PSE 667
- j. Partial Differential Equations and Fourier Series MAT 517
- k. Topics in Applied Mathematics MAT 518
- l. Statistical Analysis APM 510
- m. Advanced Physical Chemistry CHE 566
- n. Molecular Spectroscopy and Structure CHE 546
- o. Introduction to C and C++ CIS 504
- p. Product and New Venture Management MAR 757
- q. Professional and Technical Writing WRT 605

BPE Option

All graduate students will be required to take 9 credits of coursework from the following 3 groups. At least 3 credits must be taken from each of A, B and C. Students may obtain credit for equivalent courses taken elsewhere upon approval of the steering committee and appropriate petition procedures.

Option	Core Course Groups		
	Group A	Group B	Group C
PSE	Pulping & Bleaching Wood Chemistry	Papermaking Processes	Paper Properties
BPE	Biochemistry Wood Chemistry Microbiology Pulping & Bleaching	Transport Phenomena Bioseparations Colloidal Science	Bioprocess Kinetics Reaction engineering Process Design Advanced Thermodynamics Catalysis

Elective Courses

Additional courses will be selected in consultation with the student's major professor with the aim of supporting the student's thesis research and/or to further a particular career objective. The courses may be selected from those offered by Paper & BioProcess Engineering, other units within the College or at neighboring Syracuse University, as appropriate (*cf.* Minor).

QUALIFYING PROCEDURES

PRELIMINARY EXAMINATION

Students without MS

All students entering the Ph.D. program without having previously completed a Master's degree *are required to take an oral examination* to ascertain their level of understanding of the basic principles and techniques required for functioning effectively in a Ph.D. program in Paper Science and Engineering or BioProcess Engineering. The results of the preliminary examination will be used to guide the major professor and the student in identifying the appropriate coursework to successfully complete the requirements for the doctorate.

Examination Committee

The preliminary examination is to be an oral examination administered by an Examination Committee consisting of the Faculty Chair, the Major Professor and at least two other members of the faculty. Students will be examined to determine their understanding of the basic principles of pulp and paper technology as defined by pulping and bleaching, paper properties and papermaking and one of the following: chemical engineering, organic/wood chemistry, physical chemistry or engineering mechanics. The oral examination may be supplemented by a written one, if the Examination Committee deems this to be desirable.

Students with MS

Students entering the Ph.D. program with a Master's degree *may be exempted* from the preliminary examination provided that a review of the student's record by the PBE Graduate Studies Committee indicates that such action is justified.

The examination is to be completed prior to the beginning of the second semester during the first year of residency (*cf.* residency in General Information).

CANDIDACY EXAMINATION

Prior to beginning the doctoral thesis research, each student will be required to demonstrate the depth of her/his knowledge by successfully completing an examination when the course work is essentially complete. The candidacy exam is designed to assess the student's ability to successfully attack and solve an assigned problem using information acquired in formal courses and the published literature in association with the application of well-founded scientific judgment and acquired professional experience. Of the two examination prescribed alternatives, "forms" Paper Science and Engineering has traditionally employed and recommends selection of "Form 2". The procedures for the use of "Form 2" (in **Form 6A** of the "Handbook") are as follows: a faculty examining committee consisting of at least three persons will prepare a pool of suitable topics of which one will be selected and assigned to the student. *Five working days* after being assigned a topic, the student will meet with the examining committee to review his/her progress and to receive whatever instruction the committee deems necessary. Following the meeting, the student has *four weeks* to complete and submit to the committee a written comprehensive report on the topic and to prepare to discuss it during an oral examination. If the examination is failed, the student will be assigned a new topic and required to report the process outlined. A second failure will result in the student being terminated from graduate study. (Time limits, p. 26).

TOOLS OF RESEARCH

A candidate for the Ph.D. degree must show competence in *three* of the four following areas as manifested by passing an acceptable course with a "B" or better and/or as revealed in and through oral and written reports whose acceptability is certified by the student's steering committee.

- Computer Programming
- Advanced Mathematics (two courses beyond calculus) or statistics (two courses)
- Oral and Written Communication Skills
- Foreign Language (*i.e.* ability to utilize and/or translate technical articles from another language into English).

Elective Courses

Additional courses will be selected in consultation with the student's major professor with the aim of supporting the student's thesis research and/or to further a particular career objective. The courses may be selected from those offered by Paper & BioProcess Engineering, other units within the College or at neighboring Syracuse University, as appropriate (*cf.* Minor).

Seminars

Participation in seminars, including the preparation and presentation of technical material, is vital to the student's graduate education. The students are required to participate in graduate seminars, as follows: Each student is expected to participate in topic seminars, including presentations, as determined by the Faculty. This requirement can be fulfilled, with appropriate approval, by seminars offered at Syracuse University or the SUNY Health Sciences Center.

Research Credit

A degree candidate is required to complete a research-oriented thesis (Option 1 in "Handbook") for which will be awarded at least 12 but no more than 30 credits toward the total of 60 required for the degree. Options 2 and 3 in the "Handbook" are not recognized by Paper and BioProcess Engineering.

