Syllabus: ABEN 473 – Agricultural Power
Fall Semester, 2018

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

Class info: Lecture- 12:00 to 12:50 p.m. M & W. ABEN room 208
Lab 2:00 – 4:50 p.m. Monday Service Center
3 cr.

Instructor: Tom Bon, Office: ABEN 202. Phone: (23)1-7275.
e-mail: Thomas.Bon@ndsu.nodak.edu

Office hrs: 9:30 to 10:30 a.m. M, Tu, W, Th, and F.
Also you can call for an appointment or drop by and see if I am in my office, I am usually available if I am in my office unless it is just before a class or meeting.

Student Outcomes:

1. Understand vehicle principles, equipment interface to the machine, traction, power train, and engine principles. (abet 1)
2. Conduct experiments, analyze collected information, and appropriately present the results. (abet 3 and 6)
3. Understand potential trends in off-road vehicle development. (abet 4)

Overview:

The topic of off-road vehicles covers numerous applications. One of the first applications for the Agricultural and Biosystems Engineer is a tractor. However, even here there are numerous variations and specialized applications from the large four-wheel drive tractors used in tillage applications to small lawn and garden tractors. Construction equipment is another off-road application the quickly comes to mind. Often this may be road construction equipment. Mining and forestry equipment are yet other areas of specialized off-road equipment.

Off-road equipment is composed of numerous subsystems. These include the engine, drive, electrical and electronic systems, operator's cab and environment, hydraulic systems, and possibly many others. Each of the mentioned subsystems is in itself composed of subsystems. For example the engine has the valve system; the engine block, pistons, connecting rods, and crankshaft; the starting system; the alternator system; the fuel system; air cleaning system; the electronic monitoring and control system; and possibly many others.

The modern off-road vehicle is an engineering wonder. What will the future hold? No one has a crystal ball. However, there are factors than can be expected to

impact the design and development of off-road vehicles. These will be very briefly discussed in the following paragraphs.

Social trends and politics will have an impact. Social policy is trending towards pollution controls. This is exemplified by the Tier IV requirements. Work is procedding to possibly implement Tier V considerations.

Increased globalization with marketing of product around the world will continue. Companies will look at expanding their markets to new areas such as China, the former Soviet Union, South America, etc. The market in the United States is relatively small, especially with respect to combines and tractors. Several years ago the speaker from AGCO at the ASAE AEM award luncheon spoke on this topic. Platforms will need to be developed that can be sold around with world with minimal modifications.

Energy will be a factor. Fuel prices are increasing again in a fashion reminiscent of the 1970s oil crisis. Numerous factors may be affecting this, there is increased world demand for oil while some analysts believe that world production capability is reaching is peak capabilities. Fuel economy will increase in importance. Alternative fuel and/or renewable fuel sources such as biofuels are likely to obtain increasing attention as research and development topics.

The internal combustion engine has been developed for over 100 years. Will the internal combustion engine remain the power source of the future? It is unlikely that internal combustion engines will disappear quickly but there way well be alternatives in the future. For example, some of the large drag-lines used in stripe mining of coal are actually electrically powered. Will steam engines, sterling engines, fuel cells, and other technologies replace the internal engine? Time will tell.

Examination of operations will continue to see if new approaches outside of conventional thinking and methods can accomplish current tasks more quickly, more efficiently, and/or at a lower cost.

Finally, there is the possibility of true "breakout" innovations. A truly revolutionary new idea that completely changes the way current tasks are done. What might this be? If I knew, I would be rich enough to retire and teach as a hobby.

Grading:

The course will be graded with the following weights:

	473	673
1 hr exams (ideally 3) & quizzes	40%	35%
Laboratory reports	15%	10%
Homework	10%	10%
Lab presentations	10%	10%
Other (for graduate students)		15%
Final exam	25%	20%
Total	100%	100%

<u>Final Exam is scheduled for Monday, December 16, 2019, from 1:00 p.m. to 3:00 p.m.</u>

I use a straight grading system. The breaks are, 90% (A), 80% (B), 70% (C), 60% (D), and below failing.

Homework is due by 5:00 p.m. on the due date. Homework must be given to me in class, emailed to me, or placed in my mailbox. My mailbox is located in ABEN 100. Late homework will be discounted 10% if I receive it before I have graded the assignments and 30% if I receive it after I have graded the assignments.

Quizzes may be given anytime. They may be announced or unannounced. They are worth about 10 pts each. Quizzes will be used to test the understanding of concepts and to encourage students to keep up with the material. **If a quiz is missed, it cannot be made up.** Generally, I drop the lowest quiz from the grades. If a quiz is missed, that is the one dropped. Extenuating circumstances may be considered at the instructor's discretion. If you expect to miss a class due to items such as interviews, professional trips, etc., please inform me by e-mail before the event. If you are caught in sudden events such as illnesses, family emergencies, etc. please inform me as soon as possible.

