Office of the Registrar
FORM 40G REV. 4/10

PURDUE UNIVERSITY
REQUEST FOR ADDITION, EXPIRATION,
OR REVISION OF A GRADUATE COURSE
(50000-60000 LEVEL)

Graduate Council Doc. No. 12-47a
EFD 45-12

DEPARTMENT: School of Chemical Engineering
EFFECTIVE SESSION: ~~Spring 2013~~ Fall 2013 (20141D)

INSTRUCTIONS: Please check the items below which describe the purpose of this request.

- [x] 1. New course with supporting documents (complete proposal form)
- [ ] 2. Add existing course offered at another campus
- [ ] 3. Expiration of a course
- [ ] 4. Change in course number
- [ ] 5. Change in course title
- [ ] 6. Change in course credit/type
- [ ] 7. Change in course attributes
- [ ] 8. Change in instructional hours
- [ ] 9. Change in course description
- [ ] 10. Change in course requisites/restrictions
- [ ] 11. Change in semesters offered
- [ ] 12. Transfer from one department to another

PROPOSED:		EXISTING:	
Subject Abbreviation	CHE	Subject Abbreviation	
Course Number	53800	Course Number	
Long Title	Design and Processing of Particulate Products		
Short Title	Des & Proc of Particulate Prod		

Abbreviation will be entered by the Office of the Registrar if omitted. (30 CHARACTERS ONLY)

TERMS OFFERED
Check All That Apply:
[x] Fall [x] Spring [ ] Summer

CAMPUS(ES) INVOLVED
[ ] Calumet [ ] N. Central
[ ] Cont Ed [ ] Tech Statewide
[ ] Ft. Wayne [x] W. Lafayette
[ ] Indianapolis

CREDIT TYPE
1. Fixed Credit: Cr. Hrs. 3
2. Variable Credit Range:
Minimum Cr. Hrs
(Check One) To [ ] Or [ ]
Maximum Cr. Hrs
3. Equivalent Credit: Yes [ ] No [x]
4. Thesis Credit: Yes [ ] No [x]

COURSE ATTRIBUTES: Check All That Apply
1. Pass/Not Pass Only [ ]
2. Satisfactory/Unsatisfactory Only [ ]
3. Repeatable [ ]
Maximum Repeatable Credit [ ]
4. Credit by Examination [ ]
5. Special Fees [ ]
6. Registration Approval Type
Department [ ] Instructor [ ]
7. Variable Title [ ]
8. Honors [ ]
9. Full Time Privilege [ ]
10. Off Campus Experience [ ]

Schedule Type	Minutes Per Mtg	Meetings Per Week	Weeks Offered	% of Credit Allocated
Lecture	50	3	16	100
Recitation				
Presentation				
Laboratory				
Lab Prep				
Studio				
Distance				
Clinic				
Experiential				
Research				
Ind. Study				
Pract/Observ				

Cross-Listed Courses

2013 FEB 25 AM 9:3
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COURSE DESCRIPTION (INCLUDE REQUISITES/RESTRICTIONS):
Pre-requisites: CHE34800 or CHE37800.
Characterization particulate systems, use of population balances to describe processes that make or transform particles, applications in important unit processes including crystallization, granulation, milling, aerosol processes. Professor Litster.

Calumet Department Head	Date	Calumet School Dean	Date	Calumet Undergrad Curriculm Committee	Date
Fort Wayne Department Head	Date	Fort Wayne School Dean	Date	Fort Wayne Chancellor	Date
Indianapolis Department Head	Date	Indianapolis School Dean	Date	Undergrad Curriculm Committee	Date
AVarma 7/1/2012				APPROVED 2/21/13	
North Central Department Head	Date	North Central School Dean	Date	Date Approved by Graduate Council	
			11/9/12	Tria L. Payne 2/22/13	
West Lafayette Department Head	Date	West Lafayette College/School Dean	Date	Graduate Council Secretary	Date
2/21/13				Sandra Schaller 3/18/13	
Graduate Area Committee Convener	Date	Graduate Dean	Date	West Lafayette Registrar	Date

OFFICE OF THE REGISTRAR

(Grad Form 40G [Excel format] - Does not include the Graduate Council's required supporting document. See pdf version of Form 40G)

45-12 VD 3/12/13

To: Faculty of the College of Engineering

From: Faculty of the School of Chemical Engineering

RE: New 500 level Course, CHE 53800, Design and Processing of Particulate Products

The faculty of the School of Chemical Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

CHE 53800: Design and Processing of Particulate Products
Sem 1 or 2, cr. 3, LEC 3
Pre-requisites: CHE34800 or CHE37800

Description: Characterization particulate systems, use of population balances to describe processes that make or transform particles, applications in important unit processes including crystallization, granulation, milling, aerosol processes.