THESIS

To complete this degree, in addition to completion of necessary coursework, students prepare a thesis, which investigates a problem that initiates, expands or clarifies knowledge in the field. Students are required to define an appropriate problem for investigation; review relevant information; develop a study plan incorporating investigative techniques appropriate to the problem; implement the plan; and relate the results to theory or body of knowledge in the field. The student must successfully defend the thesis for degree completion. The thesis is prepared and bound according to College standards and deposited in Moon Memorial Library, and submitted for microfilming to UMI (*cf.* APPENDICES).

Thesis Seminar

Students completing the doctoral degree are required to present a "*Capstone Seminar*" on their thesis. The purpose of the capstone seminar is to provide an opportunity for the graduate student to present technical information to a critical body of professionals and peers. This seminar will be presented before the defense-of-

thesis examination. Each seminar is open to the College community and will be announced *one week* prior to presentation College-wide to encourage attendance by students and faculty. Students will formally register for Seminar (PSE 797, section 4, 1 credit hour) during their final semester and will be assigned a grade (A-F) by the department chair, after obtaining input from a section of the audience. A grade of "F" will require the seminar being repeated.

Thesis Defense Examination

Form 5A describes the procedures for the defense. **Form 5B** has to be sent to the Faculty Chair, who forwards it to the Dean of Instruction and Graduate Studies at least *one month prior to defense* to appoint the examination chair.



GRADUATE PROGRAM DESCRIPTION

AREAS OF STUDY

The general program of a student is implied by the title of the program in which the degree is awarded. The student's option is listed on the student's transcript as identified in the study plan. The following areas of study within the Paper Science and Engineering option are offered by the department.

Paper Science & Engineering Option

Research in this area may be conducted by the Empire State Paper Research Institute in conjunction with the Empire State Paper Research Associates, a global consortium of industry in pulp and paper. The institute and the consortium have had a historic and strong association for more than 62 years. Projects conducted in the department develop fundamental knowledge of pulp and paper processes with a strong industrial focus. Many research projects in this area have extensive connections to industrial organizations. Research is also supported by various US federal and NY state governmental agencies, sometimes in conjunction with private industrial partners as well as members of the Empire State Paper Research Associates.

PULPING & BLEACHING PROCESSES(MS, PHD)

- Reaction mechanisms and kinetics
- Applications of biotechnology
- Lignin and carbohydrate chemistry
- Chemicals from wood and pulping residues
- Energy from wood and pulping residues
- Chemical modification in mechanical pulping
- Catalytic and activation effects

This area of study focuses on chemical relationships and reactions basic to the manufacture and bleaching of pulp, as well as some papermaking operations. Courses in theoretical and applied chemistry are indicated, as well as specialized courses addressed directly to pulping and bleaching. Research centers on these same topics, currently stressing new and improved processes to increase energy efficiency and reduce environmental impact. These include studies on the pre-extraction of wood chips to produce acetic acid from acetyl groups, production of hydrogen and carbon monoxide from gasification of wood and pulping effluents, delignification and brightening with oxygen, hydrogen peroxide and ozone, enzyme treatment of effluent streams, mechanisms of carbohydrate reactions, and photosensitization of bleached pulps.

PARTICIPATING FACULTY: AMIDON, BUJANOVIC, FRANCIS, LAI, LIU

COLLOIDAL CHEMISTRY AND FIBER FLOCCULATION(MS, PHD)

- Paper sheet formation mechanisms
- Wet-end chemistry and physics
- Effects of additives in fiber networks

This study area deals with colloidal phenomena in the papermaking process, in particular the interaction among fibers, fine particles, polymeric additives, and electrolytes in stock preparation and sheet formation. Research topics fall into two categories: fundamental colloidal behavior of particles and behavior of paper stock on the paper machine. In the latter, extensive use is made of pilot plant facilities in Walters Hall. Current research projects include non-sulfur pulping, biopulping, chemicals and energy as byproducts, effects of wet pressing and press drying on sheet properties, pulping of tropical woods, and computer simulation and control of papermaking. Supporting this work is an experimental pulp and paper mill with two complete paper machines, a pressurized refiner and extensive auxiliary equipment.

PARTICIPATING FACULTY: AMIDON, BUJANOVIC, DOELLE, FRANCIS, RAMARAO, SCOTT.

FIBER & PAPER PHYSICS (MS, PHD)

- Fiber orientation and sheet properties
- Adsorption and transport of moisture in paper materials
- Mechano-sorptive phenomena

Mechanical behavior of fibers, paper and board, and other fiber networks and composites depends upon variables of material, process and structure at all levels, especially structural anisotropy. Recommended courses focus on mechanical and chemical engineering, mechanics of materials, physics, mathematics and statistics, microscopy, and wood and fiber properties. Research topics are basic in nature, designed to describe and model quantitatively the properties and behavior of fibers and fibrous structures. Current projects include studies of transient moisture sorption by paper materials, the effect of moisture on mechanical properties, influence of sheet structure on properties, use of image processing to characterize deformational behavior of paper, and determination of elastic constants of paper.

PARTICIPATING FACULTY: DOELLE, HANNA, RAMARAO, SCOTT.

