Syllabus: ABEN 473/673 – Agricultural Power
Fall Semester, 2022

Class info: Lecture- 12:00 to 12:50 p.m. M & W. ABEN room 208
Lab 2:00 – 4:50 p.m. Wednesday at Service Center (or other announced room) 3 cr.

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Office hours: 1:00 to 5:00 pm M & Tue, 1:00 to 2:0 pm W.
You can also email for an appointment.

Bulletin description:
Theory, analysis, and testing of internal combustion engines, traction, power trains, hydraulic systems, vehicle dynamics, stability, and ergonomics in tractor design. Electrical power units including motors. Alternative energy systems. 2 lectures, 1 three-hour laboratory.

Pre-requisites and Co-requisites: ME 350

Course objectives

1) students will be introduced to power sources and units of off-road vehicles and their operational principles, *CAN bus communication system*, calculation of traction forces and measurement tools and methods of power outputs of tractors
2) student will master how to compute and select power sources of agricultural machinery, and perform tests, analyze and present data.
3) graduate students will be introduced to the simulation model development of power sources and dynamics of agricultural machines and off-road vehicles.

Outcomes
After completing the course, the students will be able to:

1. **Understand** off-road vehicle operational principles, traction, power-train types and energy sources of agricultural machinery, and internal combustion and electrical engine principles, CAN bus communications (ABET 1) – [A, student outcome 1 (Table 1)]
2. **Apply** engineering knowledge of statics, kinetic and potential energy, fluids, and electricity to understand their experiments (ABET 1) - [A, student learning outcome 1 (Table 1)]

3. **Present** the measurement and engineering calculation results and **communicate** acquired information professionally (ABET 3) [B, Student outcome 3 (Table 1)]
4. **Design** an experiment, conduct the experiment, collect experimental data, analyze the collected data, and draw conclusions from the analyzed data (ABET 6) - [A, student outcome 6 (Table 1)]

Table 1. Program educational objectives and supporting student outcomes. *

	Graduates are expected to have established themselves as practicing engineers who, within a few years of graduation:
A	Successfully address emerging engineering challenges in the design or evaluation of machine systems, processing systems, and natural resources and environmental systems affecting the production of food, feed, and other bio-based products. Technical learning outcomes include student outcomes (1), (2), and (6): 1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics 2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors 6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
B	Effectively use professional communication, critical thinking, and interpersonal skills as team leaders and team members. Communicational learning outcomes include student outcomes (3) and (5): 3. an ability to communicate effectively with a range of audiences 5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
C	Responsibly serve the public and their employers by participating in professional development and by maintaining the highest standard of professional ethics. Contextual learning outcomes include student outcomes (4) and (7): 4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts 7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

* See https://www.ndsu.edu/aben/about/abet_accredited/ for the current ABEN program educational objectives. See https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2021-2022/ for information on ABET student outcomes 1-7, effective as part of the "Criteria for Accrediting Engineering Programs, 2021-2022."

Note: The table shows how course contributes to program outcomes, and how assessment is carried out to continually improve the course.

Required student resources:
Students are expected to have daily access to the course Blackboard website for access to course announcements, assignments, project, including the on-line sources, and other reading materials. **A personal computer (laptop) with MATLAB/Simulink** and these toolboxes: Curve Fitting Toolbox, Statistics and Machine Learning toolbox, Symbolic Math Toolbox, Simscape, Simscape Driveline, Simscape Electrical, Simscape Fluids, and Simscape Multibody **installed is needed.** If you need help to get MATLAB/Simulink package installed, ask for assistance from IT help desk.

Textbook:
Off-Road Vehicle Engineering Principles. 2003. Goering, Stone, Smith and Turnquist. ASAE. ISBN no. 1-892769-26-3 (need access to this textbook)