Reason: The course has been taught as Particle Design and Process CHE 59700, in the spring 2008 semester with 9 students, in the fall 2009 semester with 20 students, in the spring 2011 semester with 26 students, and in the fall 2012 semester with 45 students.

AVarma

A. Varma, Head
School of Chemical Engineering
Date: 7/1/12

APPROVED FOR THE FACULTY
OF THE SCHOOLS OF ENGINEERING
BY THE ENGINEERING
CURRICULUM COMMITTEE

ECC Minutes 11/12/12

Date 11/29/12

Chairman ECC

CHE 53800 Design and Processing of Particulate Products

Level: **500, undergraduate and graduate**
Credit hours: **3**
Instructor: **Jim Litster**
FRNY G027A
jlitster@purdue.edu

Purpose of the course

Particle design is the production of new particles with specific attributes. These attributes are controlled by the size, morphology and surface properties of the particles that are produced. To control these attributes, both the particle formation processes and the feed formulation properties need to be controlled. There are many particle design processes including crystallisation and precipitation; granulation; jet break up and spray drying; aerosol processes; chemical vapour deposition; suspension polymerisation; and grinding.

The products of interest are many and varied including protein and other biological materials, pharmaceuticals, detergents and consumer goods, foods, ceramics and high value materials, fertilizers and agricultural chemicals, and minerals. Estimates by the chemical industry (i.e. DuPont) are that **over 80%** of the products are in the form of particles either as delivered or during manufacturing. This course will study a series of particulate design processes with special emphasis on design and operation to control particle attributes. Therefore, this course teaches skills that are currently in high demand.

Course learning goals

1. Learn the definition of some key particle properties and appreciate the critical importance of particle characterization in the design of particulate processes.
2. Gain an understanding of the population balance as a way of analyzing particulate processes and be able to apply it to a new, unseen problem.
3. Gain an understanding of important science underlying many particulate processes including powder wetting and particle mechanics.
4. Use a combination of this science base, prior chemical engineering knowledge and the population balance to solve design and operating problems in crystallization, granulation, grinding, spray drying and aerosol processes.
5. Become familiar with some of the typical engineering equipment used for each process studied.

Course Notes

A set of course notes is available at the Boiler Copy Shop in the PMU. The notes consist of outlines for each module, powerpoint slides for lectures, and some written text book style notes. It is **essential** that students bring these notes to class. Some additional notes will be prepared during semester and these will be made available via the course blackboard site.

Recommended Texts

The Science and Engineering of Granulation Processes, Jim Litster and Bryan Ennis, Kluwer Press, 2004. (Call number: 620.43 Sci27 2004). [Note that this text will be replaced by a new text: *Particulate Products and Processes* , Jim Litster and Carl Wassgren, which is currently being prepared under a contract from Cambridge University Press.]

The following references are recommended reading and will be held in reserve at the library.

Allen, T., 2003. Powder Sampling and Particle Size Measurement, 1st Edition, Elsevier, Amsterdam. (Call Number: 620.43 AL54po 2003) .

Masters, K, 2002. Spray Drying in Practice, 7th Edition, Longman, (Call Number: 660.28426 M393s 1985)

Mullin, J.W, 2001. Crystallisation, 4th Edition, Butterworth Heinmann, Oxford. (Call Number: 660.284298 M917c 2001)

Perry, R.H., Green, D.W. & Maloney, J.O., 2008. Perry's Chemical Engineers Handbook, 8th edition, McGraw-Hill, New York. (Call Number: 660 C418 2008)

Rhodes, M. J. , 2008. Introduction to Particle Technology (2nd ed.), John Wiley, Chichester; New York . (Call Number: 620.43 R346i 2008)

Unit outlines in the course notes also give bibliographies for further reading.

Other Resources

Additional resource and links, homework problems and solutions will be posted on the blackboard website throughout the semester.