PROCESS & ENVIRONMENTAL SYSTEMS ENGINEERING (MPS, MS, PHD)

- Energy from biomass and other renewable sources
- Bioseparations of lignocellulosic materials into useful components
- Bioprocessing of renewable materials
- Creation of new bioproducts using ecologically sustainable processes

Process engineering links research with development, design, operation, and optimization of manufacturing methods and equipment, seeking improvement through technological innovation consistent with environmental and resource stewardship. Principles of engineering science and mathematics are applied to analysis and dynamic modeling of units and systems, with increasing use of computers in both research and professional practice. Research here includes process dynamics and control, studies of new pulping and bleaching processes, characterization and treatment of waste streams, byproduct recovery, and computer simulation of paper processing systems. The extensive laboratories and pilot plant in Walters Hall are strongly supported by computing facilities and expertise on campus. Appropriate advanced courses in engineering, mathematics and computer science are available to suit individual student interests and needs.

PARTICIPATING FACULTY: CHATTERJEE, FRANCIS, LIU, RAMARAO, SCOTT.

PULP AND PAPER TECHNOLOGY (MPS)

- Pulping conditions and fiber properties
- Fungal and enzymatic treatments
- Chemicals and energy as byproducts
- Statistical analysis of paper structure
- Recycling of papermaking fibers

Studies in this area deal closely with processes involved in the manufacture of pulp and paper. Courses concerned with this subject are central to a student's program, extended and enriched with selected courses in chemistry, polymers, chemical engineering, process control, applied mathematics, and computer applications. Current research projects include non-sulfur pulping, biopulping, chemicals and energy as byproducts, effects of wet pressing and press drying on sheet properties, pulping of tropical woods, and computer simulation and control of papermaking. Supporting this work is an experimental pulp and paper mill with two complete paper machines, a pressurized refiner and extensive auxiliary equipment.

PARTICIPATING FACULTY: AMIDON, BUJANOVIC, DOELLE, FRANCIS, HANNA, LAI, LIU, SCOTT.

Bioprocess Engineering Option

Research in this area may be conducted by the Biorefinery Research Institute. Projects conducted in the department develop fundamental knowledge biorefinery processes for application in the production of a wide spectrum of industrial products and fuels from bioresources, primarily lignocellulosics. Research is also supported by various US federal and NY state governmental agencies, sometimes in conjunction with private industrial partners.

BIOCATALYSIS & BIOREACTION ENGINEERING (MS, PHD)

- Reaction mechanisms and kinetics
- Catalytic and activation effects
- Enzyme Chemistry, Engineering
- Fermentation Engineering
- Engineering of Bioreactors

Biocatalysis is the study of biological and chemical processes involving biocatalysts, enzymes and proteins. This area of study prepares students for traditional 'upstream' operations: principles of design and operation of bioreactors and fermenters. Chemical and biological processes often involve reactions at the interfaces of liquid and solid, and are frequently diffusion limited. Understanding of surface activities as well as effective modeling of the process kinetics enables the engineer to design processes with optimal yield, rate of reaction using appropriately sized equipment. These form the core of

most bioprocesses in the industry. Pilot plant facilities in these areas are also available.

PARTICIPATING FACULTY: AMIDON, CHATTERJEE, LIU, FIESCHKO, SCOTT.

BIOSEPARATIONS ENGINEERING (MS, PHD)

- Membrane Based Separations: Micro, Ultra & Nanofiltration; Functionalized membranes
- Adsorptive, Extractive and Reactive separations
- Solid Liquid separations: filtration, centrifugation
- Chromatographic separations
- Novel separation technologies: Simulated moving bed & expanded bed adsorption & chromatography

Bioseparations is the study of separation of valuable products from the output of bioreactors using the wide spectrum of unit operations. Traditional 'downstream' operations include membrane and chromatography processes. This area encompasses study of unit operations, separations, transport phenomena, thermodynamics, colloid and surface science and process engineering. There is extensive research effort and focus in this area. Current projects include membrane separations, adsorption, filtration, centrifugation, and novel separations based on functional materials. Pilot plant facilities in these areas are also available.

PARTICIPATING FACULTY: AMIDON, CHATTERJEE, DOELLE, LIU, FIESCHKO, FRANCIS, RAMARAO.

BIOPROCESS DESIGN, SIMULATION AND CONTROL (MS, PHD)

- Process Design
- Process Simulation, Dynamics, Control
- Batch Process Scheduling

This area of study involves the design, simulation and control of batch and continuous processes. Coursework is concentrated in process simulation, process analysis and dynamics and control. This is supplemented by studies in downstream and upstream processing. The dynamic operation and scheduling of batch plants is an important aspect of bioprocesses. Process economics are an important adjunct to the modeling of manufacturing processes. Pilot plant facilities in these areas are also available.

PARTICIPATING FACULTY: AMIDON, CHATTERJEE, FIESCHKO, RAMARAO, SCOTT.

BIOENVIRONMENTAL ENGINEERING (MS, PHD)

- Anaerobic and Aerobic Bioreactors
- Sludge & wastewater treatments

- Bacterial and enzymatic processes in environmental remediation

Bioenvironmental engineering links research with environmental and bioresource stewardship. Research here includes process dynamics and control, characterization and treatment of waste streams from bioprocesses, byproduct recovery, and computer simulation of environmental processing systems. The extensive laboratories and pilot plant in Walters Hall are strongly supported by computing facilities and expertise on campus. Pilot plant facilities in these areas are also available.

