TO: The Engineering Faculty

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

RE: New Course – ABE 50502, Particle, Powder, and Compact Characterization Laboratory

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
Restrictions: Upper-division (senior-level status and above)
Cross-listed: ME 59700 (temp #)/ME 53202 (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: ME 53201 or ABE 50501 (may be taken concurrently)
Restrictions: Upper-division (senior-level status and above)
Cross-listed course: ME 53202

Course Description: The goal of this laboratory course is to train students on state-of-the-art laboratory equipment used to measure the mechanical properties of particles, granules, powders, and compacts.

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. The course has been cross-listed with ME 59700 and will now be cross-listed with ME 53202 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 53102/ABE 50502
Particle, Powder, and Compact Characterization Laboratory

Course Outcomes [Related ME Program Outcomes in brackets]

1. Follow laboratory safety guidelines. [6]
2. Operate common laboratory equipment and follow standard operating procedures used to measure the mechanical properties of particles, granules, powders, and compacts. [6]
3. As part of a team, plan and perform measurements, analyze results, and summarize the results in a written report. [3,5,6]

Introduction and Fundamentals (0.5 weeks)

1. Material sampling

Particle characterization (1.5 weeks)

1. Particle size, size distribution, and shape
2. Particle density

Powder characterization (2 weeks)

1. Powder bulk density and compressibility
2. Surface area
3. Moisture sorption
4. Powder flow

Compact characterization (1 week)

1. Compact mechanical properties
2. Compact characterization using X-ray microtomography

COURSE NUMBER: Part Powd & Comp Char Lab/ME 50502/ABE 53202	**COURSE TITLE:** Particle, Powder, and Compact Characterization Laboratory (1) **SHORT TITLE (max 30 char):** Part Powd & Comp Char Lab
REQUIRED COURSE OR ELECTIVE COURSE: Elective	**PROPOSED EFFECTIVE TERM:** Spring 2023 **TERMS OFFERED:** Spring semester (once in 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 provide hands-on laboratory experiments for measuring the physical and mechanical characteristics of particulate materials. 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 students how to make laboratory measurements of particle, powder, and compact properties in order to 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. The corresponding Particle, Powder, and Compact Characterization course, to be offered at the graduate level, should be taken as a co-requisite or pre-requisite to this laboratory course. 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 required	**PRE-REQUISITIES:** ME 53101/ABE 50501 (or as co-requisite) **ATTRIBUTES**: Upper Division (senior status and above) **RESTRICTIONS:** **COURSE REPEATABLE?** Yes
COORDINATING FACULTY: Carl Wassgren, Kingsly Ambrose	
COURSE DESCRIPTION: The goal of this laboratory course is to train students on state-of-the-art laboratory equipment used to measure the mechanical properties of particles, granules, powders, and compacts.	**COURSE OUTCOMES** [Related ME Program Outcomes in brackets]: Students successfully completing the course will be able to: 1. Follow laboratory safety guidelines. [6]

ASSESSMENTS TOOLS:

1. Weekly lab reports
2. Quizzes

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):
Students must pass safety quiz prior to entering the laboratory. The remainder of the course assessments will consist of laboratory reports that include the following sections: objectives, methods, results, discussion, and appendices.

2. Operate common laboratory equipment and follow standard operating procedures used to measure the mechanical properties of particles, granules, powders, and compacts. [6]
3. As part of a team, plan and perform measurements, analyze results, and summarize the results in a written report. [3,5,6]

NATURE OF DESIGN CONTENT: N/A

PROFESSIONAL COMPONENT:

Engineering Topics: Engineering Science – 100%
Engineering Design – 0%

COMPUTER USAGE: Word processing and spreadsheet software will be required to analyze data and prepare laboratory reports.

COURSE STRUCTURE/SCHEDULE:
Laboratory - 2 days per week at 75 minutes per lecture, 5 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

FINAL GRADING CRITERIA (%):

Exams & Quizzes:

Papers & Projects:

Homework:

Laboratory Exercises and reports: 95%

Class Preparation:

Other: Safety quizzes: 5%

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): N/A

ADDITIONAL COURSE INFORMATION:

PREPARED BY: Carl Wassgren

REVISION DATE: 2020 Oct 08