

Course Outline

1. COURSE INFORMATION

Session Offered	Winter 2015	
Course Name	Modelling and Simulation	
Course Code	AUTO TECH 4MS3	
Date(s) and Time(s) of lectures	Monday, 9:30 – 11:20, MARC/266 Thursday, 13:30 – 14:20, MARC/266	
Program Name	Automotive and Vehicle Technology	
Calendar Description	Multi-body dynamic modelling and simulation of automotive vibrations (ADAMS software); car body modelling; complex multi-body dynamic models and parametric solid models; engine modelling.	
Instructor(s)	Dr. D. Centea	E-Mail: Avenue Mail Office Hours & Location: MARC/272 – by appointment

2. COURSE SPECIFICS

Course Description	The course covers topics related to multibody dynamics and creates a bridge between classical vehicle dynamics and the widely-used, computer-based technique of multibody systems analysis. The first part of the course covers a three-dimensional vectorial analytical approach the multibody dynamic systems applied to vehicle dynamics. The second part of the course covers modelling of automotive suspension and the full vehicle in order to perform multibody system analysis of their dynamic behaviour through computer simulations. The lab component includes modelling and simulation of automotive systems using the multibody dynamics software ADAMS, full vehicle dynamics analyses using ADAMS/Car and Carsim. Technical reports and a design project are used to assess the modelling and simulations skills.		
Instruction Type	Code	Type	Hours per term
	C	Classroom instruction	38
	L	Laboratory, workshop or fieldwork	39
	T	Tutorial	
	DE	Distance education	
	Total Hours		77
Resources	ISBN	Textbook Title & Edition	Author & Publisher
	ISBN 13: 978-0-7506-5112-7	The Multibody Systems Approach to Vehicle Dynamics	Blundell, M. & Harty, D. <i>Elsevier</i>
	Other Supplies	Source	
Prerequisite(s)	AUTOTECH 2AC3, 3AV3, 3VD3, ENG TECH 3FE3, 3MN3		
Corequisite(s)			
Antirequisite(s)			
Course Specific Policies	The course includes a lecture component and a lab component. The lab component is mandatory. A student who does not attend a lab will not get the corresponding lab mark. A minimum of 50% for the lab component and a minimum of 50% for the lecture component are required to pass the course. All material submitted after the deadline will not be marked or reviewed		

Departmental Policies	<p>Students must maintain a GPA of 3.5/12 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>Where group work is indicated in the course outline, such collaborative work is mandatory.</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>	
3. SUB TOPIC(S)		
Week 1	<p>Introduction</p> <ul style="list-style-type: none"> ○ What is vehicle dynamics ○ Why analyse? ○ Commercial computer packages 	Chapter 1
Week 2	<p>Multibody systems simulation software</p> <ul style="list-style-type: none"> ○ Modelling features: reference frames, model components, parts, markers, equations of motion, constraints, joints, DOF, forces, and moments ○ Pre- and post-processing 	Chapter 3
Week 3	<p>Kinematics and dynamics of rigid bodies</p> <ul style="list-style-type: none"> ○ Theory of vectors: position, dot product, cross product, rotation, transformation, differentiation, integration ○ Geometry analysis: three point method, vehicle suspension geometry analysis 	Chapter 2
Week 4	<p>Kinematics and dynamics of rigid bodies</p> <ul style="list-style-type: none"> ○ Velocity analysis ○ Acceleration analysis 	Chapter 2
Week 5	<p>Kinematics and dynamics of rigid bodies</p> <ul style="list-style-type: none"> ○ Static force and moment analysis ○ Dynamics of a particle ○ Linear momentum of a rigid body ○ Angular momentum ○ Moments of inertia 	Chapter 2
Week 6	<p>Kinematics and dynamics of rigid bodies</p> <ul style="list-style-type: none"> ○ Parallel axes theorem ○ Principal axes ○ Equations of motion 	Chapter 2
<i>Mid-term recess (Monday, February 16 to Saturday, February 21)</i>		
Week 7	<p><i>Mid-term test</i></p> <p>Modelling and assembly of the full vehicle</p> <ul style="list-style-type: none"> ○ Modelling of vehicle body. ○ Modelling of suspension system: suspension models, springs and dampers, anti-roll bars 	<p>Chapters 1 ... 3</p> <p>Chapter 6</p>

Week 8	Modelling and assembly of the full vehicle <ul style="list-style-type: none"> ○ Aerodynamics effects ○ Modelling of vehicle braking 	Chapter 6
Week 9	Modelling and assembly of the full vehicle <ul style="list-style-type: none"> ○ Modelling traction ○ Modelling of steering system ○ Driver behaviour ○ Comparison of full vehicle handling models 	Chapter 6
Week 10	Simulation output and interpretation <ul style="list-style-type: none"> ○ Travel on a curved path ○ Steady state cornering ○ Ackerman steering ○ Understeer and oversteer 	Chapter 7
Week 11	Active systems <ul style="list-style-type: none"> ○ Active suspension and variable damping ○ Brake-based systems ○ Active steering systems 	Chapter 8
Week 12	Modeling and simulation of complex systems	
Week 13	<i>Review</i>	
Classes end – Wednesday, April 8, 2015 Final examination period: Friday, April 10, 2015 to Thursday, April 30, 2015 All examinations MUST BE written during the scheduled examination period.		
List of experiments		
Lab 1	Introduction to Adams	
Lab 2	Adams – Advanced 2D multibody dynamic modelling and functions	
Lab 3	Adams – Multibody dynamic modelling and grid manipulation	
Lab 4	Adams – Parametric modelling	
Lab 5	Adams – Importing solid-model geometry	
Lab 6	<i>Lab test – Multibody Dynamics using Adams</i>	
<i>Mid-term recess (Monday, February 16 to Saturday, February 21)</i>		
Lab 7	Adams/Car	
Lab 8	Adams/Car	
Lab 9	CarSim	
Lab 10	CarSim	
Lab 11	Design project	
Lab 12	Design project	
Lab 13	Design project	
Note that 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.		
4. ASSESSMENT OF LEARNING *including dates*		Weight
Mid-term test		20%
Quizzes		10%
Lab participation and reports		10%
Lab test		15%
Lab project		5%
Final examination (tests cumulative knowledge)		40%
TOTAL		100%
Percentage grades will be converted to letter grades and grade points per the University calendar.		

5. LEARNING OUTCOMES

1. Analyse kinematics and dynamics of rigid bodies using an analytical approach
2. Investigate mechanical systems using multibody system analysis
3. Develop models of automotive subsystem using multibody system simulation software
4. Simulate the dynamic behavior of mechanical automotive subsystems
5. Evaluate the dynamic response of full-vehicle models on various road surfaces
6. Prepare technical reports on modelling automotive systems and on evaluating simulation results
7. Design and refine automotive subsystems using specialized CAE software packages

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
3. 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 5 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 5 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>