PARTICIPATING FACULTY: AMIDON, CHATTERJEE, FRANCIS, LIU, RAMARAO.

RENEWABLE ENERGY & BIOFUELS (MS, PHD)

- Energy from biomass and other renewable sources
- Bioseparations of lignocellulosic materials into useful components
- Bioprocessing of renewable materials
- Creation of new bioproducts using ecologically sustainable processes

This area of study encompasses both the use of renewable and sustainable resources (e.g., wood) for the production of chemicals, advanced materials, fuel, and energy, as well as the use of bioprocessing technology to produce such products. Such bioproducts extend to the production of energy from renewable resources including the use of gasification, co-firing of byproducts, anaerobic digestion, solar, and the production of ethanol. Courses include chemical engineering, advanced chemistry, biotechnology, and bioengineering, building on a strong base of mathematics, chemistry, and biology. Current research projects in this area include the bioseparation of xylan from hardwoods, the production of ethanol and acetic acid from wood hemicelluloses, development of separation processes for various bioproducts, gasification, enzymatic processing of lignocellulosic materials, and chemical production from sustainable resources as a replacement for non-renewable fossil fuels. Pilot plant facilities in these areas are also available. Many research projects in this area have extensive connections to industrial organizations.

PARTICIPATING FACULTY: AMIDON, BUJANOVIC, CHATTERJEE, DOELLE, LAI, LIU, FIESCHKO, FRANCIS, RAMARAO, SCOTT.

BIOPHARMACEUTICALS (MS & PHD)

- Upstream Processing, Bioreactors
- Downstream Processing

Biopharmaceuticals are typically biologically active proteins produced using recombinant bacterial and mammalian cells. Bioprocesses to produce biopharmaceuticals typically utilize microbial and

mammalian cell culture fermentation processes, tangential flow filtration, centrifugation and a variety of chromatographic separations. Principles of microbiology, fermentation technology, reaction kinetics, separation science, as well as statistical process control are used to develop highly reproducible processes that can produce consistent products necessary to meet GMP (good manufacturing practice) production requirements.

PARTICIPATING FACULTY: LIU, FIESCHKO, RAMARAO

INDUSTRIAL BIOLOGICAL PROCESSES (MS, PHD)

Biological processes have been used for centuries to produce wine, beer and fermented foods. As processes and manufacturing efficiencies have improved, products such as antibiotics, vitamins, enzymes, specialty chemicals and even commodity chemicals have and are being produced using bioprocesses. Bioprocesses for these applications typically employ microbial fermentation processes, filtration or centrifugation, precipitation and/or crystallization and drying. Principles of microbiology, fermentation technology, reaction kinetics, separation science and process economics are typically required to develop large cost efficient manufacturing processes.

PARTICIPATING FACULTY: LIU, FIESCHKO, RAMARAO,

BIOPROCESS ENGINEERING (MPS)

- Energy from biomass and other renewable sources
- Bioseparations of lignocellulosic materials into useful components
- Bioprocessing of renewable materials
- Creation of new bioproducts using ecologically sustainable processes

This area of study encompasses both the use of renewable and sustainable resources (e.g., wood) for the production of chemicals, advanced materials, fuel, and energy, as well as the use of bioprocessing technology to produce such products. Such bioproducts extend to the production of energy from renewable resources including the use of gasification, co-firing of byproducts, anaerobic digestion, solar, and the production of ethanol. Courses include chemical engineering, advanced chemistry, biotechnology, and bioengineering, building on a strong base of mathematics, chemistry, and biology. Current research projects in this area include the bioseparation of xylan from hardwoods, the production of ethanol and acetic acid from wood hemicelluloses, development of separation processes for various bioproducts, gasification, enzymatic processing of lignocellulosic materials, and chemical production from sustainable resources as a replacement for non-renewable fossil fuels.

Participating Faculty: AMIDON, BUJANOVIC, S. CHATTERJEE, DOELLE, FRANCIS, LAI, LIU, RAMARAO, SCOTT

Biomaterials Engineering Option

BIOCOMPOSITE MATERIALS, BIOPOLYMERS

- Paper, Cellulosic and Natural Fibrous Materials
- Natural Rolled Erosion Control Products
- Bacterial Cellulose and Polyesters
- Wood, Lignocellulosics based composites, Fiber based composites

Various composites incorporating materials derived from bioresources such as lignocellulosics are critical to the future of sustainable development. This research area is focused towards training students on the design and performance of various composites engineered from sustainable and renewable materials. Biopolymers such as polylactic acid (PLA) and polyhydroxyalkanoates (PHA) are of particular interest for production from plant or tree based resources. These polymers besides being produced from sustainable resources, degrade quickly in the environment and reduce the environmental footprint of the products. Therefore they contribute to sustainable living besides incorporating green processing principles. They also avoid the use of fossil carbon sources helping mitigate climate change effects in the environment.

