Title: Drivability and Emission Diagnostics

Instructor: Ken Pickerill

Office location: 140D in the Transportation Technology Building

Contact information: phone: 453-9133 Cell 317-426-0074

Class Location: Room TEC 0134

Office hours: M, T, R, 10-12PM or by appointment

Class meeting time: 1:00PM-4:50 PM, M, T, R, F with Wednesdays as flex days as needed.

Credit Hours: 6.0

Start date: Tuesday, January 19  End date: Sunday, April 3rd
(Note: Final exam conducted the last day of this 10 week course.)

SIUC Holidays: King Holiday Monday, January 18
Spring Vacation Saturday, March 12, 12:00 Noon through Sunday, March 20

Course Description: An in-depth study of electronic engine controls and emission systems. Lectures focus on fuel analysis, advanced diagnostics, legislative regulations and new technologies related to engine controls and emission systems. Lab activities include the use of advanced diagnostic tools such as oscilloscopes, scan tools, exhaust gas analyzers, and chassis dynamometer.

Prerequisite: AUT 250 or consent of school. Prerequisite to: AUT 490

Course Objectives: This course will provide the student the opportunity to:

1. Identify various laws and regulations regarding emissions.
2. Identify characteristics of the different emission classifications.
3. Diagnose and repair vehicles with electronic engine control and emission systems.
4. Perform diagnosis on electronic engine control and emission systems using advanced equipment and techniques.

**Instructor Goals:**

Upon successful completion of AUTO 340-102 the student will be able to:

1. Identify vehicle tailpipe emission pollutants
2. Measure vehicle tailpipe emission gasses
3. Correlate vehicle tailpipe gas composition with engine operating condition
4. Determine OBD2 monitor readiness status
5. Test sealing integrity of vehicle evaporative system
6. Diagnose root cause of MIL illumination
7. Determine functionality of the crankcase ventilation system
8. Measure PCM inputs and outputs using an oscilloscope
9. Interpret validity of scan tool PCM data stream values
10. Identify legislation concerning vehicle fuel economy and emission control

**Textbook required:**


**Other requirements: Please note these are required!**

1. Safety glasses, closed toed shoes (required in the laboratory at all times)
2. Jumper wires and jumper test lead kit (available at campus parts store)
   (The jumper kit prevents unnecessary damage to our lab vehicle fleet and must be used)
3. Digital multimeter with 10 megaohm minimum impedance
4. Basic tool set for removing and testing fuel, ignition and emissions components
   (combination of tools with your lab partner is acceptable as long as each has access in case of absence)
5. 3 ring binder for lab sheets and other course materials (purchase by student) Labs are required to be in a binder- no loose sheets or tie banded sheets will be accepted

**Desire to Learn**

Guard SIU network ID and password carefully to prevent unauthorized access to grades or other personal data.
TOPICAL OUTLINE: (note: order may differ)

I. Course Introduction and Laboratory Safety
   A. Course overview and grading
   B. Laboratory safety
   C. Emergency procedures

II. Emission Legislation and Manufacturer Compliance
   A. Federal EPA (Environmental Protection Agency)
   B. CARB (California Air Resources Board)
   C. Federal test procedures
   D. SHED (Sealed Housing for Evaporative Determination) testing
   E. State inspection and maintenance testing

III. Emission Classifications
   A. Low emission vehicle classifications
   B. Tier classifications
   C. Diesel classifications

IV. Overview of Electronic Engine Control and Emission Systems
   A. Controller inputs and outputs
   B. Fuel injection systems
   C. Ignition systems
   D. Emission systems
   E. Engine mechanical/combustion relationships

V. New and Developing Technologies
   A. Engine electronics
   B. Fuel and emissions
   C. Engine mechanical

VI. Engine Control and Emission Diagnostics
   A. No code diagnostics
   B. Advanced scan tool functions
   C. Digital storage oscilloscope
   D. Dynamometer testing
   E. Exhaust gas analysis

VII. Fuel Characteristics and Testing
   A. Composition, ratings, and blends
   B. RVP (Reid Vapor Pressure) and alcohol content
   C. Refining process
   D. Oxygenated and reformulated
   E. Diesel

Grading Criteria: Total course points approximately 1600
Laboratory portion: Approximately 240 points, but tie into classroom work as well

A. **24 Lab sheets worth 10 points each**, (labs are done electronically and placed into the digital drop box on the website. Please do not email or text the labs if you want credit for them)

B. **Lab sessions**- I reserve the right to penalize your lab grade appropriately for the following
   - unsafe behavior
   - damage to or not reassembling vehicles
   - not replacing tools to the proper location
   - leaving your lab group behind early

C. **Any lab practical exam**- a lab practical may be given at any time during the semester- I will give you one week notice.

