# New Course EFD Template

PURDUE UNIVERSITY | College of Engineering

Engineering Faculty Document
No.: 71-26
October 31, 2025

**TO**: The Engineering Faculty

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

**RE**: New graduate course – ABE 58100/EEE 58100 Principles of Sustainable Biomanufacturing

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

**FROM** (IF ALREADY OFFERED WITH TEMPORARY NUMBER)**:**

ABE 59100

Spring

3.00 total credits; LEC/75/2/16

No prerequisites

10 graduate, 2 undergraduate

**TO:**

ABE 58100 Principles of Sustainable Biomanufacturing

Spring

3.00 total credits; LEC/75/2/16

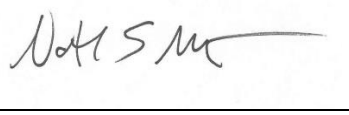
No prerequisites – graduate students with juniors/seniors by instructor approval

ABE 58100/EEE 58100, Principles of Sustainable Manufacturing, Credit Hours : 3.00. Future manufacturing demands improving manufacturing practices to meet the goals of sustainable development including responsible resource consumption, reducing overall emissions, creating zero waste systems etc. There is a significant growth in biobased manufacturing that focuses on using renewable resources, biological processes, a combination of biochemical pathways and modular processes to support responsible manufacturing. Biomanufacturing ranges from biochemicals, bioproducts, pharmaceuticals etc., thus covering a range of manufacturing sectors that are necessary to build a sustainable biobased economy. This course is designed to introduce principles of sustainability science specifically applicable to sustainable manufacturing focusing on

biomanufacturing. Emphasis will be on learning fundamentals of sustainability science and engineering, industrial ecology principles, thermodynamics for resource management, computational methods and modeling techniques, circular economy etc. widely used in sustainability assessment of industrial systems and integrating engineering design principles for sustainable design. Introduction to basic biomanufacturing practices and emerging trends will also be covered. Computational Lab training to use the methods in analysis and design of manufacturing systems will be given. Successful completion of the course will enable students to: Understand and implement sustainability science and industrial ecology principles for manufacturing systems at multiple scales. Perform quantitative sustainability assessment of manufacturing across sectors using different sustainability metrics. Model basic biomanufacturing systems to perform simulations for scenarios of different manufacturing designs. Apply the basic sustainable design principles for design of sustainable biomanufacturing systems.

**RATIONALE:**

Biomanufacturing is a growing area for food, pharmaceuticals and chemicals. While there are many courses that teach the basic science of bioprocesses needed for manufacturing, there are no courses that talk about systems scale modeling of biomanufacturing processes and its connection to sustainable scale up of the biomanufacturing systems in the economy. This course focuses on teaching interdisciplinary concepts of design that include principles of sustainable design, including economic viability, resilience to risk etc. and other factors such as resource optimization at systems scale. The course is designed to be accessible to graduate students across different colleges – College of Agriculture for students working in the field of biological engineering, biochemistry and College of Engineering for students working in the field of Chemical Engineering, Sustainability Engineering and Biomedical Engineering.



Head/Director of the Agricultural and Biological Engineering Department

Link to Curriculog entry: **https://purdue.curriculog.com/proposal:34726/form**

**ABE 591/EEE 595**

**Principles of Sustainable Biomanufacturing**

**Department of Agricultural and Biological Engineering**

**School of Sustainability Engineering and Environmental Engineering**

**Purdue University**

**Spring 2025**

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|---|---|
| **Instructor:** | Dr. Shweta Singh<br>Room ABE 3041D<br>Phone: 496-1390<br>email: singh294@purdue.edu<br>(Please email with Subject Title prefixed with "ABE-591/EEE-590") |
| **Office Hours (Instructor):** | By appointment. |
| **Instructional Modality – Lectures (Face to Face)** | T/Th (Lecture/Discussions) 1:30-2:45 , TBD |
| **TA** | N/A |
| **Office Hours (TA):** | N/A |
| **Textbook:** | 4) *Sustainable Engineering, Principles and Practice, Cambridge University Press, 2019 Bhavik. R. Bakshi, None,*<br>4) *Biomanufacturing for Sustainable Production of Biomolecules (Vijai Singh and Pau Loke Show, Springer Link, 2021)*<br>4) *Input-Output Analysis: Foundations and Extensions, Miller and Blair, ISBN : 9780511626982, DOI : https://doi.org/10.1017/CBO9780511626982*<br>4) *Other recent scientific literature will be posted on brightspace* |
| **Additional Texts (Optional):** | N/A |
| **Credits** | 3 hr |
| **Prerequisites** | Basic understanding of manufacturing, Process Engineering, Basic Programming |
| **Corequisite** | None |

**Course Learning Objectives:**

Successful completion of the course will enable the students to:

1. Learn about key sustainability challenges in the emerging areas of biological and chemical manufacturing for bio-based chemicals, pharmaceuticals, plastics etc. sector.
2. Learn about current and emerging chemical and biomanufacturing processes.

3. Learn modeling of biomanufacturing processes, biobased chemical manufacturing
4. Know and apply the principles of sustainability for evaluation of biomanufacturing processes.
5. Learn design principles for sustainable biomanufacturing processes.
6. Learn about industrial ecology principles for sustainable design of future manufacturing processes.

