

University of Nebraska - Lincoln
Department of Biological Systems Engineering
AGEN / BSEN 325 - Power Systems Design

Jan 2023

COURSE SYLLABUS

Lecture Location and Time: SPL 102, 10:00 – 10:50 a.m. on Mondays and Wednesdays

Lab Location and Time: SPL 102, 2:00 – 3:50 p.m. on Mondays

Spring Semester 2023: Jan 23rd – May 19th

Instructor:

Ian Tempelmeyer
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Office Hours:

Mondays, 11 a.m. - noon
Wednesdays, 11 a.m. - noon
or by appointment

Instructional Continuity:

If in-person classes are cancelled (e.g., inclement weather or Covid outbreak) this class will continue via Zoom meetings at the regularly scheduled class time. The Zoom meetings will be recorded and posted in Canvas for those who may not be able to attend class in real time. The primary mode of communication in this event will be via Canvas and email.

Catalog Description:

AGEN 325/BSEN 325: Power Systems Design (3 cr.)

Prerequisites: PHYS 212 or ECEN 211 or AGEN/BSEN 260, and MECH/CIVE 310 or CHME 332 or parallel, and professionally admitted engineering student.

Description: Fundamentals of power systems for machines. Introduction to fluid power (hydraulics, pneumatics): pumps, motors, cylinders, control devices and system design. Selection of electric motors as power sources, operating characteristics, and circuits. Selection of internal combustion engines as power sources.

Objectives:

Upon successful completion of this course a student will be able to:

1. use application requirements and infrastructure capabilities to select power sources.
2. determine system power requirements and design simple fluid power systems (ABET Outcome 1).
3. determine engine power required for intermittent or continuous duty and use internal combustion engine cycles and operating characteristics to select engines.
4. use system starting and operating conditions to select electric motors and safety devices to protect their circuits.
5. conduct experiments and use statistics to analyze system performance, interpret and discuss results, and report conclusions (ABET Outcome 3).

ABET Outcomes (assignments from this course will be used to assess student attainment of the following ABET Outcomes):

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
3. An ability to communicate effectively with a range of audiences.

Course Methods:

One of the desired outcomes of the Agricultural Engineering program is for you to develop into life-long learners. I hope that the procedures I use in this course help you progress towards that desired outcome. For most class days, I will assign readings (chapters or parts of chapters in the textbook, or sections or all of handouts, and online PowerPoint presentations), and an online quiz to be completed before you come to class. In class, I try to work with you to answer your questions regarding topics discussed in the reading assignment, and application of concepts to solve problems or design power systems.

Textbook and Required Materials:

- Cundiff, J. S. and Kocher, M. F. (2020). Fluid Power Circuits and Controls: Fundamentals and Applications. 2nd Edition. CRC Press, Taylor & Francis Group, Boca Raton, FL.

Students must have a scientific calculator for use on homework, labs, and exams.

Students will be required, according to University Policy and state law, to wear industrial quality eye protection when participating in lab activities that may result in hazards to the eyes.

References:

- Goering. Engine and Tractor Power. ASAE. 1986.
- Gustafson. Fundamentals of Electricity for Agriculture, 2nd ed. ASAE. 1988.
- Liljedahl, Turnquist, Smith and Hoki. Tractors and Their Power Units. Van Nostrand Reinhold. 1989. Roe. Practices and Procedures of Industrial Electric Design. McGraw-Hill Book Company. 1972.
- Srivastava, Goering and Rohrbach. Engineering Principles of Agricultural Machines, Rev. Printing. ASAE. 1996.
- Selected handbooks, handouts, and papers.