Classroom portion: Approximately 900 points

A. Quizzes and tests (about 300 points) Quizzes will be given on D2L, Midterm, unannounced quizzes and Final exams will be given in class.

B. Final examination, comprehensive style, 300 points

C. Composite Vehicle Group Project 300 Points

D. Group based Lab research project worth 100 points.

Supplemental assignments via Desire 2 Learn 200 points

(Homework, to be completed outside of class meeting times)

A. Textbook chapter review questions (10 assignments, 100 points)

B. Supplemental PDF material questions (10 assignments, 100 points)

Grading Scale: Points earned divided by points possible equals the percentage. Scores for graded materials are posted on Blackboard. The percentage determines the letter grade for the course using the departmental scale:

93-100% = A
85-92.99% = B
76-84.99% = C
70-75.99% = D
< 70% = F
**ADA Statement:** As per section 504 of the Vocational Rehabilitation Act of 1973 and the American Disabilities Act of 1990, if accommodations are needed, inform your instructor as soon as possible.

**Attendance Policy:**

_Quizzes cannot be made up for any reason. Do not ask._ If you enter late into a quiz, it is up to the instructor whether or not you will receive a quiz. Late arriving students will forfeit the late portion of quiz time. Class and quiz collection will not be delayed due to late arrival of students. _Quizzes may or may not be announced._ Quizzes are 30 points or less. Tests (over 30 points) are announced. It is the sole decision of the instructor whether a test can be made up and if a penalty is applied to the test. As a guideline: if advanced absence notice is provided I will consider validity of reason and provide terms to the student. If advanced notice is not provided, then an SIUC university excuse will be considered required input but final decision and terms/penalty of makeup is at sole discretion of the instructor. Any assignment included but not limited to composite vehicle presentation or document will result in a penalty determined by the instructor. _Any day missed in lab results in a lab session grade of zero. Leaving early from the lab will result in a lower lab session grade. Lab sessions cannot be made up on flex days._ For purposes of documentation attendance is taken daily and results posted on D2L.

_Your presence is fundamental to meeting the objectives of this course. Consequently, there will be two excused absences, quizzes cannot be made up, mid-term and final exams can be made up with a 10% penalty._

_Do not text during lecture. Switch phones and similar devices off or to vibrate mode as ringing, beeping etc. is rude and completely unacceptable._ Step out of the classroom if accepting a call. Keep feet off of furniture. Please be respectful to all parties. Do not sleep. _Keep computers on class related business._ The classroom is not a dining hall. Do not consume any food nor drink in laboratory vehicles or near equipment. Violators will be asked to leave. Leaving campus during course time is done at student risk.

**SIUC Emergency Response Emergency Procedures:**

Southern Illinois University Carbondale is committed to providing a safe and healthy environment for study and work. Because some safety and health circumstances are beyond our control, we ask that you become familiar with the SIUC Emergency Response Plan and Building Emergency Response Team (BERT) program. Emergency response information is available on posters in buildings on campus, available on the BERT’s website at [www.bert.siu.edu](http://www.bert.siu.edu), Department of Public Safety’s website [www.dps.siu.edu](http://www.dps.siu.edu) (disaster drop down) and in the Emergency Response Guidelines pamphlet. Know how to respond to each type of emergency.
Instructors will provide guidance and direction to students in the classroom in the event of an emergency affecting your location. **It is important that you follow these instructions and stay with your instructor during an evacuation or sheltering emergency.** The Building Emergency Response Team will provide assistance to your instructor in evacuating the building or sheltering within the facility.

This list is a general guideline.

