

Course Outline

1. COURSE INFORMATION

Course Code	AUTO TECH 4DV3	
Course Name	Vehicle Dynamics	
Session	Fall 2015	
Date(s) and Time(s) of lectures	Wednesday(8:30-10:20 AM), Friday(12:30-13:20AM)	
Program Name	Automotive and Vehicle Technology	
Calendar Description	Acceleration performance; braking performance; aerodynamics and rolling resistance; ride; tires; steady-state cornering; suspensions; steering systems; rollover.	
Instructor	Name(s): Moein Mehrdash e-mail address: Mehrash@mcmaster.ca	Office Hours: Friday 10:00-11:30 AM
Teaching Assistant (TA)	Name(s): N/A e-mail address:	Office Hours: N/A

2. COURSE SPECIFICS

Course Objectives	<p>A ground motor vehicle is generally intended as a vehicle with mechanical propulsion which can move on the surface of the earth. A modern motor vehicle is supported on wheels with pneumatic tires has energy source that provides the propulsion. Motor vehicle mechanics, intended as the branch of applied mechanics studying the behavior of motor vehicles and their performance. The motor vehicle performance study is started with forces acting on the motor vehicle including the behavior of pneumatic tires and aerodynamics of the vehicles. The dynamic of vehicle can then be used to predict the performance of road vehicle, such as acceleration, braking, rollover, and cornering performance. The dynamic response of vehicle to various excitation sources is another aspect of road vehicle dynamics for ride comfort considerations.</p> <p>The goal of the course is intended to provide information on road vehicle dynamics that will be useful to students in automotive engineering program. Its primary objective is to provide a description of performance, handling, and ride of ground motor vehicle. A combination of six hands-on experiences with lecture material provides outstanding learning outcomes and solid background for the students as future automotive engineers. This course's secondary objective is to serve as obtaining experience in working with automotive standards and test procedures</p>		
Instruction Type	Code	Type	Total Hours
	C	Classroom Instruction	

	L	Laboratory, workshop or fieldwork	
	T	Tutorial	
	DE	Distance Education	
	TOTAL HOURS		
Resources	ISBN	Textbook Title & Edition	Author & Publisher
	1560911999	Fundamentals of Vehicle Dynamics	Thomas D. Gillespie, Society of Automotive Engineers 1992
	Other Supplies	Theory of Ground Vehicles, J.Y. Wong, John Wiley & Sons, 2008 Road Vehicle Dynamics: Fundamentals and Modeling, Georg Rill, Crc Press Llc, 2011	
	Book Available	McMaster Bookstore	
Prerequisite(s)	AUTOTECH 3VD3, 4AE3		
Corequisite(s)			
Antirequisite(s)			
Course Specific Policies	<p>A. Assignments: The assignment submission is mandatory (zero for late submission). Assignments must be uploaded to the specified Dropbox on the Avenue to Learn (Hard-copy is not acceptable as a submission). Students are responsible to upload the assignment to the specified folder, failure to do that will not be considered as a submission.</p> <p>B. Labs: (Due Date: Lab report must be submitted in one-weeks from the lab session, Group submission) Lab attendance is mandatory. Labs missed due to illness may be excused by the professor if appropriate documentation is provided and the student completes the lab missed on his/her own time, to the professor's satisfaction.</p> <p>Students must complete and submit the lab assignments before the due date posted on Avenue. Lab reports submitted after the posted dead-line or without attending the lab will not be accepted. Lab reports must be uploaded to the specified Dropbox on the Avenue to Learn (Hard-copy is not acceptable as a submission). Students are responsible to upload the Lab reports to the specified folder, failure to do that will not be considered as a submission.</p> <p>The Lab will be held in rotating routines, thus re-arranging a new lab session for missed experiment is hardly possible.</p> <p>C. Project (Due Date: Last day of Fall calendar, Dec 8 th 2015) The project should cover a simulation with the CarSim software. If the simulation file cannot be executed by the instructor, the mark will be zero. Please make sure that your simulation files work well. Your summary report should be maximum of 5 pages in length and must be uploaded to the specified folder. Make sure your document is professional organized (if a template is provided, use the template). The report must include the result and discussion. Please use your space efficiently. You have to report the discussion and findings,</p>		