Course Outline:

The tentative course outline and schedule is as follows:

1. Fluid Power Systems:
 - a. Fluid mechanics review (4 days)
 - b. Pressure control (valves) (2 days)
 - c. Pump and system characteristics; pump/fan laws (2 days)
 - d. Motor characteristics (1 day)
 - e. Transmission and traction (2 days)
 - f. Cylinders in systems (include regeneration, synchronization, rod sizing) (3 days)
 - g. Control of temperature and contamination (2 days)
 - h. Auxiliary components (accumulators, reservoirs, instrumentation, etc.) (3 days)
2. Electric Motors:
 - a. Operating characteristics, load, and efficiency measurement (1 day)
 - b. Motors, starting methods (1 day)
 - c. Motor circuits (1 day)
3. Internal Combustion Engines:
 - a. Thermodynamic cycles (1 day)
 - b. Operating characteristics, selection (1 day)
4. Selected topics (electrical control, pneumatics, proportional systems, servo systems, programmable electronic controllers, V-belt, gear and chain drives, engine balance, etc.) (3 days)
5. Exams (2 days)

Grading System:

<u>Component of Work</u>	<u>Contribution to Course Average</u>
Reading Quizzes	10%
Homework	20%
Labs	15%
Exams	35%
Final Exam	20%

The semester average will be determined as a composite of the online quizzes, homework, exam, lab and final exam grades. The portion each component contributes to the course average is shown in the table above. The grade assigned will be based on the semester average as shown in the table below. The instructor reserves the right to adjust the scale. Borderline grades will be decided based on completion of homework, labs and class participation.

<u>Semester Average</u>	<u>Grade</u>	<u>Semester Average</u>	<u>Grade</u>	<u>Semester Average</u>	<u>Grade</u>
96.67 - 100%	A+	83.33 - 86.67%	B	70.00 - 73.33%	C-
93.33 - 96.67%	A	80.00 - 83.33%	B-	66.67 - 70.00%	D+
90.00 - 93.33%	A-	76.67 - 80.00%	C+	63.33 - 66.67%	D
86.67 - 90.00%	B+	73.33 - 76.67%	C	60.00 - 63.33%	D-
				0 - 60.00%	F

University policy regarding grades of I (incomplete) (<https://registrar.unl.edu/academic-standards/policies/incomplete-grade>) and W (withdraw) (<https://registrar.unl.edu/student/registration/add-drop-withdraw/#Withdrawals>) will be followed in this course.

Homework:

Homework must be done following the engineering problem solving format (problem statement, theory, given, determine, assumptions, solution, answer, discussion, references, check). Additional description of this format is available in the file EngrProbSolvFormat.pdf in the Canvas website for this class (in the Course Information Module). All assignments are to be submitted by uploading a file to the assignment in Canvas. Assignments not submitted at the scheduled time will be worth 1/2 credit if submitted within one week of the scheduled time.

Laboratory Exercises:

Laboratory exercises and reports must be completed to pass the course. Students are to work in your assigned lab groups to complete the laboratory assignments, with one report due from each group.

Eye and/or face protection is mandated by federal Occupational Safety and Health Administration (OSHA) standards, as well as state law (Nebraska Revised Statute, Section 85-901), which requires use of American National Standards Institute (ANSI)-approved eye protection by students, faculty, staff, and visitors at UNL who observe or participate in vocational, technical, industrial arts, chemical, or chemical-physical courses of instruction involving potential exposure to hot molten metals or other molten metals, milling, sawing, turning, shaping, cutting, grinding, or stamping of any solid materials, heat treatment, tempering, or kiln firing of any metal or other materials, gas or electric arc welding or other forms of welding processes, caustic or explosive materials, and chemical, physical, or combined chemical-physical laboratories involving caustic or explosive material, hot liquids or solids, injurious radiation, or other hazards not enumerated. Contact lenses and prescription glasses do not provide eye protection in the industrial sense and must not be worn in a hazardous environment

without addition of the appropriate safety eyewear. Some laboratory assignments in this course will require the use of appropriate eye protection and students will not be allowed to complete the assignment without proper personal protection equipment, which will be supplied by the student, unless otherwise indicated.

Students in this course must work in close physical proximity to one another for extended periods of time in order to achieve the academic goals of the course. For this reason, the Department of Biological Systems Engineering and the College of Agricultural Sciences and Natural Resources have determined that face coverings will be required in this course. If you are unwilling to comply with this requirement, please visit with your advisor about possible alternative courses that you might take in lieu of this one.