<table>
<thead>
<tr>
<th>Class #</th>
<th>Class</th>
<th>Shop</th>
<th>Assignment</th>
</tr>
</thead>
</table>
| 1      | 1. *Introduction and Safety/Drivability*  
2. *D2L Demo*  
3. *Pretest*  
4. *Intro PPT* | *Shop Tour/clean-up expectations* | 1. *Homework chapter 11 questions based on text D2L*  
2. *Pico-scope quiz D2L*  
3. *Research question* |
| 2      | 1. *Drive-ability Discussion*  
2. *Overview of emissions*  
3. *Class 2_3 Emissions* |   |   |
| 3      | *Tailpipe emissions* | *Begin Work on lab sheets/research projects* |   |
| 4      | *On Board Diagnosis*  
|        | Work on lab sheets/research projects | Assignments from week 1 due today  
Week two assignments  
• D2L quiz assigned  
Chapter 15/MAP/ BARO  
• Combustion chemistry online quiz 1 D2L  
• Research question |   |
| 5      | *Emissions control systems* | Work on lab sheets/research projects |   |
| 6      | 1. Emission controls part 2  
2. Cover combustion chemistry, Chapter 11 questions, and Pico quiz in class |   |   |
| 7      | 1. Emission controls part 3  
2. EVAP |   | Assignments for week two due today  
Assign LS2 Edit and Dyno safety Quizzes |
| 8      | 1. Touch Base on Research Project with class  
2. Open |   |   |
<table>
<thead>
<tr>
<th>Week</th>
<th>Assignment</th>
<th>Notes</th>
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<tr>
<td>9</td>
<td>1. Cover week 2 quiz and Chapter 15 homework/ 2. Barometric pressures</td>
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<tr>
<td>10</td>
<td>LS2 edit and Dyno</td>
<td>Week three assignments due  Week four assignment- Toyota A/F ratio Sensors quiz from PDF Chapter 17 Oxygen Sensors</td>
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<tr>
<td>11</td>
<td>Volumetric efficiency</td>
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<tr>
<td>12</td>
<td>Oxygen sensors and trim</td>
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<tr>
<td>13</td>
<td>Oxygen sensors and trims continued</td>
<td>Bosch GDI Handouts given  Week four assignments due  Week five assignments_ idle strategies quiz * from PDF Fuel injection and Bosch GDI Quiz from handout</td>
</tr>
<tr>
<td>14</td>
<td>A/F ratio sensors</td>
<td></td>
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<tr>
<td>15</td>
<td>Idle strategies</td>
<td>Work on lab sheets/research projects  Week four assignments due  Week five- study for midterm, Bosch GDI handout quiz</td>
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<td>16</td>
<td></td>
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<td>17</td>
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<tr>
<td>18</td>
<td>Fuel, injection systems</td>
<td></td>
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<tr>
<td>19</td>
<td>Midterm exam</td>
<td>Work on lab sheets/research projects  Week five assignments due  Assignments for week six Ignition systems quiz</td>
</tr>
<tr>
<td>20</td>
<td>Research Project Presentation</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>GDI Injection systems*</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Start ignition  Start Saluki Composite car  COP Power Point</td>
<td>Ignition systems quiz due  Week 6 assignment- Variable Valve timing quiz on D2L</td>
</tr>
<tr>
<td>23</td>
<td>Ignitions 2  Quiz over COP power point*</td>
<td></td>
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<tr>
<td>24</td>
<td>Variable Valve timing/ camshaft sprocket systems</td>
<td></td>
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<tr>
<td>25</td>
<td>Variable valve timing/ valve train systems</td>
<td>Week six due  Assignment composite car</td>
</tr>
<tr>
<td>26</td>
<td>Fuel composition Rating and blends</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Tier 3 Exhaust emissions treatment</td>
<td></td>
</tr>
</tbody>
</table>
28 Diesel emissions treatment
Assignment - Alternative fuels quiz

