ME 489/689 Vehicle Dynamics - I (3 Credits)
Spring 2024

Instructor: Dr. Xiangfa Wu, 206 Dolve Hall (231-8836), e-mail: xiangfa.wu@ndsu.edu
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Lecture Hours: **2:00 – 3:15 PM (T & Th)** Dolve 215 (Jan. 8 – May 10, 2024)
(Dead Week: April 29 – May 3)
Holidays: Martin Luther King, Jr. Day: Jan. 15 (Monday); President's Day: Feb. 19 (Monday); Spring Break: Mar. 4-8; Spring Recess: Mar. 29 - Apr. 1

Special Days: Jan. 18 (Thursday): Withdraw to zero credits at 100% refund
Feb. 19 (Monday): Withdraw to zero credits at 75% refund
Mar. 21 (Thursday): Withdraw to zero credits at 50% refund (no refunds for withdraw to zero credits after this date)
Apr. 5 (Friday): Last day to drop class with "W" record

Office Hours: **Tuesday & Thursday: 3:30 – 4:30 PM**, Other hours by appointments
Course Credit: 3

Course Website: https://bb.ndsu.nodak.edu
Prerequisite: Students registered in Professional Program

Textbook: Instructor's notes for lectures are available to students.
References:

T. D. Gillespie	Fundamentals of Vehicle Dynamics, Society of Automotive Engineers, 1992.
N. R. Jazar	Vehicle Dynamics: Theory and Application (3rd Ed.), Springer, 2017.
J. Y. Wong	Theory of Ground Vehicle (4th Ed.), John Wiley & Sons, 2008.
H. Pacejka	Tire and Vehicle Dynamics (3rd Ed.), Elsevier, 2012.
R. Limpert	Brake Design and Safety (2nd Ed.), Society of Automotive Engineers, 1999.
T. Dentom	Electric and Hybrid Vehicles, Taylor & Francis, 2016.
A. K. Baker	Vehicle Braking, Society of Automotive Engineers, 1986.
J. Reimpell & H.Stoll	The Automotive Chassis: Engineering Principles, Society of Automotive Engineers, 1996.

Course Description

This course covers the fundamental concepts, principles and methods to be used in design and operation of vehicles, built on knowledge of statics, kinematics, dynamics and machine design.

Course Objectives

1. To apply engineering sciences to automotive system design.
2. To introduce the key problems in the design and development of engineering systems such as vehicles.

Course Outcomes & Affected Program Outcomes

Expected student outcomes after the study of this course (skills that the students should possess at the completion of the course) and affected program outcomes are:

No.	Course Outcome	Affected Program Outcomes
1.	Students must be familiar with modern vehicles and their impacts to the society	2, 4
2.	Students must be familiar with dynamic axle loads.	1

3.	Students must be familiar with acceleration performance and vehicle stability during acceleration.	1, 2, 7
4.	Students must understand the Federal Motor Vehicle Standards.	2, 4
5.	Students must understand braking performance and vehicle stability during braking.	1, 2, 7
6.	Students must be familiar with road loads.	1, 7
7.	Students must be familiar with ride characteristics.	2
8.	Students must understand steady state cornering.	1
9.	Students must understand vehicle suspension.	1
10.	Students must be familiar with steering system.	1, 2,
11.	Students must understand rollover stability.	1,
12.	Students must understand vehicle structural energy absorption characteristics.	1,
13.	Students must be familiar with safety related issues.	2, 4
14.	Student must be familiar with new technological developments in ground vehicles.	2, 4, 7

Affected Program Outcomes

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
3. An ability to communicate effectively with a range of audiences
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
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
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Grading:

	Undergraduates	Graduates	Grading Scale	
Homework	15%	10%	90% or higher	= A
Quizzes (4)	15%	15%	80% - 89.99%	= B
Midterm exams (2)	30%	30%	70% - 79.99%	= C
Presentation/Project	20%	25%	60% - 67.99%	= D
Final	20%	20%	Below 60%	= F

No scaling will be applied.

Graduate students: a). Take special examinations; b). Prepare a written paper or, time permitting, an oral presentation on an instructor-selected topic related to the course material but not covered in class (points awarded will be reflected in the Homework section of grading scale); c). Prepare a written review of a recent journal article on an appropriate topic (points awarded in Homework section of grading scale).

General policies:

1. Only neatly written problems will be graded.
2. A correct answer without a correct derivation will not carry any grade.
3. All incorrect work must be clearly crossed out on the page.

4. In cases where more than one solution is presented, the solution with the most errors will be graded.
5. Each solution must have proper units.
6. Only under unusual circumstances (illness, accident, etc.) will a makeup exam be given if a student misses an exam, or final.
7. **Class notes and references** are allowed in all exams (including the final) and quizzes.