	not general information. The due day for the project is strict and cannot be changed. No mark for submission after the due date.	
Departmental Policies	<p>-Students must maintain a 3.5/12 GPA to continue in the program.</p> <p>-In order to achieve the required learning objectives, on average, B.Tech. students can expect to do at least 3 hours of “out-of-class” work for every scheduled hour in class. “Out-of-class” work includes reading, research, assignments and preparation for tests and examinations.</p> <p>-The use of cell phones, iPods, laptops and other personal electronic devices are prohibited from the classroom during the class time, unless the instructor makes an explicit exception.</p> <p>-Announcements made in class or placed on Avenue are considered to have been communicated to all students including those individuals that are not in class.</p> <p>-Instructor has the right to submit work to software to identify plagiarism.</p> <p>-Instructor is permitted to enforce a preference to shut off all electronic devices during class.</p>	
3. SUB TOPIC(S)		
Lecture No.	Topics	Text Book
Week 1	Tire Mechanics a. Introduction to coordinate system and pneumatic tire b. Rolling resistance c. Test procedures available to measure rolling resistance d. Tractive, braking, and lateral force generation and calculation	Ch. 4 and Ch. 10
Week 2	Road Vehicle Aerodynamic a. Aerodynamic forces b. Aerodynamic Optimization c. Coastdown test: theory and procedure	Ch. 4
Week 3	Static Loads: e. Coordinate systems f. Load distribution: static loads, low speed acceleration, loads on grades g. Power plant and transmission characteristics	Ch. 1
Week 4	Longitudinal Performance I: Acceleration a. Power-limited acceleration b. Traction-limited acceleration c. Maximum speed	Ch. 2
Week 5	Longitudinal Performance II: Braking a. Intro to braking forces b. Braking equation and stopping distance calculation c. Brake Proportioning d. Requirement for braking performance	Ch. 3
<i>Mid-term recess (Monday, October 12 to Saturday, October 17)</i>		
Week 6	Review and Term Test #1	
Week 7	Lateral Performance: Handling a. Steering geometry b. Steady-state handling of two-axle vehicle (neutral steer, understeer, and oversteer) c. Suspension effect in handling characteristics	Ch. 6 and Ch. 8

	d. Testing of handling characteristics (constant radius test, constant speed test, and constant steer angle test)	
Week 8	Vehicle Ride Characteristic a. Intro. to ride dynamic and perception b. Intro. to random vibration and road roughness modeling c. Internal excitation source of vibration: tire, driveline, and engine d. Two-degree-of-freedom vehicle model for sprung and unsprung mass e. Quarter-car model f. Two-degree-of-freedom vehicle model for pitch and bounce g. Passive vs. active suspensions performance evaluation h. Suspension system (structures, anti-squat and anti-dive geometry, performance categories)	Ch. 5 and Ch. 7
Week 9	Review and Term Test #2	
Week 10	Rollover a. Quasi-static rollover of a rigid vehicle b. Quasi-static rollover roll over of a suspended vehicle c. Dynamic rollover d. Lateral collision with the curb	Ch. 9
Week 11	Lateral Performance: Handling Tractor-semitrailer a. Jackknifing b. Trailer swing	Note
Week 12	Vehicle Dynamic Simulation Softwares: a. CarSim b. MapleSim c. ADAMS/CAR Final Review	Note
List of laboratory experiments:		
Lab 1	CarSim I: Tire Mechanics	
Lab 2	Aerodynamic Drag Calculation of a Vehicle	
Lab 3	Road Test Handling: Constant Velocity Cornering	
Lab 4	Suspension Experiment: Quarter and Half Car (Pitch & Bounce Analysis)	
Lab 5	CarSim II: Acceleration	
Lab 6	CarSim III: Brake System	
Lab schedule	Some of the labs will be performed on a rotating basis. The actual lab schedule will be provided by the instructor	
<p>FINAL EXAMINATIONS will be scheduled, conducted and invigilated by the Office of the Registrar. All students entering the examination room must produce a McMaster photo identification card. No other identification will be accepted. In addition, for classes that allow you to use a calculator, you must use the McMaster standard calculator. For details, please consult your Instructor.</p> <p>Note: this structure represents a plan and is subject to adjustment term by term. The instructor and the university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes.</p>		
4. ASSESSMENT OF LEARNING *including dates*		Weight
Term Test I		15
Term Test II		15
Lab Activities		20
Assignments		10

Active Learnings	5
Project	5
Final Exam	30
TOTAL	100

Percentage grades will be converted to letter grades and grade points per the University calendar.

5. LEARNING OUTCOMES

- A. Understand and generalize specific facts in road vehicle dynamics:
1. **Identify** the road loads (aerodynamic, tractive, and rolling resistance) experienced by a road vehicle
 2. **Interpret** the design considerations of a road vehicle performance in acceleration, braking, cornering, and rollover
 3. **Explain** the fundamental of ride excitation sources and how to tune vehicle response for the comfort ride
 4. **Understand** the vehicle rollover and accident experience
- B. Apply the knowledge in vehicle road test and lab experimentation situation:
1. **Determine** the road drag (rolling resistance and aerodynamic drag) of a vehicle
 2. **Demonstrate** the barking performance of a road vehicle (stopping distance and ergonomic design) based on automotive standards
 3. **Calculate** the understeer coefficient in the constant-radius test
- C. Analyze and critically evaluate the road vehicle performance
1. **Analyze and predict** vehicle performance in handling, ride, and roll stability.
 2. **Design and develop** standard road tests to evaluate the vehicle performance
 3. **Simulate** the performance a road vehicle dynamic using SimCar

6. POLICIES

Anti-Discrimination

The Faculty of Engineering is concerned with ensuring an environment that is free of all discrimination. If there is a problem, individuals are reminded that they should contact the Department Chair, the Sexual Harassment Officer or the Human Rights Consultant, as soon as possible.