PARTICIPATING FACULTY: AMIDON, BUJANOVIC, LAI, LIU, FIESCHKO, FRANCIS, RAMARAO;

BIOACTIVE MATERIALS AND BIOSENSORS.

- Bioactive Paper, Cellulosic and Natural Fibrous Materials
- E-Paper
- Photosensitive Polymers, Fibers & Materials
- Antimicrobial coatings, fibrous and nonwoven products

Novel and designed materials displaying significant biological activity e.g. antibody binding, antimicrobials, photosensitive or other kinds of stimuli responsive are being applied for a wide array of sensors and uniquely functional products. Wound and hygiene care, protective materials, identification materials are of interest.

PARTICIPATING FACULTY: AMIDON, BUJANOVIC, LAI, LIU, FIESCHKO, FRANCIS, RAMARAO;

NANOCOMPOSITES AND NANOSTRUCTURED MATERIALS.

- Nanocrystallites of cellulose from wood
- Nanostructured fibrous materials from lignocellulosics
- Functionalized nanomaterials from lignocellulosic raw materials

A new area of research is nanocomposites and nanostructured materials. Many components of plants and trees are nanostructured.

For example, cellulose microfibrils liberated from wood and plant cell walls can be incorporated into different polymers to yield composites of unique properties. These materials are usually derived from natural and renewable resources and contribute to sustainability.

PARTICIPATING FACULTY: AMIDON, LAI, LIU, FIESCHKO,
FRANCIS, RAMARAO;



Departmental Procedures

This chapter describes procedures followed in the department for graduate students. These are:

1. Graduate research projects & assignment of major professors
2. Graduate student financial assistance
3. Graduate Studies & Research Committee

1. Graduate research projects & assignments

During the first semester that a graduate student is registered, the student is assigned a research project and a major professor. For this purpose, the student visits with the departmental faculty and learns about the available research projects and the faculty interests. The student then fills in the research project interest listing his or her top preferences for thesis project and research advisor/major professor. Following this, all the newly admitted students submit the research project interest form (attached) to the graduate coordinator. A meeting of the graduate studies and research committee is held prior to the end of the semester when a matching between the faculty members' interests and students' interests in research projects is conducted. The students are notified of the research project selections after which they are encouraged to meet with their major professors and select the steering committee. The steering committee selection is sent to the chair/graduate studies coordinator. The PBE chair will send the recommendation to the college graduate studies office.

RESEARCH INTERESTS MATCHING FORM

TO BEGINNING GRADUATE STUDENTS THE DEPARTMENT OF PAPER & BIOPROCESS ENGINEERING:

Dear Student:

In order to assign thesis research advisors, the graduate studies and research committee in PBE has set up the following policy.

You are requested to meet with each of the faculty members in PBE and interview them either collectively or individually to determine the match between your research interests and the research projects that are available within the department. This should be completed by November 15, 2008. Even if you have decided on a choice of research topic and thesis advisor, we would like you to complete this process in order to familiarize yourself with the broad spectrum of our faculty members' research interests and available projects.

Please fill in the table below describing your top 3 choices for research project and advisor. The graduate studies and research committee will meet at the end of November to match student interests with research topics and advisors.

Research Faculty:

1. T. Amidon
2. B. Bujanovic
3. S. G. Chatterjee
4. K. Doelle
5. R. C. Francis
6. Y. Z. Lai
7. S. Liu
8. B. V. Ramarao
9. G. M. Scott

DATE:

STUDENT NAME: _____

PROGRAM : M. S. _____ Ph. D. _____
(Engineering & Applied Science)

OPTION: PAPER ENGINEERING _____
BIOPROCESS ENGINEERING _____

RESEARCH TOPICS:

FIRST CHOICE:
TOPIC:

MAJOR PROFESSOR (THESIS ADVISOR):

SECOND CHOICE:
TOPIC:

MAJOR PROFESSOR (THESIS ADVISOR):

THIRD CHOICE:
TOPIC:

MAJOR PROFESSOR (THESIS ADVISOR):

2. Graduate Student Financial Assistance

The department has a number of ways to provide financial assistance to graduate students. Generally speaking, the following are available.

1. State funded Graduate Assistant Positions: SGA – These positions are appointed by and are funded by the college. Graduate students are required to provide teaching assistance in various courses as assigned by the chair of PBE or the graduate studies coordinator, each semester. The positions are usually for the academic year although some may be for shorter duration.

2. Research Graduate Assistant Positions: - These positions are funded by research grants to faculty members or the departmental research groups. They are provided through the research foundation. These appointments usually run through a calendar year period although some may be of shorter duration as defined by the research grants.

3. Graduate Fellowships: - Graduate fellowships are provided by foundations and other agencies for the purpose of educating graduate students in various fields of interest. Assignment of these fellowships is through an application process first followed by selection by a committee of faculty formed for this purpose.

Some of the fellowships available in the department during the academic year 2008-2009 are:

1. Joachim Foundation Doctoral and Masters Fellowships
2. NSF-ESF K-12 Graduate Education Fellowships

Besides these fellowships, there maybe others which are available for graduate students through the college or outside charitable foundations. They are advised to contact the graduate coordinator/chair/graduate studies offices for further information.

