TO: The Engineering Faculty

FROM: The Faculty of the Department of Agricultural and Biological Engineering

RE: New Course – ABE 50501, Particle, Powder, and Compact Characterization

The Faculty of the Department of Agricultural and Biological Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

FROM:

ABE 59100 Characterization of Particles, Powders, and Compacts Sem 2 (every other odd spring semester), Class 1, Cr 2
Pre/Co-Requisites: None
Restrictions: Upper-division (senior-level status and above)
Cross-listed: ME 59700 (temp #)/ME 53201 (permanent#)
Temporary course number. The course has been taught Spring 2010 (9), Fall 2011 (15), Spring 2013 (12), Spring 2015 (15), Spring 2017 (9), Spring 2019 (17), Spring 2021 (15) with relative consistency.

TO:

ABE 50501 Particle, Powder, and Compact Characterization Sem 2, Class 1, Cr 2
Pre/Co-Requisites: None
Restrictions: Upper-division (senior-level status and above)
Cross-listed course: ME 53201

Course Description: The goal of this course is to familiarize students with the properties and methods used to characterize the physical and mechanical behavior of particles, granules, and compacts with the intention of using these properties for process and performance design.

Reason: This course has previously been offered as an ABE 59100 course titled "Characterization of Particles, Powders, and Compacts" six times since 2010. The course has been cross-listed with ME 59700 and will now be cross-listed with ME 53201 which has been approved.

Details of this course are outlined in the appended material below.

Nathan S. Mosier, Head
Department of Agricultural and Biological Engineering

ME 53101/ABE 50501
Particle, Powder, and Compact Characterization

Course Outcomes [Related ME Program Outcomes in brackets]

1. Define and describe the significant properties of particles, granules, powders, and compacts. [1]
2. Explain how these properties are measured. [1]
3. Illustrate how these properties influence the performance of particle-based products and manufacturing processes. [1]
4. Create a computational or a web-based tool that demonstrates or implements concepts from the course. [1,2,3,5]

Introduction and Fundamentals
(1 week)

1. Importance of characterization
2. Material sampling

Particle characterization
(4 weeks)

1. Particle size characterization
2. Particle size distributions
3. Particle and granule shape, texture, surface area, porosity, and density
4. Particle adhesion

Powder characterization
(2.5 weeks)

1. Powder bulk density and compressibility
2. Powder flow
3. Constitutive laws

Compact characterization (2.5 weeks)

1. Mechanical properties
2. Friction and coefficient of restitution

COURSE NUMBER: Part Powd Comp Charact/ME 53101/ABE 50501	**COURSE TITLE: Particle, Powder, and Compact Characterization** (2) **SHORT TITLE (max 30 char):** Part Powd Comp Charact
REQUIRED COURSE OR ELECTIVE COURSE: Elective	**PROPOSED EFFECTIVE TERM:** Spring 2023 **TERMS OFFERED:** Spring semester (once every two years)
JUSTIFICATION FOR THE COURSE: Particulate materials are common in industrial practice. For example, approximately one-half of the products and at least three-quarters of the materials in the chemical industry are in granular form. Despite their ubiquity, a recent study found that 80% of solids processing facilities had solids handling difficulties. Furthermore, these facilities typically only reached between 40-50% of their design capacity. Unfortunately, most engineering students in the U.S. have no exposure to particulate materials. This course is the only one at Purdue to describe the physical and mechanical characteristics of particulate materials and the methods used to measure these properties. This course is foundational since other particle-related courses will build on this knowledge. This course is part of a goal to provide the knowledge, tools, and trained workforce needed to effectively design and manufacture particulate products.	**JUSTIFICATION OF THE NEED FOR THE COURSE**: Purdue, currently has more than 30 faculty with research interests involving particulate materials. The faculty research areas include pharmaceuticals, agricultural materials, energetic materials, chemicals, consumer products, food products, battery materials, and ceramics. This course teaches the fundamentals of particle, powder, and compact characterization to students who work in these research areas and other allied subjects and prepare them for careers in particle science and engineering. It is the only course at Purdue that focuses on this foundational topic. Enrollment over the last six offerings has consistently been on the order of 10 to 20 students, with students from a variety of engineering disciplines.
JUSTIFICATION THAT THE COURSE WILL BE TAUGHT AT GRADUATE LEVEL: This course is taught at the graduate level since students would benefit from prior exposure to courses on mechanics of materials and fluid mechanics, which are typically taught at the undergraduate level. In addition, this course will support student and faculty research activities in the field of particle science and engineering.	**JUSTIFICATION FOR ONLINE/DISTANCE DELIVERY: N/A**
TEXTBOOK/REQUIRED MATERIAL: None	**PRE-REQUISITIES:** **ATTRIBUTES**: Upper Division (senior status and above) **RESTRICTIONS:** **COURSE REPEATABLE?** Yes
COORDINATING FACULTY: Carl Wassgren, Kingsly Ambrose	
COURSE DESCRIPTION: The goal of this course is to familiarize students with the properties and methods used to characterize the physical and mechanical behavior of particles, granules, and compacts with the intention of using these properties for process and performance design.	**COURSE OUTCOMES** [Related ME Program Outcomes in brackets]: 1. Define and describe the significant properties of particles, granules, powders, and compacts. [1] 2. Explain how these properties are measured. [1]