Assignment Overview and Policy

- **About 10 in-class unannounced pop-up quizzes** based on in-class covered materials, reading assignments, and self-study exercises. Out of 10 quizzes, **randomly chosen 5 quizzes** will be graded. **No make-up** quizzes allowed, except for a prior justification and approval of the instructor at least 24 hours before the class.
- **About 10 lab reports** based on the learned outcomes from the guest speaker presentations, industry visits, and collected data from the laboratory materials. Lab reports of graduate students will be in a higher standard than the ones of undergraduate students.
- **Tests**. There will be two in-class tests: **Test 1** on Week 6 and **Test 2** on Week 12/13. Prior to tests, there will be pre-test reviews of the questions included in Tests. For a **make-up exam**, the instructor's approval for any excusable justification at least 48 hours before the test date is needed as described in NDSU policy 333: https://www.ndsu.edu/fileadmin/policy/333.pdf
- **One team project (report) and presentation** for undergraduate students **(ABEN473)**
- **One individual project with a 6-page long research paper** for graduate students (**ABEN 673**).
- **Self-study homework** assignments based on covered and additional learning materials.
- **Due dates** for assignments and lab reports will be announced with the assignments. Late assignments will be accepted with a 10% penalty per NDSU class day, but will not be accepted after solutions are posted/handed out/discussed in class.
- **Active participation** during in-class discussions is strongly encouraged. Note that you will earn extra credits by actively participating in-class discussions.

Course delivery strategies:

- Lecture materials in power point presentations, MATLAB scripts and Simulink simulation models. Most of the lectures will be based on open discussions. All students are encouraged to be involved. All questions are welcome!
- Live in-class MATLAB/Simulink modelling exercises.

- In-class exercise problem solving demos.
- Guest speakers from industry and industry visits are planned.
- Laboratory exercises and measurements in ABEN.

ATTENDANCE STATEMENT

According to NDSU Policy 333 (www.ndsu.edu/fileadmin/policy/333.pdf), attendance in classes is expected. Attendance in classes is expected and important. (The term "class" includes class, online class, laboratory, field trips, group exercises, or other activities.) However, there are instances in which students are unable to attend class, and if those are described in policy 333 (https://www.ndsu.edu/fileadmin/policy/333.pdf), then those absences will be excused. Absences not covered under policy 333 are excusable at the discretion of the instructor. However, class policies regarding class absence are provided below. (Note: NDSU Student Health Service does not provide students with excuses for class absences or tardiness due to illness or injury.) If a student will be missing class for an event related to university clubs or teams, or other excusable reason to be determined by the instructor, the student must let the instructor know before he/she misses the class. Consideration will be given to those students who have a valid excusable reason when making a determination regarding making up assignments or tests.

VETERANS AND MILITARY PERSONNEL

Veterans and student service members with special circumstances or who are activated are encouraged to notify the instructor as soon as possible and are encouraged to provide Activation Orders.

AMERICANS WITH DISABILITIES ACT FOR STUDENTS WITH SPECIAL NEEDS STATEMENT

Any students with disabilities or other special needs, who need special accommodations in this course, are invited to share these concerns or requests with the instructor and contact the Disability Services Office (www.ndsu.edu/disabilityservices) as soon as possible. Veterans and student soldiers with special circumstances or who are activated are encouraged to notify the instructor in advance

APPROVED ACADEMIC HONESTY STATEMENT

The academic community is operated on the basis of honesty, integrity, and fair play. NDSU Policy 335: Code of Academic Responsibility and Conduct applies to cases in which cheating, plagiarism, or other academic misconduct have occurred in an instructional context. Students found guilty of academic misconduct are subject to penalties, up to and possibly including suspension and/or expulsion. Student academic misconduct records are maintained by the Office of Registration and

Records. Informational resources about academic honesty for students and instructional staff members can be found at www.ndsu.edu/academichonesty .
COE Honor Pledge: "On my honor I will not give nor receive unauthorized assistance in completing assignments and work submitted for review or assessment. Furthermore, I understand the requirements in the College of Engineering Honor System and accept the responsibility I have to complete all my work with complete integrity. Students who are suspected of academic dishonesty may not withdraw from the course in which dishonesty is suspected while the case is under review by the Honor Commission (NDSU Policy 335, 5b)."

Academic Calendar of Fall 2022* –
(http://https://www.ndsu.edu/onestop/academic-calendar)

Date		Day	Description
Aug	22	Mon	Classes begin at 4:00 p.m.
Aug	23	Tue	First full day of classes
Aug	31	Wed	Last day for no-record Drop of classes @ 100% refund**(full semester classes only)*
Aug	31	Wed	Last day to Withdraw to Zero Credits @ 100% refund**(full semester classes only)*
Sep	5	Mon	**HOLIDAY** — Labor Day *(no classes, offices closed)*
Sep	12	Mon	Last day to submit requests to Audit, Pass/Fail
Sep	30	Fri	Last day to Withdraw to Zero Credits @ 75% refund**(full semester classes only).*
Oct	14	Fri	Grades of 'Incomplete' convert to 'F'
Oct	30	Sun	Last day to Withdraw to Zero Credits @ 50% refund**(full semester classes only).* ***No refunds issued for withdraw to zero credits after this date.***