Teaching and learning methods

A variety of teaching and learning approaches will be used in this course. Each unit will be introduced with a problem or case study. Classes will vary to suit the topic under study and will include a mix of lectures, structured tutorials, demonstrations and group based workshops. All classes will be organized to maximize interaction between the instructor and the students. The emphasis will be on developing a strong understanding of scientific basics and tools for analysis, rather than a descriptive presentation of equipment and processes.

Syllabus and Schedule

Unit Titles

1. Particle characterization and the population balance
2. Crystallization
3. Granulation
4. Grinding
5. Spray Drying and Prilling

Unit outlines give the learning goals and resources for each unit in detail.

Schedule

Week 1 to 3	Introduction, Unit 1
Week 4 to 6	Unit 2
Week 7 to 9	Unit 3
Week 10 to 11	Unit 4
Week 12 to 13	Unit 5
Week 14 to 15	Student project presentations and course review

Assessment

Assessment Item	Date	Weighting
Unit problems & workshops	Continuous	10%
Mid Term Exam 1	TBA	20%
Mid Term Exam 2	TBA	20%
Team project	TBA	20%
Final Exam	Exam week	30%

Unit problems: A set of tutorial problems will accompany each unit. These are to be done as homework. Class problem solving sessions are timetabled to help students with these tasks. Students may hand in problem solutions for feedback. Worked solutions will be provided. ***The tutorial problems are good preparation for the three exams.*** Some computer lab workshops using gProms software will be run. 10% of the grade will be for completing the workshop exercises, some of which will need to be completed out of class time.

Exams: The exams will be open book. Questions will predominantly test students' ability to solve engineering problems using the concepts covered in the course. The first two exams will be on Unit 1 and Unit 2 respectively. The final two hour exam will assess the whole course, but will be weighted heavily towards units 3, 4 and 5.

Team project: Students will work in teams of three or four students on a realistic and open ended problem on some aspect of particle design and processing. The project will involve problem definition, planning, request for laboratory data (but no laboratory work by the student team), developing a model using gProms, an oral presentation and written

report. Full details of assessment criteria and timetable will be handed out with the project description.

Grades: The overall mark for the course will be the weighted average of the marks for each assessment item. The minimum overall mark to achieve each grade is likely to be: A (85%), A- (82%), B+ (78%), B (75%), B- (72%), C+ (68%), C (65%), C- (62%), D+ (58%), D (54%), D- (50%). Some cut offs may be reduced depending on the difficulty of assessment items.

CHE 53800

EFD 45-12

Supporting Document for a New Graduate Course

To: Purdue University Graduate Council

From:
Faculty Member: Jim Litster
Department: Chemical Engineering
Campus: West Lafayette

Date: July 1, 2012

Subject: Proposal for New Graduate Course-Documentation Required by the Graduate Council to Accompany Registrar's Form 40G

For Reviewer's comments only (Select One)

Reviewer:

Comments:

Contact for information if questions arise:
Name: Karissa Raderstorf
Phone Number: 765.494.0756
E-mail: Kraderstorf@purdue.edu
Campus Address: FRNY 1057

Course Subject Abbreviation and Number: CHE 53800

Course Title: Design and Processing of Particulate Products

A. Justification for the Course:

- Provide a complete and detailed explanation of the need for the course (e. g., in the preparation of students, in providing new knowledge/training in one or more topics, in meeting degree requirements, etc.), how the course contributes to existing majors and/or concentrations, and how the course relates to other graduate courses offered by the department, other departments, or interdisciplinary programs.

- Justify the level of the proposed graduate course (50000- or 60000-level) including statements on, but not limited to: (1) the target audience, including the anticipated number of undergraduate and graduate students who will enroll in the course; and (2) the rigor of the course.

B. Learning Outcomes and Method of Evaluation or Assessment:

- Describe the course objectives and student learning outcomes that address the objectives (i.e., knowledge, communication, critical thinking, ethical research, etc.).

- Describe the methods of evaluation or assessment of student learning outcomes. (Include evidence for both direct and indirect methods.)

- Grading criteria (select from dropdown box); include a statement describing the criteria that will be used to assess students and how the final grade will be determined.

Criteria | Exams and Quizzes

- Identify the method(s) of instruction (select from dropdown box) and describe how the methods promote the likely success of the desired student learning outcomes.

Method of Instruction | Lecture

C. **Prerequisite(s):**

- List prerequisite courses by subject abbreviation, number, and title.
- List other prerequisites and/or experiences/background required. If no prerequisites are indicated, provide an explanation for their absence.