Most people learn best by doing, and lab is where you get to work with the equipment, measurement instruments, concepts and principles discussed in lecture. As best I can, I will have the handout for lab available in Canvas on Monday morning each week. Some labs will involve obtaining measurements on equipment and performing analyses. Other lab periods may be used to review and discuss lab reports, and to take exams. Since we only have four hydraulic test benches, lab groups may have to take turns with the test benches. The plan for rotating groups with the lab benches will be discussed in lab. Read the lab exercise and make any preparations you can before the lab period to save time in lab.

Learning to write good technical reports is critical to your success after graduation. Those who do good technical work in an efficient manner and prepare a concise, well written report will be appreciated more (larger raises, faster promotions) than those who don't. I plan to discuss lab reports with each group individually to help you improve your report writing. Expect to receive lots of comments and questions on your lab reports. Comments and questions should be considered as means to help you improve, NOT as personal attacks! All lab assignments are to be submitted by uploading a file to the assignment in Canvas. Laboratory reports not submitted at the scheduled time will be worth ½ the credit earned if submitted within one week of the scheduled time. Lab reports submitted more than one week late will not be accepted.

Attendance and Engagement Policy:

Attendance (in-person) in class and labs is expected, however if you are sick, please do not come to class, but let me know by email that you will not be in-person. Students are responsible for knowing all material discussed in class sessions. See the "Laboratory Exercises" section of this syllabus for a description of participation in your laboratory section. Changes to the class and lab schedules and assignments will be announced in class or lab or in Canvas. If you expect to miss class for some reason, arrangements must be made with the instructor in advance.

Exams:

The tentative dates for exams are February 27 and April 17, 2022, during the regularly scheduled class time. Questions and problems on the exams will be from the course topics as announced in class and/or in Canvas approximately one week before each exam. Alternate exam times, or makeup exams may be arranged at the discretion of the instructor if arrangements are made **in advance**. Exams are generally open book, and open notes, and require use of a scientific calculator. Use of computers, smart phones, or other digital devices during exams is not permitted.

Final Exam:

The final examination will be given on Friday, May 19, 2023, at 7:30 A.M. in the room normally scheduled for class. You may view UNL's final exam schedule on the University's website at the following link: <https://registrar.unl.edu/academic-calendar/final-exam/>. (be sure the Academic Year shown is 2022-2023, and click on the Spring 2023 tab if necessary)

Academic Dishonesty:

Students are expected to adhere to guidelines concerning academic dishonesty described in the UNL Student Code of Conduct (<http://stuafs.unl.edu/ja/code/>), particularly Article III, Section B. The BSE Department documentation regarding academic dishonesty can be accessed at <https://engineering.unl.edu/bse/bse-academic-resources/> under the heading “Planning for Success”. Students are encouraged to contact the instructor for clarification of these guidelines if they have questions or concerns.

Information for Emergency Response:

Fire Alarm (or other evacuation): In the event of a fire alarm: gather belongings (purse, keys, cell phone, N-Card, etc.) and use the nearest safe exit to leave the building. Do not use the elevators. After exiting notify emergency personnel of the location of persons unable to exit the building. Do not return to building unless told to do so by emergency personnel.

Tornado Warning: When sirens sound, move to the lowest interior area of building or designated shelter. Stay away from windows and stay near an inside wall when possible.

Active Shooter

Evacuate: If there is a safe escape path, leave belongings behind, hold hands in the air, and follow police officer instructions.

Hide out: If evacuation is impossible secure yourself in your space by turning out lights, closing blinds and barricading doors if possible.

Take action: As a last resort, and only when your life is in imminent danger, attempt to disrupt and/or incapacitate the active shooter.

UNL Alert: Notifications about serious incidents on campus are sent via text message, email, unl.edu website, and social media. For more information go to: <https://unlalert.unl.edu/unlalert/>.

Additional emergency planning and preparedness information can be accessed at: <https://emergency.unl.edu>.