Anyone in the class who has a diagnosed disability or other special need should inform the instructor as soon as possible. The counseling center should also be notified so the counseling center can work with the instructor and student to best accommodate the situation.

ACADEMIC HONESTY:

Students with disabilities needing special consideration are requested to alert me at the first class.

Honor Code

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 Dishonesty Defined (Source: NDSU Policy 335, 2a-m)

Academic misconduct (intentional or otherwise) includes but is not limited to the following:

1. Plagiarizing, i.e., submitting work that is, in part or in whole, not entirely one's own, without attributing such portions to their correct sources.
    - Cases of apparently unintentional plagiarism or source misuse must be handled on a case-by-case basis and in the context of the instructor's policies. Unintentional plagiarism may constitute academic misconduct.
    - Improper attribution of sources may be a symptom of bad writing and not plagiarism. Instructors are encouraged to recognize that citation skills are developed over time and are contextual.
2. Receiving, possessing, distributing or using any material or assistance not authorized by the instructional staff member in the preparation of papers, reports, examinations or any class assignments to be submitted for credit as part of a course or to fulfill other academic requirements.
3. Unauthorized collaborating on individual assignments or representing work from unauthorized collaboration as independent work.
4. Having others take examinations or complete assignments (e.g., papers, reports, laboratory data, or products) for oneself.
5. Stealing or otherwise improperly obtaining copies of an examination or assignment before or after its administration, and/or passing it onto other students.
6. Unauthorized copying, in part or in whole, of exams or assignments kept by the instructional staff member, including those handed out in class for review purposes.
7. Altering or correcting a paper, report, presentation, examination, or any class assignment, in part or in whole, without the instructional staff member's permission, and submitting it for re-evaluation or re-grading.
8. Misrepresenting one's attendance or the attendance of others (e.g., by PRS or attendance sheet) in a course or practical experience where credit is given and/or a mandatory attendance policy is in effect.
9. Fabricating or falsifying information in research, papers, or reports.
10. Aiding or abetting academic misconduct, i.e., knowingly giving assistance not authorized by the instructional staff member to another in the preparation of papers, reports, presentations, examinations, or laboratory data and products.
11. Unauthorized copying of another student's work (e.g., data, results in a lab report, or exam).
12. Tampering with or destroying materials, (e.g., in order to impair another student's performance).
13. Utilizing false or misleading information (e.g., illness or family emergency) to gain extension or exemption on an assignment or test.

Lectures:

My plans are to start a major revision of this course. Student feedback and suggestions will be sought in the class evaluations. I will go through this list pretty much sequentially.

Topics (subject to possible change):

Introduction, pretest, history	Chapter 1
Combustion and Tier levels	
Overview of an off-road machine	
Tractor testing principles	
Machinery/Implement interface	
Ground/Propulsion system interaction	
Power Train principles	
Clutches and Brakes	
Engine Principles	
Electrical/Electronic Systems	
Operator Platform/Ergonomics	
CAN Bus	

Some topics will definitely be covered more thoroughly than others.

Laboratory exercises:

I will be working with Mr. Solseng and Mr. Moos to set up the laboratory exercises. These are topics to be considered. Working with them and the weather will affect which laboratory exercises are used and the dates they are used. Materials will be posted on the web a few days before the lab for students to familiarize themselves with the upcoming lab. There will be a major report required for the tractor-testing laboratory. Many other laboratory exercises will have in lab reports.

<u>Lab topics:</u>

Excel spreadsheets for eqn. solving
Big Iron
Engine testing
Possible CNH testing facility tour
Possible CNH assembly line tour
Power trains
Slippage and traction
Experimental Design
Presentations (each person, expected to cover 1 weeks)

<u>Final Exam is scheduled for Monday, December 16, 2018, from 1:00 p.m. to 3:00 p.m</u>

Some information concerning ABET:

Graduates are expected to have established themselves as practicing engineers who, within a few years of graduation:

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 biobased 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.

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 and
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.

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 and
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

NDSU undergraduate engineering programs are accredited by ABET. For more information about ABET, please visit https://www.abet.org/ ABET is also developed and administers the Fundamentals of Engineering (FE) exams and the Professional Engineering (PE) exams.

Problem Format:

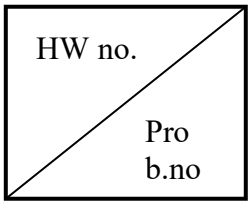
If using ASME engineering paper:

Fill out information including Name, Course, Homework no. and problem no on Problem line, and date due.

ON the sheet, Given: **including a sketch for the problem**, Find: listing the objectives, and the Soln. Include assumptions, show formulas, calculation line (formulas with numbers and units used) and box or underline answers and place ANSW by the answer.

