This course covers advanced materials related to mathematical models and designs in automotive vehicles as multiple degrees of freedom systems to describe their dynamic behaviors in acceleration, braking, steering, rollover, aerodynamics, suspensions, tires, and drive trains. 3 credit hours.

- **Prerequisite**
  Undergraduate courses in dynamics of machines (MAE 315), aerospace structures (MAE 472) or equivalent or consent of instructor.

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**Course Objectives**

A special focus of this course aims at enabling students to apply the theories they learned in mechanics, energy, structures, design, materials, dynamics, aerodynamics, vibrations, and controls to a real-world system they encounter every day. From the basic theories, this course further extends to the development in next-generation vehicle technologies.

By the end of the course, the students will be able to:

- Demonstrate a skill to apply basic theories to establish useful models for either the entire vehicle or components of the vehicle.
- Interpret the properties of critical factors in vehicle motion control
- Apply the models established from basic theories for vehicle design and improvement
- Identify key components and their working principles of modern vehicles
- Identify the technology improvements in vehicles in the last several decades
- Identify technologies critical to next-generation vehicle designs based on literature reviews and actual test data.
- Relate the course materials to daily driving experience of a vehicle, in particular those related to driving safety.

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**Tentative Course Topics**

**Outline of Course**

<table>
<thead>
<tr>
<th>Lecture weeks (two 75 minute lectures per week)</th>
<th>Topics</th>
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<tr>
<td>Week 1</td>
<td>Course Syllabus and Policies; Introduction: history, vehicle classifications, fundamental approaches to vehicle dynamics modeling, motion analysis, force analysis, and energy analysis</td>
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<tr>
<td>Week 2-3</td>
<td>Acceleration Performance: power train components; power-limited acceleration; traction limited acceleration; transverse weight shift; front wheel drive vs rear wheel drive vs. all-wheel drive vehicles</td>
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<td>Week 4-5</td>
<td><strong>Braking Performance</strong>: braking force analysis; brake design and analysis; federal regulation on braking performance; anti-lock braking system; wheel lock-up; tire/road friction; safety and maintenance issues in braking.</td>
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<td>Week 6</td>
<td><strong>Road Loads</strong>: wind drag and car body design, rolling resistance; breakdowns of total road loads; gas mileage analysis and driving styles</td>
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<td>Week 7-9</td>
<td><strong>Tire and Tire Dynamics</strong>: tire specifications and constructions; tire motion analysis; tire force analysis; tire contact stress analysis; tire vibration analysis; tire wear and maintenance.</td>
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<tr>
<td>Week 9</td>
<td>Mid Term Examination</td>
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<td>Week 10</td>
<td><strong>Ride</strong>: riding comfort; perception of vibration; vibration sources; vibration transmission to the passengers; vibration models; vibration isolation techniques.</td>
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<td>Week 11-12</td>
<td><strong>Cornering/steering</strong>: lower speed cornering; high speed corner; cornering bicycle model; steering angle; suspension roll and cornering performance; over-steering vs. under-steering; cornering force analysis.</td>
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<tr>
<td>Week 13-14</td>
<td><strong>Suspension Systems</strong>: general kinematics; vehicle constraint analysis; practical designs; active suspension systems</td>
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<tr>
<td>Week 15</td>
<td><strong>Future trends in vehicle design</strong></td>
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- **Course Requirements**

  **Homework Assignments**: 20% For on-campus students, homework assignments should be submitted in the beginning of the class on the scheduled due day, collected either by the instructor or the studio. For off-campus students, homework assignments can be submitted electronically to: Homework_EOL@ncsu.edu before 12:00 PM on the scheduled due day. Make sure that the cover page contains the course number, instructor's name, number of the assignment, the date the video is viewed, and the corresponding due date.

  **Examinations**: One midterm exams (25%), one term report (25%) and a Final Exam (30%).

  **Software Requirement**: Access to standard engineering software (MATLAB, Excel, etc.) MATLAB is accessible through the Virtual Computing Lab.

  **PROJECTS**: none.
Textbook & References


Reference books:


Computer and Internet Requirements

NCSU and Engineering Online have recommended minimum specifications for computers. For details, click here.

Instructor

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