Dynamic Analysis and Controls of Automatic Transmissions

AUTO 563

Shushan Bai
GM Powertrain
Know Each Other

- Your name, work experiences, academic background and etc.
- Your expectation to the course.
<table>
<thead>
<tr>
<th>Session</th>
<th>Topic</th>
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| 1 Jan. 8 | **Introduction to the world of automatic transmissions**  
Static analysis of planetary gear trains  
Torque ratio and speed ratio analysis using algebraic method, level diagram method and matrix method. |
| 2 Jan. 15 | **Gear shift mechanics** |
| 3 Jan. 22 | **Simulation of dynamic systems in SIMULINK** |
| 4 Jan. 29 | **Dynamic modeling and analysis of planetary gear trains:**  
Dynamic modeling of simple planetary gear sets and planetary gear trains. Generic dual clutch model to simulate gear shifting. |
| 5 Feb. 5 | **Hydraulic control systems and simulation models:**  
Proportional pressure control solenoid, pressure regulating valve, hydraulic actuator, pulse width modulated (PWM) solenoid, clutch control system, and overall hydraulic control system. |
| 6 Feb. 12 | **Clutch-to-clutch shift controls:**  
| 7 Feb. 19 | **Midterm preparation and final project kickoff** |
| 8 Feb. 26 | **Midterm exam** |
| 9 Mar. 5 | **Winter Break (no class).** |
| 10 Mar. 12 | **Presentation of final project proposal** |
| 11 Mar. 19 | **Shift scheduling system and integrated powertrain control:**  
Performance, drivability and fuel economy. Shift map based and AI based shift-scheduling system.  
Integrated powertrain control. |
| 12 Mar. 26 | **Electronically controlled torque converter clutch:**  
Control strategies, stability and response, disturbance rejection.  
**Friction launch control**  
Mechanization of friction launch clutches: DCT, MTA. Control strategies. |
| 13 Apr. 2 | **Belt CVT ratio and torque capacity control** |
| 14 Apr. 9 | **Torsional vibration damper and centrifugal pendulum vibration absorber** |
| 15 Apr. 16 | **Dual clutch transmission (DCT) and controls**  
**Final project preparation** |
| 16 Apr. 23 | **Presentation of final project.** |

Class Expectation: active involvements, learning through discussions
Grading Police:
2 home works before the midterm (25%)
Midterm (25%)
Final Project (50%)

Will consider curve the grade if necessary
• Matlab/Simulink is used throughout the course for modeling and simulation of transmissions and control systems.
• Matlab/Simulink is not a prerequisite, and there will be tutorial sessions.
• If you are not familiar with Matlab/Simulink, it is a plus if you do some self teachings before hand.

http://www.mathworks.com/academia/student_center/tutorials/
http://www.engin.umich.edu/class/ctms/
• No regular office hour. If necessary could meet by appointment.

• Feel free to email me if you need any help.
  ✓ sbai@umich.edu
  ✓ shushan.bai@gm.com
Final Project Essentials

- Group work is highly encouraged (3 to 4 members per group)
- Project has to be built off of topics and techniques introduced in the class.
- A list of suggested final projects will be provided, it is highly recommended to choose from the list.

**Professional work is expected**
- Project approval presentation and peer review
- Written project report
- Oral project presentation
- Literature search

**Written report format (5-7 pages with references sited)**
- Abstract
- Purpose
- Literature search
- Discussion
  - Physical system description
  - Control description
  - Approach to modeling
  - Model description
  - Simulation Results
  - Major areas of discovery
  - Conclusion/Recommendations

**Presentation 15 min with Power Point (off campus students provide voice over Power Point)**

**Projects will be eligible for an A+ by meeting the above requirements and:**
- Demonstrating modeling and simulation skills above those demonstrated in class.
- Selection of an innovative or topical system to work on
- Teaches something above and beyond the formal class content