D. **Course Instructor(s):**

- Provide the name, rank, and department/program affiliation of the instructor(s).
- Is the instructor currently a member of the Graduate Faculty? X Yes — No
  (If the answer is no, indicate when it is expected that a request will be submitted.)

E. **Course Outline:**

- Provide an outline of topics to be covered and indicate the relative amount of time or emphasis devoted to each topic. If laboratory or field experiences are used to supplement a lecture course, explain the value of the experience(s) to enhance the quality of the course and student learning. For special topics courses, include a sample outline of a course that would be offered under the proposed course.

F. **Reading List (including course text):**

- A primary reading list or bibliography should be limited to material the students will be required to read in order to successfully complete the course. It should not be a compilation of general reference material.
- A secondary reading list or bibliography should include material students may use as background information.

G. **Library Resources**

- Describe the library resources that are currently available or the resources needed to support this proposed course.

H. **Example of a Course Syllabus** (While not a necessary component of this supporting document, an example of a course syllabus is available, for information, by clicking on the link below, which goes to the *Graduate School's Policies and Procedures Manual for Administering Graduate Student Programs*. See Appendix K.)
http://www.gradschool.purdue.edu/downloads/Graduate_School_Policies_and_Procedures_Manual.pdf

CHE 53800

EFD 45-12

Supporting Document for a New Graduate Course – Addendum

A. Justification for the Course:

This course has been taught as Particle Design and Process CHE 59700, in the spring 2008 semester with 9 students, in the fall 2009 semester with 20 students, in the spring 2011 semester with 26 students, and in the fall 2012 semester with 45 students. After review of the increasing course enrollment, it was recognized that these skills the course offers are in high demand and in an area we must regularly offer to our students.

B. Learning Outcomes and Method of Evaluation Assessment:

The key learning objectives for the course are:

- Learn the definition of some key particle properties and appreciate the critical importance of particle characterization in the design of particulate processes.
- Gain an understanding of the population balance as a way of analyzing particulate processes and be able to apply it to a new, unseen problem.
- Gain an understanding of important science underlying many particulate processes including powder, wetting and particle mechanics.
- Use a combination of this science base, prior chemical engineering knowledge and the population balance to solve design and operating problems in crystallization, granulation, grinding, spray drying and aerosol processes.
- Become familiar with some o the typical engineering equipment used for each process studied.

Course grades will be based on the following components: unit problems & workshop (10%), exam 1 (20%), exam 2 (20%), team project (20%) and a final exam (30%).

The overall mark for the course will be the weighted average of the marks for each assessment item. The minimum overall mark to achieve each grade is likely to be: A (85%), A- (82%), B+ (78%), B (75%), B- (72%), C+ (68%), C (65%), C- (62%), D+ (58%), D (54%), D- (50%).

Grading criteria

- Exams and Quizzes
- Papers and Projects

Method of Instruction

- Lecture
- Tutorials
- Demonstrations
- Group Workshops

CHE 53000

EFD 45-12

Prerequisite(s):

CHE 34800: Chem Reaction Engr or CHE 378000: Heat & Mass Transfer

C. Course Instructor(s):

James D Litster, Professor of Chemical Engineering, Professor of Industrial and Physical Pharmacy, Director, Graduate Studies, School of Chemical Engineering, West Lafayette campus

D. Course Outline:

Unit 1: Particle characterization and the population balance
Unit 2: Crystallization
Unit 3: Granulation
Unit 4: Grinding
Unit 5: Spray Drying and Prilling

E. Reading List:

The Science and Engineering of Granulation Processes, Jim Litster and Bruan Ennis, Kluwer Press, 2004. (Call number: 620.43 Sci27 2004).

*Note that this text will be replaced by Particulate *Products and Processes*, Jim Litster and Carl Wassgren, which his currently being prepared under a contract from Cambridge University Press.

F. Library Resources:

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Perry, R.H., Green, D.W. & Maloney, J.O., 2008. Perry's Chemical Engineers Handbook, 8th edition, McGraw-Hill, New York. (Call Number 660 C418 2008)

Rhodes, M. J., 2008. Introduction to Particle Technology (2nd ed.), John Wiley, Chichester; New York. (Call Number: 620.43 R346i 2008)

G. Example of Course Syllabus: