

# Course Syllabus

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## BSE 4524: Biological Process Plant Design

*Syllabus and Course Outline*

*Fall 2016*

Location: Torgersen 1040

Meeting Day/Time: MWF 8-8:50am

Instructor: Ryan S. Senger

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Office Hours: Friday 3-5pm

TA: Bill Carswell

Office: 302 HABB1

Office Hours: Friday 3-5pm

Course (Catalog) Description:

**4524: Bioprocess Engineering:** Engineering principles for design of systems for processing biological materials into primary and secondary products. Delivery, scheduling, storage requirement, economic analysis. Process control and instrumentation of bioprocessing plants.

**Prerequisites:** BSE 4504 or graduate-level standing with permission.

**Textbook:** Turton, R.; Bailie, R.C.; Whiting, W.B.; Shaeiwitz, J.A. (2012) Analysis, synthesis, and design of chemical processes. 4th Edition. Prentice Hall, Upper Saddle River. ISBN-13: 978-0-13-261812-0.

**Course Objectives:** Upon successful completion of this course, students shall be able to do the following:

1. Design a plant layout for processing of biological materials.
2. Trace all chemical and biological components through a process flow diagram and be able to explain the function of all unit operations.
3. Use appropriate software (SuperPRO Designer) to size piping, holding tanks, heat exchangers, refrigeration equipment, and other ancillary equipment needed to insure that material and/or product flows in an optimum manner through the plant.
4. Build a process flow diagram from scratch using SuperPRO Designer software.
5. Compute fixed and operating cost for plant equipment and prepare an annual budget.
6. Complete economic and profitability analyses for a proposed processing plant.
7. Evaluate plant operations to insure that applicable safety and environmental (OSHA, HACCP) regulations are met.

8. Function as a team member designing a process flow diagram and plant layout.

**Justification:** There are common elements in the design of any biological material processing plant whether a pharmaceutical, food or non-food product is produced. Raw material is received, processed, and delivered to a utilization point within the plant. Product is packaged, stored, and shipped. Certain material and energy flow decisions must be made. Applicable safety and environmental regulations must be met. This course presents these elements with emphasis on the interactions and effects that occur when individual pieces of equipment are connected in a system. Common topics are collected in this course so that they do not have to be covered in other technical electives. The introduction to SuperPRO Designer and the design of control systems given in this course will be expanded with more detailed examples from courses such as BSE 4504, Bioprocess Engineering and BSE 4604, Food Engineering.

### Evaluation and Grading

Item	Percentage
Homework	10%
Quizzes (4)	20%
Mid-Term Exam	20%
Final Exam	25%
Team Project	15%
Class Participation	10%
Total	100%

### Course Policies

**Canvas:** The course syllabus, lectures, schedule, and other relevant materials will be placed on the [Canvas website](#) developed for this course. Students unable to access this website should contact the instructor immediately.

**Homework:** Assignments will be posted on Canvas at least one week before the due date. Students are encouraged to work in teams and consult with classmates regarding homework problems. However, each student must submit his or her own homework assignments. Any assignment submitted with two or more names will not be graded. Even though teamwork is encouraged, all submitted homework assignments must be the student's own work. In other words, no two homework assignments should be identical. Homework assignments will be submitted electronically to Canvas. Homework assignments must be submitted by midnight on the due date.

**BSE Opportunities Website:** With each homework assignment, you will be asked to upload two opportunities to the [BSE Opportunities Website \(https://secure.hosting.vt.edu/www.opportunities.bse.vt.edu/\)](#). Opportunities include job postings, internships, awards, graduate school programs, etc. You are allowed to submit opportunities to any category on the website; however, please do not submit duplicates. To post an opportunity, click the "post an opportunity" link in the left hand navigation bar on the site and follow instructions. If you do not have access to post to the site, please contact the administrator immediately via the "contact us" link on the page.

**Class Attendance:** It is strongly recommended that students attend all class periods and participate in class discussions. This will be reflected in the student's grade through better performance on homework assignments and exams. Spontaneous class discussions may not appear in the pre-prepared lecture notes posted on the Canvas website; however, this material may appear in a homework or exam question. Students are encouraged (but not required) to let the instructor know when they need to miss class.

**Class Participation:** The grade for class participation will be assigned by the instructor at the end of the semester. The following will be taken into account: (i) participation in class discussions, (ii) willingness to ask questions, (iii) class attendance, and (iv) focusing on class-related work while class is in session.

**Virginia Tech Honor System:** The Undergraduate Honor Code pledge that each member of the university community agrees to abide by states:

"As a Hokie, I will conduct myself with honor and integrity at all times. I will not lie, cheat, or steal, nor will I accept the actions of those who do."

Students enrolled in this course are responsible for abiding by the Honor Code. A student who has doubts about how the Honor Code applies to any assignment is responsible for obtaining specific guidance from the course instructor before submitting the assignment for evaluation. Ignorance of the rules does not exclude any member of the University community from the requirements and expectations of the Honor Code.

As a University requirement, all incidents of cheating and plagiarism must be reported by the course instructor to the VT Honor Code Panel. This includes the use of unapproved wireless devices during tests and multiple students submitting identical homework assignments. Any incidence of suspected dishonorable conduct must be reported.

For additional information about the Honor Code, please click [here \(http://www.honorsystem.vt.edu/\)](http://www.honorsystem.vt.edu/).

**Late Assignments:** Homework assignments must be submitted to Canvas by midnight on the due date. Homework assignments submitted after the due date will receive a penalty of 10% per day.










**Team Project:** Teams will consist of BSE senior design teams. Those not currently taking BSE senior design will be assigned to an existing team. Teams will apply the methods learned in this class to their senior design projects. The teams will give short presentations and submit a short report at the end of the semester.




















**Make-Up Exams:** In the event that an exam must be taken at an earlier or later date or time, written notice is required 1 week before the scheduled exam date. In the case of an emergency or illness, special arrangements will be allowed as long as written documentation or a doctor's note is submitted.


















**Students with Disabilities:** Any student who feels he or she may need accommodation because of a disability (e.g., learning disability, attention deficit disorder, psychological, physical, etc.), please make an appointment to see me during office hours.

**Principles of Community:** A learning environment will be created strictly adhering to the [Virginia Tech Principles of Community \(http://www.vt.edu/diversity/principles-of-community.html\)](http://www.vt.edu/diversity/principles-of-community.html).

## Assignments Summary:

Date	Details	
Mon Aug 22, 2016	 <b>1 - Course Introduction; Diagrams for understanding chemical/biological processes</b> ( <a href="https://canvas.vt.edu/calendar?event_id=24393&amp;include_contexts=course_27620">https://canvas.vt.edu/calendar?event_id=24393&amp;include_contexts=course_27620</a> )	8am to 8:50am
Wed Aug 24, 2016	 <b>2 - Understanding process diagrams</b> ( <a href="https://canvas.vt.edu/calendar?event_id=24394&amp;include_contexts=course_27620">https://canvas.vt.edu/calendar?event_id=24394&amp;include_contexts=course_27620</a> )	8am to 8:50am
Fri Aug 26, 2016	 <b>3 - PFD structure and hierarchical approach</b> ( <a href="https://canvas.vt.edu/calendar?event_id=24395&amp;include_contexts=course_27620">https://canvas.vt.edu/calendar?event_id=24395&amp;include_contexts=course_27620</a> )	8am to 8:50am
Mon Aug 29, 2016	 <b>4 - Concluding the hierarchical approach</b> ( <a href="https://canvas.vt.edu/calendar?event_id=24396&amp;include_contexts=course_27620">https://canvas.vt.edu/calendar?event_id=24396&amp;include_contexts=course_27620</a> )	8am to 8:50am
Wed Aug 31, 2016	 <b>5 - Tracing chemicals through the process flow diagram</b> ( <a href="https://canvas.vt.edu/calendar?event_id=24397&amp;include_contexts=course_27620">https://canvas.vt.edu/calendar?event_id=24397&amp;include_contexts=course_27620</a> )	8am to 8:50am
	 <b>HW1</b> ( <a href="https://canvas.vt.edu/courses/27620/assignments/78542">https://canvas.vt.edu/courses/27620/assignments/78542</a> )	due by 11:59pm
Fri Sep 2, 2016	 <b>SuperPRO Designer – Case Study (Part 1)</b> ( <a href="https://canvas.vt.edu/calendar?event_id=24398&amp;include_contexts=course_27620">https://canvas.vt.edu/calendar?event_id=24398&amp;include_contexts=course_27620</a> )	8am to 8:50am
Mon Sep 5, 2016	 <b>Labor Day (No Class)</b> ( <a href="https://canvas.vt.edu/calendar?event_id=24399&amp;include_contexts=course_27620">https://canvas.vt.edu/calendar?event_id=24399&amp;include_contexts=course_27620</a> )	8am to 8:50am
Wed Sep 7, 2016	 <b>SuperPRO Designer – Case Study (Part 2)</b> ( <a href="https://canvas.vt.edu/calendar?event_id=24400&amp;include_contexts=course_27620">https://canvas.vt.edu/calendar?event_id=24400&amp;include_contexts=course_27620</a> )	8am to 8:50am

	 <a href="https://canvas.vt.edu/courses/27620/assignments/78825">Quiz 1 (https://canvas.vt.edu/courses/27620/assignments/78825)</a>	due by 8:30am
Fri Sep 9, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24450&amp;include_contexts=course_27620">6 - Batch processing (https://canvas.vt.edu/calendar?event_id=24450&amp;include_contexts=course_27620)</a>	8am to 8:50am
Mon Sep 12, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24451&amp;include_contexts=course_27620">7 - Batch processing (https://canvas.vt.edu/calendar?event_id=24451&amp;include_contexts=course_27620)</a>	8am to 8:50am
Wed Sep 14, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24452&amp;include_contexts=course_27620">Homework review session (https://canvas.vt.edu/calendar?event_id=24452&amp;include_contexts=course_27620)</a>	8am to 8:50am
Fri Sep 16, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24453&amp;include_contexts=course_27620">8 - Chemical product design (https://canvas.vt.edu/calendar?event_id=24453&amp;include_contexts=course_27620)</a>	8am to 8:50am
	 <a href="https://canvas.vt.edu/courses/27620/assignments/78543">HW2 (https://canvas.vt.edu/courses/27620/assignments/78543)</a>	due by 11:59pm
Mon Sep 19, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24454&amp;include_contexts=course_27620">SuperPRO Designer – Case Study (Part 3) (https://canvas.vt.edu/calendar?event_id=24454&amp;include_contexts=course_27620)</a>	8am to 8:50am
Wed Sep 21, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24455&amp;include_contexts=course_27620">SuperPRO Designer – Case Study (Part 4) (https://canvas.vt.edu/calendar?event_id=24455&amp;include_contexts=course_27620)</a>	8am to 8:50am
	 <a href="https://canvas.vt.edu/courses/27620/assignments/78828">Quiz 2 (https://canvas.vt.edu/courses/27620/assignments/78828)</a>	due by 8:30am
Fri Sep 23, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24456&amp;include_contexts=course_27620">9 - Estimation of capital costs (https://canvas.vt.edu/calendar?event_id=24456&amp;include_contexts=course_27620)</a>	8am to 8:50am
Mon Sep 26, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24457&amp;include_contexts=course_27620">10 - Estimation of capital costs (https://canvas.vt.edu/calendar?event_id=24457&amp;include_contexts=course_27620)</a>	8am to 8:50am
Wed Sep 28, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24458&amp;include_contexts=course_27620">Homework review session (https://canvas.vt.edu/calendar?event_id=24458&amp;include_contexts=course_27620)</a>	8am to 8:50am
	 <a href="https://canvas.vt.edu/courses/27620/assignments/78821">HW3 (https://canvas.vt.edu/courses/27620/assignments/78821)</a>	due by 11:59pm
Fri Sep 30, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24459&amp;include_contexts=course_27620">11 - Estimation of manufacturing costs (https://canvas.vt.edu/calendar?event_id=24459&amp;include_contexts=course_27620)</a>	8am to 8:50am
Mon Oct 3, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24460&amp;include_contexts=course_27620">12 - Estimation of manufacturing costs (https://canvas.vt.edu/calendar?event_id=24460&amp;include_contexts=course_27620)</a>	8am to 8:50am
Wed Oct 5, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24461&amp;include_contexts=course_27620">SuperPRO Designer – Case Study (Part 5) (https://canvas.vt.edu/calendar?event_id=24461&amp;include_contexts=course_27620)</a>	8am to 8:50am
	 <a href="https://canvas.vt.edu/courses/27620/assignments/78830">Mid-Term Exam (https://canvas.vt.edu/courses/27620/assignments/78830)</a>	due by 6:30pm
Fri Oct 7, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24462&amp;include_contexts=course_27620">SuperPRO Designer – Case Study (Part 6) (https://canvas.vt.edu/calendar?event_id=24462&amp;include_contexts=course_27620)</a>	8am to 8:50am
Mon Oct 10, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24463&amp;include_contexts=course_27620">SuperPRO Designer – Case Study (Part 7) (https://canvas.vt.edu/calendar?event_id=24463&amp;include_contexts=course_27620)</a>	

	<a href="https://canvas.vt.edu/calendar?event_id=24463&amp;include_contexts=course_27620">event_id=24463&amp;include_contexts=course_27620</a>	8am to 8:50am
Wed Oct 12, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24464&amp;include_contexts=course_27620">Homework review session (https://canvas.vt.edu/calendar?event_id=24464&amp;include_contexts=course_27620)</a>	8am to 8:50am
	 <a href="https://canvas.vt.edu/courses/27620/assignments/78822">HW4 (https://canvas.vt.edu/courses/27620/assignments/78822)</a>	due by 11:59pm
Fri Oct 14, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24465&amp;include_contexts=course_27620">Fall Break (No Class) (https://canvas.vt.edu/calendar?event_id=24465&amp;include_contexts=course_27620)</a>	8am to 8:50am
Mon Oct 17, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24466&amp;include_contexts=course_27620">No Class (https://canvas.vt.edu/calendar?event_id=24466&amp;include_contexts=course_27620)</a>	8am to 8:50am
Wed Oct 19, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24467&amp;include_contexts=course_27620">13 - Engineering economic analysis (https://canvas.vt.edu/calendar?event_id=24467&amp;include_contexts=course_27620)</a>	8am to 8:50am
Fri Oct 21, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24468&amp;include_contexts=course_27620">14 - Cash flow diagrams (https://canvas.vt.edu/calendar?event_id=24468&amp;include_contexts=course_27620)</a>	8am to 8:50am
Mon Oct 24, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24469&amp;include_contexts=course_27620">15 - Profitability analysis (https://canvas.vt.edu/calendar?event_id=24469&amp;include_contexts=course_27620)</a>	8am to 8:50am
Wed Oct 26, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24470&amp;include_contexts=course_27620">16 - Discounted profitability analysis (https://canvas.vt.edu/calendar?event_id=24470&amp;include_contexts=course_27620)</a>	8am to 8:50am
	 <a href="https://canvas.vt.edu/courses/27620/assignments/78827">Quiz 3 (https://canvas.vt.edu/courses/27620/assignments/78827)</a>	due by 8:30am
Fri Oct 28, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24471&amp;include_contexts=course_27620">17 - Process economics example (https://canvas.vt.edu/calendar?event_id=24471&amp;include_contexts=course_27620)</a>	8am to 8:50am
Mon Oct 31, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24472&amp;include_contexts=course_27620">SuperPRO Designer – Case Study (Part 8) (https://canvas.vt.edu/calendar?event_id=24472&amp;include_contexts=course_27620)</a>	8am to 8:50am
Wed Nov 2, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24473&amp;include_contexts=course_27620">Homework review session (https://canvas.vt.edu/calendar?event_id=24473&amp;include_contexts=course_27620)</a>	8am to 8:50am
	 <a href="https://canvas.vt.edu/courses/27620/assignments/78823">HW5 (https://canvas.vt.edu/courses/27620/assignments/78823)</a>	due by 11:59pm
Fri Nov 4, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24474&amp;include_contexts=course_27620">SuperPRO Designer – Case Study (Part 9) (https://canvas.vt.edu/calendar?event_id=24474&amp;include_contexts=course_27620)</a>	8am to 8:50am
Mon Nov 7, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24475&amp;include_contexts=course_27620">18 - Process Optimization (https://canvas.vt.edu/calendar?event_id=24475&amp;include_contexts=course_27620)</a>	8am to 8:50am
Wed Nov 9, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24476&amp;include_contexts=course_27620">19 - Process Optimization (https://canvas.vt.edu/calendar?event_id=24476&amp;include_contexts=course_27620)</a>	8am to 8:50am
Fri Nov 11, 2016	 <a href="https://canvas.vt.edu/calendar?event_id=24477&amp;include_contexts=course_27620">SuperPRO Designer – Team project reviews (Part 10) (https://canvas.vt.edu/calendar?event_id=24477&amp;include_contexts=course_27620)</a>	8am to 8:50am