4. Graduate Awards: - Each year competitive awards are given to graduate students for their graduate work. Three awards are usually given although more may be available depending on funding sources. The three are:

- a. Solvay Paperboard Graduate Award for the student demonstrating best record and research in recycling studies

b. The Renata Marton Distinguished Graduate Student Award given for the student best demonstrating excellence in graduate studies in PBE.

c. The Edwin C. Jahn memorial Award for student demonstrating excellence in graduate research, given by the Empire State Paper Research Institute.

These awards are made during the fall meeting of the Syracuse Pulp & Paper Foundation and/or the Empire State Paper Research Institute.

3. Graduate Studies and Research Committee

The graduate studies and research committee of the department of Paper and Bioprocess Engineering is responsible for developing the procedures outlined in this report. This committee is appointed by the department and meets approximately every month to discuss graduate studies & set policies in this regard. These are then modified & voted for approval in the departmental faculty meetings. The current (AY 2008-2009) graduate studies committee is comprised of:

Prof. B. V. Ramarao Chair

Dr. Y. Z. Lai

Prof. T. E. Amidon

Prof. Shijie Liu

Dr. Raymond Francis

Prof. Biljana Bujanovic

FLOWSHEET OF PROCEDURES

	FORMS	TIMING
Student is accepted to program		
Major professor is appointed	Forms 2A+B	End of Sem 1
Program of study	Form 3B (MS)	End of Sem 1
Semester plans	Form 4	End of Sem 1
Steering committee is appointed	Forms 2A+B	End of Sem 1
Request chair for thesis exam	Form 5B	
CAPSTONE seminar		
Defense of thesis exam	Form 5E	
Academic requirements completed	Form 9	
Student submits 4+ completed, signed theses	Microfilm. Diploma form, and fees	
Commencement and convocation		



SAMPLE GRADUATE PROGRAMS

Sample Courses Semester by Semester

MS Program

PSE Option

SEMESTER 1		
Course	Number	Credits
Pulping Technology	PSE 550	3
Paper Properties	PSE 668	3
Paper Coating and Conv	PSE 666	3
Thesis Research	PSE 899	3
SEMESTER 2		
Colloidal and Interfacial Sci	PSE 667	3
Papermaking Processes	PSE 665	3
Process Control	PSE 667	3
Thesis Research	PSE 899	3
SEMESTER 3		
Prof and Tech Writing	WRT 605	3
Thesis Research	PSE 899	3
Capstone Seminar	PSE 797	1

Ph D Program

SEMESTER 4		
Course	Number	Credits
Management in Paper Ind	PSE 656	3
Polymer properties	FCH 552	3
Materials and Proc in Mfg	MEE 636	3
Thesis Research	PSE 999	3
SEMESTER 5		
Chemical Eng Thermodyn	CEN 656	3
Thesis Research	PSE 899	9
SEMESTER 6		
Thesis Research	PSE 899	12
SEMESTER 7		
Thesis Research	PSE 899	6
Capstone Seminar	PSE 797	1

The student is expected to be knowledgeable in the areas of pulping and bleaching, paper properties, and papermaking, either through having passed these as an undergraduate (UG) at this College or by passing, with a grade of "B" or better, the corresponding graduate level courses (G). (Undergraduate level course credits may not be applied toward graduate degree course requirements).

Course	G
Pulping Technology	PSE 550
Paper Properties	PSE 668
Papermaking Processes	PSE 665

PSE 550 Principles of Pulping and Bleaching (3)

Two hours of lecture and three hours of laboratory per week plus literature study of assigned topics, independent project planning and/or laboratory study. Discussion of pulping and bleaching processes. Effects of chemical and physical variables on the wood components and pulp properties; chemistry involved. Experiments in pulping and bleaching and pulp evaluation. Spring.

Prerequisites: Organic, physical and analytic chemistry.

PSE 570 Principles of Mass and Energy Balances (3)

Three hours of lecture per week. Conservation of mass and energy applied to steady-state and dynamic process units and systems. Problem analysis and solution; computational techniques. Thermodynamic data and their use; real vs. perfect gases; steam properties; psychrometry. Computer simulation of steady and non-steady state process systems. Fall.

Prerequisites: Physics, Calculus, and General Chemistry. Note: Credit will not be granted for both PSE 370 and PSE 570.

PSE 571 Fluid Mechanics (3)

Three hours of lecture per week. Fluid statics. Principles of mass, energy and momentum balance. Bernoulli's equation. Application to pipe flows, flow measurement and porous media. Movement of particles in fluid media. Rheology of fluids and suspensions typical in the pulp and paper industry (pulp, black liquor, etc.) Filtration and sedimentation of fibrous and particulate suspensions. Characteristics of pumps. Flow systems with economic considerations. Analysis of some papermaking operations such as drainage, dewatering, vacuum dewatering and wet pressing. Fall.

Prerequisites: Physics, Chemistry, Calculus. Note: Credit will not be granted for both PSE 371 and PSE 571.

PSE 596 Special Topics (1 - 3)

Lectures, conferences, discussions and laboratory. Topics in environmental and resource engineering not covered in established courses. Designed for the beginning graduate student or selected upper-division undergraduate. Fall and/or Spring.