All arrangements for makeup exams must be made in advance of the regularly scheduled exams.

Homework Assignments:

1. Homework assignments and due dates will be posted through the electronic course blackboard.
2. Homework assignments are requested to work on engineering paper with necessary steps and descriptions.
3. Late assignments will not be accepted unless, under unusual circumstances, special arrangements are made at least 24 hours in advance. In general, no makeups will be given.
4. You are welcome to discuss your homework with others and the instructor. However, you are expected to do the work yourself.

Term Project/Presentation:

All students are required to complete a group project (with 3 or 4 members enrolled in this class), which will involve a certain topic of vehicle dynamics that may or may not be covered in class or an in-depth understanding of an interesting topic with practical applications. **Your responsibility is to formulate an engineering problem statement and then perform the engineering analysis and/or research, but not just to conduct a routine literature review.**

An executive summary, less than one page, will be posted on Blackboard as the Project Definition (with project title, group member names, brief project description, and sketch/diagram if necessary).

The project report must be typed in MS-Word and printed, and the corresponding electronic version (*.docx/*.PDF) should be submitted. The report may include an executive summary, historical background/introduction, problem statement, analytical description and solution, applications, advantages and disadvantages, relationship with the other subjects of dynamics, recommendations, acknowledgements, and references. The length of the project report should be no more than 12 pages [with single column, single space, font type: times new roman, font size: 11 pounds, page margins (top, bottom and sides): 1 inch].

The oral presentation (20 minutes for presentation and 5-10 minutes for questions) is based on the study and outcomes of the term project. All the group members are required to present the project. An electronic PPT or PDF file of the presentation is required to submit.

Honesty:

All work in this course must be completed in a manner consistent with NDSU University Senate Policy, Section 335. Code of Academic Responsibility and Conduct (available on the Web at http://www ndsu.nodak.edu/policy/335.htm). Violation of this code will result in a penalty or penalties to be determined by the instructor to fit the extent of the offense and the circumstances of the particular case. The instructor may: (1) fail the student for the particular assignment or test, (2) give the student a failing grade in the course, or (3) recommend that the student drop the course.

Attendance:

Students should realize that there are materials covered in class, which may not be discussed in the textbook. Every student is responsible for **ALL** material presented in class whether or not s/he was present in class. If you miss a class, it is your responsibility to obtain notes from other classmates. Full credit can be received for work

turned in late due to an excused absence. It is the student's responsibility to contact the instructor in such a case. If you are going to miss a test for a good reason, inform your instructor **BEFORE** the test to arrange for a make-up exam. In such a case, a **written document/memo** with authority's signature or administrative approval is needed.

"Veterans and student soldiers with special circumstances or who are activated are encouraged to notify the instructor in advance."

Disabilities:

Any student with disability who needs accommodations is encouraged to talk to the instructor as soon as possible to make appropriate arrangements for these accommodations

Tentative Course Outline (Subject to changes):

Week		Days	Topics	HW Problems to be posted on blackboard
1	T	1/9	Introduction of Modern Vehicles & Vehicle Dynamics	
	Th	1/11	Introduction of Modern Vehicles & Vehicle Dynamics	
2	T	1/16	Fundamental Approaches to Vehicle Modeling	
	Th	1/18	Fundamental Approaches to Vehicle Modeling	
3	T	1/23	Acceleration Performance	
	Th	1/25	Acceleration Performance	
4	T	1/30	Acceleration Performance	
	Th	2/1	Braking Performance	
5	T	2/6	Braking Performance	
	Th	2/8	Braking Performance	
6	T	2/13	**Exam I**	
	Th	2/15	Road Loads	
7	T	2/20	Road Loads	
	Th	2/22	Ride	
8	T	2/27	Ride	
	Th	2/29	Ride	
9		3/4-8	**Spring Break (No Class)**	
10	T	3/12	Steady-state Cornering	
	Th	3/14	Steady-state Cornering	
11	T	3/19	Suspension Mechanisms	
	Th	3/21	Suspension Mechanisms	
12	T	3/26	Steering Systems	
	Th	3/28	Steering Systems	
13	T	4/2	Steering Systems	
	Th	4/4	**Exam-II**	
14	T	4/9	Rollover	
	Th	4/11	Rollover	
15	T	4/16	Tires	
	Th	4/18	Tires	
16	T	4/23	Vehicle Vibration & Collision	
	Th	4/25	Vehicle Vibration & Collision	
17	T	4/30	Project Presentation (**Dead Week**)	
	Th	5/2	Project Presentation (**Dead Week**) **- Project Report Due**	
Final			**Final Exam at 8:00 - 10:00 AM, Thursday, May 9**	