Mon Nov 14, 2016

 **SuperPRO Designer – Team project reviews (Part 11)**  
([https://canvas.vt.edu/calendar?event\\_id=24478&include\\_contexts=course\\_27620](https://canvas.vt.edu/calendar?event_id=24478&include_contexts=course_27620))

8am to 8:50am

Wed Nov 16, 2016

 **Homework review session** ([https://canvas.vt.edu/calendar?event\\_id=24479&include\\_contexts=course\\_27620](https://canvas.vt.edu/calendar?event_id=24479&include_contexts=course_27620))

8am to 8:50am

 **HW6** (<https://canvas.vt.edu/courses/27620/assignments/78824>)


due by 11:59pm

Fri Nov 18, 2016

 **No Class** ([https://canvas.vt.edu/calendar?event\\_id=24480&include\\_contexts=course\\_27620](https://canvas.vt.edu/calendar?event_id=24480&include_contexts=course_27620))


8am to 8:50am

Mon Nov 21, 2016

 **Thanksgiving Break (No Class)** ([https://canvas.vt.edu/calendar?event\\_id=24481&include\\_contexts=course\\_27620](https://canvas.vt.edu/calendar?event_id=24481&include_contexts=course_27620))


8am to 8:50am

Wed Nov 23, 2016

 **Thanksgiving Break (No Class)** ([https://canvas.vt.edu/calendar?event\\_id=24482&include\\_contexts=course\\_27620](https://canvas.vt.edu/calendar?event_id=24482&include_contexts=course_27620))


8am to 8:50am

Fri Nov 25, 2016

 **Thanksgiving Break (No Class)** ([https://canvas.vt.edu/calendar?event\\_id=24483&include\\_contexts=course\\_27620](https://canvas.vt.edu/calendar?event_id=24483&include_contexts=course_27620))


8am to 8:50am

Mon Nov 28, 2016

 **20 - Decision making and game theory** ([https://canvas.vt.edu/calendar?event\\_id=24484&include\\_contexts=course\\_27620](https://canvas.vt.edu/calendar?event_id=24484&include_contexts=course_27620))

8am to 8:50am

Wed Nov 30, 2016

 **21 - Ethics** ([https://canvas.vt.edu/calendar?event\\_id=24485&include\\_contexts=course\\_27620](https://canvas.vt.edu/calendar?event_id=24485&include_contexts=course_27620))

8am to 8:50am

 **Quiz 4** (<https://canvas.vt.edu/courses/27620/assignments/78829>)

due by 8:30am

Fri Dec 2, 2016

 **Team presentations** ([https://canvas.vt.edu/calendar?event\\_id=24486&include\\_contexts=course\\_27620](https://canvas.vt.edu/calendar?event_id=24486&include_contexts=course_27620))

8am to 8:50am

Mon Dec 5, 2016

 **Team presentations** ([https://canvas.vt.edu/calendar?event\\_id=24487&include\\_contexts=course\\_27620](https://canvas.vt.edu/calendar?event_id=24487&include_contexts=course_27620))

8am to 8:50am

Wed Dec 7, 2016

 **Team presentations** ([https://canvas.vt.edu/calendar?event\\_id=24488&include\\_contexts=course\\_27620](https://canvas.vt.edu/calendar?event_id=24488&include_contexts=course_27620))

8am to 8:50am

 **Class Participation Grade**  
(<https://canvas.vt.edu/courses/27620/assignments/78545>)

due by 11:59pm

 **Team Project** (<https://canvas.vt.edu/courses/27620/assignments/78546>)

due by 11:59pm

Mon Dec 12, 2016

 **Final Exam** (<https://canvas.vt.edu/courses/27620/assignments/78831>)

due by 11:59pm