Services for Students with Disabilities:

The University strives to make all learning experiences as accessible as possible. If you anticipate or experience barriers based on your disability (including mental health, chronic or temporary medical conditions), please let me know immediately so that we can discuss options privately. To establish reasonable accommodations, I may request that you register with Services for Students with Disabilities (SSD). If you are eligible for services and register with their office, make arrangements with me as soon as possible to discuss your accommodations so they can be implemented in a timely manner. SSD contact information: 117 Louise Pound Hall.; 402-472-3787, <https://www.unl.edu/ssd/>.

Mental Health and Wellbeing Resources:

UNL offers a variety of options to students to aid them in dealing with stress and adversity. Counseling and Psychological & Services (CAPS) is a multidisciplinary team of psychologists and counselors that works collaboratively with Nebraska students to help them explore their feelings and thoughts and learn helpful ways to improve their mental, psychological, and emotional well-being when issues arise. CAPS can be reached by calling 402-472-7450. Big Red Resilience & Well-Being provides one-on-one well-being coaching to any student who wants to enhance their well-being. Trained well-being coaches help students create and be grateful for positive experiences, practice resilience and self-compassion, and find support as they need it. BRRWB can be reached by calling 402-472-8770.

COVID-19 Information:

For the latest information on issues related to the COVID-19 pandemic, refer to the University website: <https://covid19.unl.edu>

Diversity & Inclusiveness:

UNL values diversity in the broadest sense – gender, age, race, ethnicity, sexual orientation, economic status, physical and intellectual ability, religion, education, and geography. We believe that acknowledging, building understanding, and incorporating diversity throughout the curriculum will best prepare you for a career in a global society. The inclusive learning environment we seek to foster is one where diverse perspectives are recognized and respected, and therefore conversations within your course must be civil and respectful of individual ideas, experiences, and beliefs that may be different from your own. To challenge ideas or beliefs in a manner that is considerate of the individual expressing them is encouraged, but disrespect or hostility toward any person is not acceptable behavior in the classroom. According to our Student Code of Conduct, speech that is abusive, harassing, intimidating, or coercive is prohibited. Students who engage in such speech will be asked to leave the classroom and further disciplinary actions may be taken.

Title IX Policy:

Any unwanted conduct of a sexual nature, whether verbal, physical, written, or pictorial, which has the purpose or effect of creating a hostile environment for the person subjected to the conduct, or any solicitation of sexual conduct of any nature when submission to or rejection of such contact is used as the basis for either implicitly or explicitly imposing favorable or adverse terms and conditions of academic standing constitutes sexual harassment and will not be condoned or tolerated. Moreover, sexual misconduct including stalking, dating or domestic violence and sexual assault is prohibited.

Appropriate corrective action will be taken toward any student or employee who is found to have violated UNL's non-discrimination, sexual harassment and/or sexual misconduct policies. Further, UNL commits itself toward the assurance of non-retaliation toward any person who reports harassment, sexual misconduct, or discrimination or who participates in an investigation of such conduct.

If you suspect or experience discrimination, sexual harassment, or retaliation toward yourself or others, please keep records or other evidence of specifics and report the conduct. If you do not feel comfortable telling a person to stop inappropriate behavior, or if the behavior does not cease once you have made the request that it do so, you may seek assistance from an administrator, professor, or counselor. Persons designated by the University as Responsible Employees are required to report sexual discrimination, harassment and misconduct reported to them. Other employees are encouraged to provide assistance and/or report.

Detailed information about support and resources, and how to report an incident of sexual discrimination, harassment, or misconduct, is available on the Institutional Equity and Compliance Title IX website. You can contact the office directly at 402-472-3417.

UNL Academic Calendar:

For a complete list of academic holidays and schedules: <https://registrar.unl.edu/academic-calendar/#tab2>

Inclement Weather:

The decision to close the University or implement a delayed opening or early closure shall be made by the Chancellor on the recommendation of the Vice Chancellor for Business & Finance. Your instructor will communicate via Canvas announcement regarding the closing option and details on the coursework. You may find the complete inclement weather policy on this linked page: <https://bf.unl.edu/policies/inclement-weather>