PSE 656 Management in the Paper Industry (3)

Three hours of lecture per week. Provides the student with interactive contact with active executives in the paper and allied industries. The student will develop and present studies of business cases in discussion forum to the class. An understanding of how general managers operate to manage an entire organization will be presented by visiting experts, class participation, group presentations, written papers, and examinations. The student will critically review selected literature and present their findings. Spring.

Note: Credit will not be granted for both PSE 456 and PSE 656.

PSE 665 Paper Properties (4)

Three hours of lecture, three hours of laboratory per week and discussion plus evaluation of literature, independent project planning and/or laboratory study. Evaluation and study of the physical, optical and chemical properties of paper and the interrelationships existing among paper manufacturing methods, papermaking additives, test results and the ultimate properties desired in the finished paper. Fall.

Prerequisite: Permission of instructor. Note: Credit will not be granted for both PSE 465 and PSE 665.

PSE 666 Paper Coating and Converting (3)

Three hours of lecture per week. Evaluation and study of the various coating materials and processes used by the paper industry. Introduction to polymers and their use in converting operations, fundamentals and parameters which control their use, effects on final properties of papers. Spring.

Prerequisite: ERE 677. Note: Credit will not be granted for both PSE 466 and PSE 666.

PSE 667 Colloidal and Interface Science Applications in Papermaking (3)

Three hours of lecture per week. Provides the student with the fundamental principles of Colloidal and Interface Science as it relates to the interaction of papermaking materials and chemical additives in the wet end of a paper machine system. The topics of retention

of fine solids and dewatering are addressed in detail. Spring.

Pre- or co-requisite: Physical chemistry.

PSE 668 Papermaking Processes (3)

Two hours of lecture and three hours of laboratory per week. Study of the papermaking process from theoretical and practical standpoints featuring the operation of the pilot paper machines. Emphasis is on the fundamentals of stock preparation and paper machine operations, papermaking process and product design, evaluation of the finished product, and the collection and analysis of process data. An independent project is required in conjunction with the undergraduate paper machine runs. Spring.

Pre- or co-requisite(s): PSE 300, PSE 370, PSE 665. Note: Credit will not be granted for both PSE 468 and PSE 668.

PSE 677 Process Control (3)

Three hours of lecture per week. Presents an introduction to the principles of process control. Linear analysis, Laplace transforms, and nonlinear simulation are presented and applied to feedback, and feedforward control. Examples of process simulation, accuracy and stability of control are drawn from paper industry processes. Process identification using numerical techniques and MATLAB. Fall.

Prerequisite: Differential Equations. Note: Credit will not be granted for both PSE 477 and PSE 677.

PSE 796 Advanced Topics (1 - 3)

Lectures, conferences, discussions and laboratory. Advanced topics in forest engineering, paper science and engineering, and wood products engineering. Fall and/or Spring.

Prerequisite: Permission of instructor.

PSE 797 Seminar (1 - 3)

Discussion of assigned topics in the fields related to Paper Science Engineering. Spring and Fall.

PSE 798 Research in Paper Science Engineering (1 - 12)

Independent research topics in Paper Science Engineering. Fall, Spring or Summer. Credit hours to be arranged.

PSE 898 Professional Experience/Synthesis (1 - 6)

A supervised, documented professional work experience in the Master of Professional Studies degree program. Fall, Spring, or Summer.

Pre- or co-requisite(s): Approval of proposed study plan by advisor, Faculty, and any sponsoring organization.

PSE 899 Master's Thesis Research (1 - 12)

Research and independent study for the master's thesis. Fall, Spring or Summer.

Credit hours to be arranged.

PSE 999 Doctoral Thesis Research (1 - 12)

Research and independent study for the doctoral dissertation. Fall, Spring or Summer.

Credit hours to be arranged.

BPE Option

MS Program

SEMESTER 1		
Course	Number	Credits
Microbiology	BPE 501	3
Bioseparations	BPE 620	3
Paper Coating and Conv	PSE 666	3
Thesis Research	BPE 899	3
SEMESTER 2		
Colloidal and Interfacial Sci	PSE 667	3
Bioreaction Eng	BPE 621	3
Bioprocess Design	BPE 681	3
Thesis Research	BPE 899	3
SEMESTER 3		
Prof and Tech Writing	WRT 605	3
Thesis Research	BPE 899	3
Capstone Seminar	BPE 797	1

Ph D Program

SEMESTER 4		
Course	Number	Credits
Biomass Energy	BPE 641	3
Polymer properties	FCH 552	3
Biorefinery Proc	BPE 680	3
Thesis Research	BPE 999	3
SEMESTER 5		
Chemical Eng Thermodyn	CEN 656	3
Thesis Research	BPE 899	9
SEMESTER 6		
Thesis Research	BPE 899	12
SEMESTER 7		
Thesis Research	BPE 899	6
Capstone Seminar	BPE 797	1

All graduate students will be required to take 9 credits of coursework from the following 3 groups. At least 3 credits must be taken from each of A, B and C. Students may obtain credit for equivalent courses taken elsewhere upon approval of the steering committee and appropriate petition procedures.

