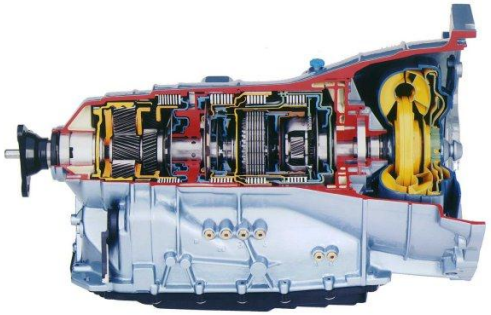
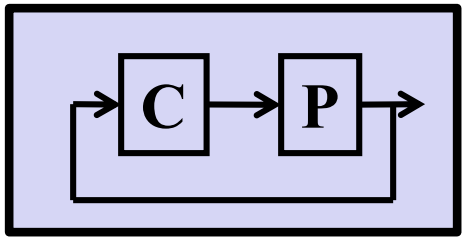
Dynamic Analysis and Controls of Automatic Transmissions

AUTO 563

Shushan Bai
GM Powertrain





Know Each Other

- Your name, work experiences, academic background and etc.
- Your expectation to the course.

Session	Topic
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:** Control strategies. Shift smoothness and robustness. Torque and inertia phase control. Clutch dynamics and its effect to clutch-to-clutch shift control. Clutch fill detection.
7 Feb. 19	**Midterm preparation and final project kickoff**
8 Feb. 26	**Midterm exam**
Mar. 5	**Winter Break (no class)**.
9 Mar. 12	**Presentation of final project proposal**
10 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.
11 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.
12 Apr. 2	**Belt CVT ratio and torque capacity control**
13 Apr. 9	**Torsional vibration damper and centrifugal pendulum vibration absorber**
14 Apr. 16	**Dual clutch transmission (DCT) and controls** **Final project preparation**
15 Apr. 23	**Presentation of final project.**

Text Book: 'Dynamic Analysis and Control System Design of Automatic Transmissions', SAE International, Shushan Bai, Joel Maguire, Huei Peng, ISBN 978-0-7680-7604-2

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/Simuink, 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 chose 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