ASSESSMENTS TOOLS:

1. Weekly in-class quizzes
2. Project report
3. Project presentation

PROVIDE ADDT'L INFO ABOUT THE ASSESSMENT METHOD(s) THAT ADDRESS THE LEARNING OUTCOMES LISTED ABOVE (few sentences describing assignment, prj, etc and how they address learning objectives):

Weekly in-class quizzes will be used to assess student performance on objectives 1, 2, and 3 (define, describe, explain, and illustrate properties, measurement techniques, and impact on product and manufacturing performance). The project report and presentation will satisfy learning objective 4, which focuses on applying the course knowledge to develop a characterization tool.

3. Illustrate how these properties influence the performance of particle-based products and manufacturing processes. [1]
4. Create a computational or a web-based tool that demonstrates or implements concepts from the course. [1,2,3,5]

NATURE OF DESIGN CONTENT: The course project involves designing and creating a computational tool used for material characterization. Examples include a tool that converts between particle size distributions, reporting statistics from distributions, and the bulk solid fraction of particle mixtures.

PROFESSIONAL COMPONENT:

Engineering Topics: Engineering Science – 80%
Engineering Design – 20%

COMPUTER USAGE: Word processing, spreadsheet, and some programming will be required for the course project.

COURSE STRUCTURE/SCHEDULE:

Lecture - 2 days per week at 75 minutes per lecture, 10 weeks

RELATED ME PROGRAM OUTCOMES:

1. Engineering fundamentals
2. Engineering design
3. Communication skills
4. Ethical/Prof. responsibilities
5. Teamwork skills
6. Experimental skills
7. Knowledge acquisition

GRADE MODE (Regular; Pass/No Pass; Audit; Satisfactory/Unsatisfactory: Regular, P/NP, Audit

FINAL GRADING CRITERIA (%):

Exams & Quizzes: 80%

Papers & Projects: 20% **Homework:**

Laboratory Exercises:

Class Preparation:

Other:

Grading Scale: 90/80/70/60

LIBRARY RESOURCES (describe any library resources that are currently available or the resources needed to support this proposed course. If none needed, explain how the students will complete their research for the course):

Allen, T., *Particle Size Measurement,* Vols. 1 and 2, 5th ed., Chapman and Hall.
Fayed, M.E. and Otten, L., eds., *Handbook of Powder Science and Technology*, Chapman and Hall. (ISBN 0-412-99621-9)
Ganderton, D., Jones, T., and McGinity, J., eds., *Advances in Pharmaceutical Sciences*, Vol. 7, Academic Press. (ISBN 0-12-032307-9)
Hiestand, E.N., *Mechanics and Physical Principles for Powders and compacts*, 2nd ed., SSCI Inc., West Lafayette, IN. (ISBN 978-0-96706-712-4)
Litster, J. and Ennis, B., *The Science and Engineering of Granulation Processes*, Kluwer. (ISBN 1-4020- 1877-0)
Masuda, H., Higashitani, K., and Yoshida, H., eds., *Powder Technology Handbook*, 3rd ed., Taylor and Francis. (ISBN 978-1-57444-782-8)
Rhodes, M., *Introduction to Particle Technology*, 2nd ed., Wiley. (ISBN 978-0-470-01428-8)
Rhodes, M.J., ed., *Principles of Powder Technology*, Wiley. (ISBN 0-471-92422-9)
Rumpf, H., *Particle Technology*, Chapman and Hall. (ISBN 0-412-35230-3)
Svarovsky, L., *Powder Testing Guide Methods of Measuring the Physical Properties of Bulk Powders*, Kluwer. (ISBN 1-85166-137-9)

ADDITIONAL FEES: No

EXPLANATION OF COURSE FEES (Coop, Lab, Rate Request):

ADDITIONAL COURSE INFORMATION:

PREPARED BY: Carl Wassgren

REVISION DATE: 2020 Oct 08