For regular engineering paper or ordinary paper.

Top line: Date due, course, Name and page #/total pages in problem set (exp. 7/10).



Follow the procedure for Given, Find, and Sol'n. as mentioned for the ASME paper. For the ME paper, fill out the sections provided at the top of each sheet. **Every sheet in a problem set should have the basic information at the top of each sheet.** In the solution section you should have the formula(s) used, formulas if rearranged, values and units in the formulas, and the solution.

HW problems will be scored from 0-10 based on the solution (method and answer). Regardless of the final answer, 1 points will be deducted (per problem, as appropriate) for each of the guidelines not followed.

a) Use proper problem-solving format [Given, Find, Solution].
b) Including all given and assumed information. This should include a sketch when appropriate. Any starting equations should be noted [e.g. $T=F\cdot r$] and all terms/variables should be clearly defined with units [e.g. $r = 14.2$ cm].
c) Clearly show <u>all</u> work.
d) Include units clearly in all stages of calculations and show how they cancel out
e) Clearly mark final answer (underline or double underline).
f) Use an appropriate number of significant digits and scientific notation when appropriate.
g) Avoiding cramming too much on the paper – it facilitates mistakes and makes it difficult to follow.
h) Write on only one side of the paper.
i) Remove the frayed edges if using a spiral bound notebook.
j) Staple sheets together.

Note that does not apply to the problem, the student should note this on the sheet such as, "No assumptions were required." Up to 5 points may be taken off of a problem for

formatting issues. Hopefully this does not occur after the first HW assignment or two. My major focus points include putting in the diagram, following the order, and clearly stating the answer with

Rough homework examples follow.

Name: Joe Bison

Sheet 1 of 12

Course: ABEN-ME 479

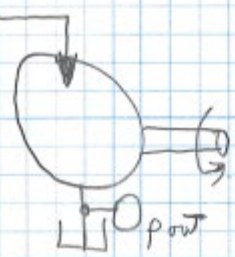
Problem: HW#5 Prob #1

Date: 08/22/2019

Given:

$Q_{in} = 20\,gpm$ p_1

$\eta_{overall} = 0.90$



$N = 800\,rpm.$

$P_{out} = 25\,hp.$

Find: p_1 for the system.

Solution:

Assumptions - pout of the motor = 0 psig.
- use gage pressures.
- ignore line loses.

More Than 1 method could be used to solve this problem.

$$\eta_{overall} = \frac{P_{out}}{P_{in}} = 0.90$$

$$P_{in} = \frac{P_{out}}{\eta_{overall}} = \frac{25\,hp}{0.90}$$

$$P_{in} = 27.7\overline{7}\,hp$$

$$P_{in} = \Delta p = p_1 - p_{out} = p_1 - 0 = p_1$$

$$P_{in} = P_{HYD} = \frac{\Delta P \cdot Q}{1{,}714\,\frac{psi \cdot gpm}{hp}}$$

$$\Delta p = \frac{1714\,\frac{psi \cdot gpm}{hp} \cdot P_{HYD}}{Q} = \frac{1{,}714\,\frac{psi \cdot gpm}{hp} \cdot 27.7\overline{7}\,hp}{20\,gpm}$$

$$\Delta p = 2{,}380.\overline{5}\,psig = p_1$$

$p_1 \cong 2380\,psi$ to $\approx 2{,}400\,psig$ Answer

Due: 08/22/2019 ABEN-ME 479 Joe Bison 1/12.

HW #5

Prob #1

Given:

$Q_{in} = 20\,gpm$

$\eta_{overall} = 0.90$

Find: p_1 for the system.

Solution:

Assumptions:
- $p_{out} = 0\,psig$
- use gage pressures
- ignore line loses

More than one method could be used to solve the problem.

$$\eta_{overall} = \frac{P_{out}}{P_{in}}$$

$$P_{in} = \frac{P_{out}}{\eta_{overall}} = \frac{25\,hp}{0.90}$$

$$P_{in} = 27.7\bar{7}\,hp$$

$$\Delta p = p_1 - p_{out} = p_1 - 0\,psig = p_1$$

$$P_{in} = P_{HYD} = \frac{\Delta p \cdot Q}{1{,}714\,\frac{psi\text{-}gpm}{hp}}$$

$$\Delta p = \frac{1{,}714\,\frac{psi \cdot gpm}{hp} \cdot P_{in}}{Q} = \frac{1{,}714\,\frac{psi\text{-}gpm}{hp} \cdot 27.7\bar{7}\,hp}{20\,gpm}$$

$$\Delta p = 2380.5\,psig = p_1$$

$p_1 \cong 2380\,psig$ (could also say $p_1 \cong 2{,}400\,psig$) Answer.