<http://www.mcmaster.ca/policy/General/HR/Anti-Discrimination%20policy.pdf>

Academic Integrity

You are required to exhibit honestly and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various kinds of academic dishonesty please refer to the Academic Integrity Policy, located at: <http://www.mcmaster.ca/policy/Students-AcademicStudies/AcademicIntegrity.pdf>.

The following illustrates only three forms of academic dishonesty:

1. Plagiarism. E.g. the submission of work that is not own or for which other credit has been obtained
 2. Improper collaboration in group work
- Copying or using unauthorized aids in tests and examinations.

Requests for Relief for Missed Academic Term Work (Assignments, Mid-Terms, etc.)

The McMaster Student Absence Form is a self-reporting tool for **Undergraduate Students** to report absences that last up to 3 days and provides the ability to request accommodation for any missed academic work. Please note, this tool cannot be used during any final examination period.

You may submit a maximum of 1 Academic Work Missed requests per term. It is YOUR responsibility to

follow up with your Instructor immediately regarding the nature of the accommodation.

If you are absent more than 3 days or exceed 1 request per term you MUST visit your Associate Dean's Office (Faculty Office). You may be required to provide supporting documentation.

This form should be filled out immediately when you are about to return to class after your absence.

<http://www.mcmaster.ca/msaf/>

E-Learning Policy

Consistent with the Bachelor of Technology's policy to utilize e-learning as a complement to traditional classroom instruction, students are expected to obtain appropriate passwords and accounts to access Avenue To Learn for this course. Materials will be posted by class for student download. It is expected that students will avail themselves of these materials prior to class. Students should be aware that, when they access the electronic components of this course, private information such as first and last names, user names for the McMaster e-mail account, and program affiliation may become apparent to all other students in the course. The available information is dependent on the technology used. Continuation in this course will be deemed consent to this disclosure. If you have any questions or concerns about this disclosure please discuss this with the course instructor. Avenue can be accessed via

<http://avenue.mcmaster.ca>.

Communications

It is the student's responsibility to:

- Maintain current contact information with the University, including address, phone numbers, and emergency contact information.
 - Use the University provided e-mail address or maintain a valid forwarding e-mail address.
 - Regularly check the official University communications channels. Official University communications are considered received if sent by postal mail, by fax, or by e-mail to the student's designated primary e-mail account via their @mcmaster.ca alias.
 - Accept that forwarded e-mails may be lost and that e-mail is considered received if sent via the student's @mcmaster.ca alias.
- Check the McMaster/Avenue email and course websites on a regular basis during the term.

Turnitin (Optional)

This course will be using a web-based service (Turnitin.com) to reveal plagiarism. Students submit their assignment/work electronically to Turnitin.com where it is checked against the internet, published works and Turnitin's database for similar or identical work. If Turnitin finds similar or identical work that has not been properly cited, a report is sent to the instructor showing the student's work and the original source. The instructor reviews what Turnitin has found and then determines if he/she thinks there is a problem with the work. Students who do not wish to submit their work to Turnitin.com must still submit a copy to the instructor. No penalty will be assigned to a student who does not submit work to Turnitin.com. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, etc.). To see the Turnitin.com Policy, please go to

<http://www.mcmaster.ca/academicintegrity/turnitin/students/>

Protection of Privacy Act (FIPPA)

The Freedom of Information and Protection of Privacy Act (FIPPA) applies to universities. Instructors should take care to protect student names, student numbers, grades and all other personal information at all times. For example, the submission and return of assignments and posting of grades must be done in a manner that ensures confidentiality.

<http://www.mcmaster.ca/univsec/fippa/fippa.cfm>

Academic Accommodation of Students with Disabilities Policy

Students who require academic accommodation must contact Student Accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contacted by phone 905-525-9140 ext. 28652 or e-mail sas@mcmaster.ca. For further information consult McMaster's policy for Academic Accommodation of Students with Disabilities

<http://www.mcmaster.ca/policy/Students-AcademicStudies/AcademicAccommodation->

[StudentsWithDisabilities.pdf](#)

Students must forward a copy of the SAS accommodation to the instructor of each course and to the Program Administrator of the B.Tech. Program immediately upon receipt. If a student with a disability chooses NOT to take advantage of a SAS accommodation and chooses to sit for a regular exam, a petition for relief may not be filed after the examination is complete. <http://sas.mcmaster.ca>

Student Code of Conduct

The Student Code of Conduct (SCC) exists to promote the safety and security of all the students in the McMaster community and to encourage respect for others, their property and the laws of the land. McMaster University is a community which values mutual respect for the rights, responsibilities, dignity and well-being of others. The purpose of the Student Code of Conduct is to outline accepted standards of behavior that are harmonious with the goals and the well-being of the University community, and to define the procedures to be followed when students fail to meet the accepted standards of behavior. All students have the responsibility to familiarize themselves with the University regulations and the conduct expected of them while studying at McMaster University.

<http://judicialaffairs.mcmaster.ca/pdf/SCC.pdf>