Date		Day	Description
Nov	10	Thur	Last day to Drop classes with 'W' record
Nov	11	Fri	**HOLIDAY** — Veterans Day *(no classes, offices closed)*
Nov	23-25	Wed-Fri	**HOLIDAY** — Thanksgiving *(no classes; offices closed Thursday, offices open Wednesday& Friday)*
Dec	5-9	Mon-Fri	Dead Week
Dec	9	Fri	Last day of Fall classes
Dec	12-16	Mon-Fri	Final Examinations

***** Modified/Shortened form.

Table 2. Course Outline***** (Tentative):

Week	Topics
Week 1: 08/22 -08/26	Course introduction, syllabus, policy, and assignments Introduction to MATLAB/Simulink environment
Week 2: 08/29-09/02	Introduction to MATLAB/Simulink environment **Laboratory Work # 1.** Numerical Analysis and Simulation problem
Week 3: 09/05-09/09	Overview of Off-Road Vehicles **Laboratory Work # 2.** Equation Solver Problem
Week 4: 09/12-09/16	Internal Combustion Engine. Thermodynamics **Laboratory Work # 3.** Big Iron Farm Show
Week 5: 09/19-09/23	Engine Performance. Engine and Off-road Vehicle Testing Principles **Laboratory Work # 4.** Engine Performance
Week 6: 09/26-09/30	Engine and Off-road Vehicle Testing Principles Review of week 1-5 materials. **Test 1**
Week 7: 10/03-10/07	Tractor/Implement Drivelines **Laboratory Work # 5.** Guest Speaker//Industry Visit
Week 8: 10/10-10/14	Traction. Ground/Propulsion System Interaction **Laboratory Work # 6.** Slippage and Traction
Week 9: 10/17-10/21	Power-Train Principles. Clutches and Brakes. **Laboratory Work # 7.** Power-trains. PTO.

Week 10: 10/24-10/28	Power-Train Principles. Clutches and Brakes.
Week 11: 10/31-10/4	Electrical/Electronic Systems **Laboratory Work # 8.** Guest Speaker//Industry Visit
Week 12: 11/07 – 11/11	Operator Platform/Ergonomics Review of week 7-11: **Test 2**
Week 13: 11/14 – 11/18	Operator Platform/Ergonomics **Laboratory Work # 9.** Experimental Design
Week 14: 11/21 -11/25	CAN Bus 11/23-11/25 - Thanksgiving break
DW -Week 15: 11/28-12/02	Electrical Power for Agricultural Machines **Laboratory Work # 10.** Electrical Powered Vehicle Simulation Exercise
DW - Week 16: 12/05-12/09	Electrical Power for Agricultural Machines
Week 17: 12/12-12/16	Project Presentations

***Disclaimer:** *The course outline is subject to change.*
Some topics will definitely be covered more thoroughly than others.

Laboratory Exercises:
During our laboratory studies in the shop, we will work with Mr. Johnston and Mr. Solseng to set up the laboratory exercises. The weather will affect which laboratory exercises are taken and the dates they are performed. Notes will be posted on the BB before the lab.

Grade Distribution: ABEN 473
Your grade in this course will be based on the following point breakdown.

Assessment	Number	Point Value	Total Points
Quiz	10 (5 graded)	1	5
Test 1	1	20	20
Test 2	1	20	20
Laboratory report (Lab Tile, *Data presentation*, Executive Summary, References)	10	2.5	25
Project	1	20	20
Project Presentation	1	10	10
Total Course Points			**100**

Grade Distribution: ABEN673

Your grade in this course will be based on the following point breakdown.

Assessment	Number	Point Value	Total Points
Quiz	10 (5 graded)	1	5
Test 1	1	20	20
Test 2	1	20	20
Laboratory report (Lab title, Lab Procedures, *Results and Discussion*, Executive Summary, References)	10	2.5	25
Project and Paper	1	20 (10+10)	20
Project presentation	1	10	10
Total Course Points			**100**

Grades will follow the standard NDSU grading scale:

A: 100-90% B: 80-89% C: 70-79% D: 60-69% F: <60%