Option	Core Course Groups		
	Group A	Group B	Group C
PSE	Pulping & Bleaching Wood Chemistry	Papermaking Processes	Paper Properties
BPE	Biochemistry Wood Chemistry Microbiology Pulping & Bleaching	Transport Phenomena Bioseparations Colloidal Science	Bioprocess Kinetics Reaction engineering Process Design Advanced Thermodynamics Catalysis

BPE 501 Bioprocess Microbiology (3)

Two hours of lecture and three hours of laboratory/discussion per week. Topics include general microbiology, enzymology, enzyme kinetics, biochemistry, metabolic regulation, microbial growth and product formation (with general stoichiometry), media formulation and bioprocess design including batch, fed-batch, and continuous modes, techniques for product recovery and purification, and mammalian cell lines/culture. Microbiological growth media, batching, and the operation of bench-top bioreactors and various analytical instrumentation. Fall.

Prerequisites: Permission of instructor; basic understanding of chemistry and biology; appropriate quantitative skills.

BPE 535 Transport Phenomena (3)

Three hours of lecture per week. Principles of heat and mass transfer as applied to the bioprocess industries. Topics include conduction, convective heat and mass transfer, diffusion of both steady-state and transient situations, analogies for heat and mass transfer, boundary layers, porous media transport, heat and mass transfer analysis. Discussion of specific bioprocess examples. Spring.

Note: Credit will not be granted for both BPE 335 and BPE 535.

BPE 596 Special Topics (1 - 3)

Lectures, conferences, discussions and laboratory. Topics in environmental and resource engineering not covered in established courses. Designed for the beginning graduate student or selected upper-division undergraduate. Fall and/or Spring.

BPE 620 Bioseparations (3)

Three hours of lecture per week. Cell disruption, solid liquid separations, centrifugation, chromatographic techniques (gel filtration, affinity, ion exchange), and membrane processes. Extraction. Crystallization and drying. Aseptic filtration. Fall.

Prerequisite: BPE 501. Note: Credit will not be granted for both BPE 620 and BPE 420.

BPE 621 Bioreaction Engineering (3)

Three hours of lecture/discussion per week. Bioprocess kinetics, reaction engineering, mass and energy balances, stoichiometry, enzyme kinetics, growth and product synthesis kinetics, mass transfer effects, bioreactor analysis and design, instrumentation and control, batch processing, bioreactor scale-up, agitation, oxygen delivery, heat removal and kinetics of sterilization (clean and sterilization in place (CIP and SIP). Spring.

Prerequisites: Mass and Heat Transfer, or Transport Phenomena. Note: Credit will not be granted for both BPE 621 and PBE 421.

BPE 641 Biomass Energy (3)

Three hours of lecture per week. Historical, current and future uses of biomass as a source of renewable energy for the production of bioenergy, biofuels and bioproducts. Characteristics of biomass, their conversion to different forms of energy and end products and an assessment of their sustainability. Spring.

Prerequisite: ESC 525, ESC 535 or permission of instructor; one semester of freshman chemistry or permission of instructor.

BPE 680 Introduction to Biorefinery Processes (3)

Forty five hours of lecture and discussions. Topics covered in this course include chemical and physical properties of biomass feedstocks; chemical processes and biological processes associated with converting plant biomass and agricultural residues to chemicals, liquid fuels, and materials. Discussions will be more geared towards green chemistry and/or environmentally benign processes. While discussions will lead to political and policy trends on sustainability and renewability, more engineering and engineering science aspects will be covered. Fall.

Prerequisite(s): ERE 542 or BPE 421. Co-requisite(s): BPE 542

BPE 681 Bioprocess Plant Design (3)

Three hours of lecture per week. Topics covered include integration of process and support systems and equipment; concepts of facility design integrating Good Manufacturing Practice (GMP), equipment and systems cleanability, people flow, product protection, capital investment, and operating costs. This course will focus towards facility design in the biopharmaceutical industry. Spring.

Prerequisites: BPE 620, BPE 621 or equivalents.

BPE 796 Advanced Topics (1 - 3)

Lectures, conferences, discussions and laboratory. Advanced topics in forest engineering, paper science and engineering, and wood products engineering. Fall and/or Spring.

Prerequisite: Permission of instructor.

BPE 797 Seminar (1 - 3)

Discussion of assigned topics in the fields related to Bioprocess Engineering. Spring and Fall.

BPE 798 Research in Bioprocess Engineering (1 - 12)

Independent research topics in Bioprocess Engineering. Fall, Spring or Summer.

Credit hours to be arranged.

BPE 898 Professional Experience/Synthesis (1 - 6)

A supervised, documented professional work experience in the Master of Professional Studies degree program. Fall, Spring, or Summer.

Pre- or co-requisite(s): Approval of proposed study plan by advisor, Faculty, and any sponsoring organization.

BPE 899 Master's Thesis Research (1 - 12)

Research and independent study for the master's thesis. Fall, Spring or Summer.

Credit hours to be arranged.

BPE 999 Doctoral Thesis Research (1 - 12)

Research and independent study for the doctoral dissertation. Fall, Spring or Summer.

Credit hours to be arranged.

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