

**BBE 4xxx/5xxx Spring
Off-road Vehicle Design
Tues, 6:00-9:00 p.m., Nicholson Hall 115**

Contact Information:

Instructor

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Appointments by arrangement.

Text

Off-Road Vehicle Engineering Principles. C. E. Goering et al. 2003. ASAE Publication 801M10103

References

Vehicle Traction Mechanics. R. N. Yong et al. 1984. Elsevier Science Publications. ISBN 0-444-42378-8
Soil Cutting and Tillage. E. McKyes. 1985. Elsevier Science Publications. ISBN 0-444-42548-9
The Mechanics of Tractor-Implement Performance. R.H. Macmillan.
www.eprints.unimelb.edu.au

Class Objectives

The students in this class will develop an understanding of the mechanics involved in designing and testing an off-road vehicle. The lectures will focus on vehicle mechanics, traction and vehicle performance. The students will develop an understanding of the complexity and modeling of vehicle interaction with soil, muskeg, and snow.

Teaching Philosophy

My philosophy is to provide an unbiased forum that allows students to learn and develop knowledge in the area of Off-road Vehicle Design. Students are encouraged to express

their ideas and concerns during the course to enable a mutually enjoyable learning experience. Students are encouraged to keep in touch after finishing the course.

Grading and Coursework

1. Five sets of homework problems or questions. Worth 25 points per set.
2. Three exams including two mid-terms and a final. Exams are comprehensive building on concepts throughout class. The midterms are worth 100 points each and the final is worth 150 points. Examinations are open book and open notes.
3. Case study report. A 20-30 page design study of an off-road vehicle or system in the student's interest area. 100 points
4. *Project for graduate credit This project may be an extension of the case study or a separate project. The project shall include an in depth literature review of the topic chosen and the development of a paper for publication.*

**Points possible are: 150 homework + mid-terms 200 + final 150 + Case Report 100+(graduate project 150)
= 600 points**

GRADE SCALE (based on final percentage):

A 93-100% B+ 87-89.9% C+ 77-79.9% D+ 67-69.9%
A- 90-92.9% B 83-86.9% C 73-76.9% D 60-66.9%
B- 80-82.9% C- 70-73.9%

Late Work: Homework is due at the beginning of lecture on the date indicated on the assignment. **Only hard copies are accepted for grading (No email!!!).** A 10% reduction in points will be assessed for each day after the due date.

Make-ups: No make-ups are allowed for missed quizzes during lectures. Make-up assignments are allowed if negotiated prior to missing the work. No "extra" assignments are allowed to make up points

Incomplete Grade: An incomplete grade may be negotiated with the instructor. The terms of the incomplete, and the completion date of the deficient coursework must be agreed upon in writing at least one week before the date of the final exam. The document must be signed by the student and the instructor.

Scholastic Dishonesty: Scholastic dishonesty includes plagiarizing; cheating on assignments, examinations, or quizzes; engaging in unauthorized collaboration on academic work; taking, acquiring, or using test materials without faculty permission; submitting false or incomplete records of academic achievement; acting alone or in

cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement; altering forging, or misusing a University academic record; or fabricating or falsifying data, research procedures, or data analysis. It is also unacceptable to cut and paste web-based information, claiming it as your own work unless it is properly cited and used only to support your OWN original writing. If you have any doubts, please discuss questions with the course instructor BEFORE turning in an assignment.

A student who engages in or facilitates scholastic dishonesty can be assigned a penalty which can include an "F" or "N" for the course. If you have any questions regarding the expectations for a specific assignment or exam, ask. The University of Minnesota expects that ALL cases of scholastic dishonesty will be reported centrally along with supporting documentation.

Classroom Involvement and Attention: All students should be engaged in lectures, activities, and discussions. Laptop computers are allowed in the classroom for class-related activities such as note taking or tracking course notes/readings online. If you'd like to read the newspaper, surf the web, text message, or do things other than participate in class in a way that is obvious or distracting to classmates or the instructor, you will be asked to put the distracting material/item away. Please turn off cell phones before class, and DO NOT take calls while in class. If you are expecting someone to call (in the event of an urgent situation), please notify the instructor before class, and step outside before you take the call. No tobacco products of ANY type are allowed in class. You are welcome to eat in class, though please be discreet and clean up your area before you leave class.

Grade Disputes: If you would like to question the points you earned for a particular exercise, you may do so in writing only. Re-grading will be conducted on the whole piece of work.

Key Dates:

January 22nd	Tues	Classes begin
February 26	Tues	BBE 5480 Mid term examination-1
March 17-21st	Mon-Fri	Spring Break
April 8th	Tues	BBE 5480 Mid term examination-2
April 29th	Tues	Case Study Reports
May 6th	Tues	Final examination

Week	Topic	Reading
1 Jan 22	Development of Off-road Vehicles Types of vehicle, vehicle function, energy sources, energy conversion devices. Tractor design, world trends for off-road vehicles, engineering standards	Chapter 1
2 Jan 29	Engine Performance Measures Power flow in an engine, mean effective pressure, thermal efficiency, speed control and torque generation, performance maps, optimizing engine efficiency	Chapter 2
3 Feb 5	Engine and Vehicle Testing Engine dynamometers, measurement of fuel and air flow, combustion data acquisition and interpretation, standardized tractor tests	Chapter 3
4 Feb 12	Hydraulic Systems Hydraulic system components, types of hydraulic system, transient analysis, hydraulic control systems	Chapter 11
5 Feb 19	Drive Trains Clutches and brakes, transmission load matching, types of transmissions, power-shift and CVT transmissions, differentials and final drives	Chapter 12
6 Feb 26	Midterm 1	
7 Mar 4	Traction and Transport Devices Tire loading, deformation, pressure distribution, and dynamic stiffness and damping characteristics. Fundamental mechanics of traction. Traction testing, tire and soil parameters and traction prediction	Chapter 13
8 Mar 11	Chassis Mechanics Introduction and simplifying assumptions. Equations of motion, static force analysis. Lateral and longitudinal stability. Transient and steady state handling. Lateral stability in a steady state turn. Steering force analysis	Chapter 14
Mar 18	No Class Spring Break	
9 Mar 25	Human Factors and Safety Operator machine interface, control location using standards and anthropometric data. Control labeling. Operator environment heat balance. ROPS design and testing	Chapter 15

10 Apr 1	Vehicle Sound and Vibration Control Basics of sound measurement. In cab and external sound measurement. Sound measurement standards for vehicles. Vibration measurement and control, operator seating with active and passive suspension systems	Chapter 15 and reference material
11 Apr 8	Midterm 2	
12 Apr 15	Vehicle Ride Simulation An introduction to multi-body dynamics, methods for deriving equations of motion, overview of simulation software for MBD systems	Refs and handout material
13 Apr 22	Vehicle Electrical and Electronic Systems Fundamental elements of electrical systems, electronic control units and sensors, controller area networks on mobile equipment, system environmental concerns	Chapter 10
14 Apr 29	Design Presentations Presentation of completed designs for vehicle competition	
15 May 6	Final Examination	