**Tentative Lecture Schedule**

| LEC | Date | | | Topic |
|---|---|---|---|---|
| 01 | Tu | Jan | 14 | Introduction |
| 02 | Th | | 16 | Sustainability Science and Sustainable Manufacturing |
| 03 | Tu | | 21 | Pharmaceutical manufacturing and Biobased chemicals: Overview of sustainability challenges |
| 04 | Th | | 23 | Health industry and medical devices: Challenges in sustainable manufacturing |
| 05 | Tu | | 28 | Sustainability Assessment methods: Life Cycle Assessment in Process Manufacturing |
| 06 | Th | | 30 | Life Cycle Model Building for Pharmaceutical Drug Product |
| 07 | Tu | Feb | 4 | Types of Life Cycle Assessment Models, Process LCA Computation |
| 08 | Th | | 6 | Hands on exercise for topics learnt for Life Cycle model building: Computational Lab |
| 09 | Tu | | 11 | Biomanufacturing Processes: Key unit operations, processes, mechanisms |
| 10 | Th | | 13 | Modeling Biomanufacturing process |
| 11 | Tu | | 18 | Modeling Biomanufacturing process: Example and in class practice |
| 12 | Th | | 20 | Sustainability assessment of Biomanufacturing |
| 13 | Tu | | 25 | Sustainability Assessment of Biomanufacturing process: In class practice |
| 14 | Th | | 27 | Introduction to Macroeconomic Theory |
| 15 | Tu | March | 4 | Application of Macroeconomic Theory in Manufacturing Industries for Sustainability, Input-Output Models |
| 16 | Th | | 6 | Real world Macroeconomic models, In class computational Lab : modeling biomanufacturing systems using Input-Output models |
| 17 | Tu | | 18 | Material Flow Analysis (MFA): Building MFA model for Biomanufacturing and application to sustainable design |
| 18 | Th | | 20 | Introduction to Physical Input-Output Models, Theory of building PIOTs |
| 19 | Tu | | 25 | PIOT-Hub: Computational Tool for building PIOTs, Building models in class |

| | | | | |
|---|---|---|---|---|
| 20 | Th | | 27 | Hybrid IO modeling, theory and examples |
| 21 | Tu | April | 1 | Hybrid IO modeling of biomanufacturing case study |
| 22 | Th | | 3 | Dynamic Material Flow Analysis |
| 23 | Tu | | 8 | Modeling Dynamic Material Flow Analysis for Biomanufacturing process |
| 24 | Th | | 10 | Dynamic MFA: Application for Sustainability Assessment of case study on biomanufacturing |
| 25 | Tu | | 15 | Class Project: In class building models |
| 26 | Th | | 17 | Biologics manufacturing: Review for sustainability challenges |
| 27 | Tu | | 22 | Supply Chains in Pharmaceutical Manufacturing: Sustainability challenges and modeling |
| 28 | Th | | 24 | Course Project |
| 29 | Tu | | 29 | Course Project Presentations |
| **30** | **Th** | **May** | **1** | Course Project Presentations |

**Grading Scheme: We will follow an absolute scale for this course.**

The final grades will be determined using the following table, based on the adjusted final score.

$97 \leq \text{score} \Rightarrow$ A+ $\quad 93 \leq \text{score} < 97 \Rightarrow$ A $\quad 90 \leq \text{score} < 93 \Rightarrow$ A-

$87 \leq \text{score} < 90 \Rightarrow$ B+ $\quad 83 \leq \text{score} < 87 \Rightarrow$ B $\quad 80 \leq \text{score} < 83 \Rightarrow$ B-

$77 \leq \text{score} < 80 \Rightarrow$ C+ $\quad 73 \leq \text{score} < 77 \Rightarrow$ C $\quad 70 \leq \text{score} < 73 \Rightarrow$ C-

$67 \leq \text{score} < 70 \Rightarrow$ D+ $\quad 63 \leq \text{score} < 67 \Rightarrow$ D $\quad 60 \leq \text{score} < 63 \Rightarrow$ D-

$\text{score} < 60 \Rightarrow$ F

| **Component** | **% Weighting** |
|---|---|
| **HWs** | **30 %** |
| **Database/Model Development** | **20 %** |
| **Course Project** | **50 %** |

Assignment re-grade requests must be submitted within one week of the date the graded document has been made available for return. Re-grades submitted after this deadline will not be considered. Re-grade requests must include a statement detailing the justification for the re-grade. Note that the item to be re-graded is re-graded from scratch and may result in a score lower than the original score.

**Course Project**

There will be one team course project. The course project should be designed with following components

1. Sustainability assessment of your choice of biomanufacturing process or biobased/biopharmaceutical products with alternative feedstocks, alternative processes.

2. Application of all methods learnt in the course in different capacity. With interpretations and conclusions.
3. Developing of models that are reproducible, and datasets generated will be submitted to opensource with DOI.

*Notes*:

1. The Purdue University Code of Honor is in effect for all students:

   http://www.purdue.edu/studentregulations/student_conduct/codeofhonor.html

   All academic dishonesty incidents will be reported to the Office of the Dean of Students.

2. Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 and http://www.purdue.edu/caps (during and after hours, on weekends and holidays), or through counselors located in PUSH (business hours).

2. Non-discrimination: Purdue University is committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. Purdue's non-discrimination policy can be found at http://www.purdue.edu/purdue/ea_eou_statement.html