29 Composite Car Follow up

30 Hybrid development

31 Alternative fuels
Alternative fuels quiz due from D2L
Assignment Composite car and

32 Composite Car Classwork

33 Hybrid car overview

34 Fuel Economy
Individual Research Lab Sheets
Assignment-EVAP quiz on D2L*
Mazda quiz on D2L

35 Lab Practical – NOTE May not be needed
Lab Practical on an individual basis

36 Composite car groups work in class
Finish lab work as needed

37 AUT 340 Review sheet/ Quiz Show Review
Finish lab work as needed
EVAP/ Mazda quizzes due quiz due from D2L

38 EVAP, ORVR
Finish lab work as needed

39 New Issues/ Jeopardy 1/Jeopardy 2

40 / Final Written Exam
Final Day of class
Final exam

Work groups Fall 2015

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
<th>Group 5</th>
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<tr>
<td>Wiring</td>
<td>Specifications</td>
<td>PCM</td>
<td>Regulatory</td>
<td>Serviceability</td>
</tr>
<tr>
<td>Batista, Sergio</td>
<td>Dannatt, Evan M.</td>
<td>Lawless, Harley J.</td>
<td>Petty, Brendan</td>
<td>Simmons, Austin G.</td>
</tr>
<tr>
<td>Bouras, Paul A.</td>
<td>Doorn, Thomas E.</td>
<td>Liscovitz, Samuel M.</td>
<td>Reed, Adam C.</td>
<td>Trettel, Matthew J.</td>
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<tr>
<td>Clauson, Ryan P.</td>
<td>Elliott, Jacob P.</td>
<td>Mcclendon, Robert D.</td>
<td>Rusnak, Eric B.</td>
<td>Weith, Zachary J.</td>
</tr>
<tr>
<td>Clavero, Christopher R.</td>
<td>Gordon, Gabrielle E.</td>
<td>Palermo, Kyle J.</td>
<td>Shivetts, Kyle J.</td>
<td>White, Nicholas A.</td>
</tr>
</tbody>
</table>
Group lab research project

Rubric for major projects

NOTE: All work submitted must be your own- no copy and paste of text or photos!

<table>
<thead>
<tr>
<th>Component</th>
<th>Up to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project completeness/accuracy/works cited APA style/effort shows</td>
<td>25 %</td>
</tr>
<tr>
<td>Professional in appearance</td>
<td>10 %</td>
</tr>
<tr>
<td>Student produced video up to +5 %</td>
<td>10 %</td>
</tr>
<tr>
<td>Class presentation/supporting materials</td>
<td>10 %</td>
</tr>
<tr>
<td>Excel based graphs and charts inserted into document up to +5 %</td>
<td></td>
</tr>
<tr>
<td>Associated monitors covered for each system</td>
<td>10 %</td>
</tr>
<tr>
<td>Procedure explained to verify system performance/diagnosis</td>
<td>10 %</td>
</tr>
<tr>
<td>Evaluation of each system individually/comparatively</td>
<td>10 %</td>
</tr>
<tr>
<td>Participation as judged by team members</td>
<td>25 %</td>
</tr>
<tr>
<td>Research document</td>
<td>50 %</td>
</tr>
</tbody>
</table>

| >93 % A                                                           | >92.99 % B |
| >76 % C                                                          | >70 % D    |
| < 70 % F                                                         |           |

Lab Work:

Labs will be available on D2L for groups to access. You can print the labs out if you want for reference during the work, but I want them submitted to me at the digital drop box on D2L after you have made a digital copy. Any pictures or screen shots need to be placed into the Word document. In order to prevent these from being mass produced, each lab member must submit their own lab sheet to me. Even members of the same group are to submit their own work. Additionally, I will ask questions about the labs during class to verify. If you are absent, then you need to do your own lab. Copying group member’s work is not acceptable, and will result in a score of zero. The reason for doing the labs this way is comments we are getting about graduates who cannot assemble a report on a computer. **You are to complete 24 labs during the course of the 10 week course**

Lab Research Project: **Research Question due February 16th. Project presentations due March 31st**
Each group will do a research project, present the project in a 30-45 minute presentation (PowerPoint is preferred) to the class, and a report on your findings in a document sent to me on D2L (not a PowerPoint but a Word document). Research is done in the lab, not on the Internet. I do not want a book report that has been copied and pasted from the Internet (which will get you a zero). You will need to do some research on Alldata or from the manufacturer which will be credited using in-text and works cited page in APA style. Your task is to research at least two different manufacturer emissions, ignition, or fuel control systems and compare and contrast these systems in the lab and then report this information. You will use graphs of data, pico-scope screen shots, and pictures taken in the lab to compliment your work. You need to do some initial leg work and determine which vehicles are best suited to this work. I would really rather you did not use student vehicles for the project.

Minimum information to be collected:

1. All inputs and outputs listed, along with screen shots, photographs, wiring schematics inserted into the Word document
2. Associated DTCs (both generic and manufacturer specific) and a brief description for the system in question.
3. Procedure used to verify system performance, such as a related monitor for each system
4. Evaluation (compare and contrast) each system and give results to back-up your opinions.
5. Proper APA style of in-text and works cited page

Composite Vehicle Project

**Group 1 Wiring**: designs wiring system including all engine management wiring diagrams and connectors including pin outs (except for PCM) Determines size of wires, harness design, harness routing, wire colors and circuit designation names and applicable shielding; designs connectors and notes any special tools to take connectors apart. Has authority of where sensors are placed after consulting with PCM and SPEC groups. Designs power distribution center along with relays and circuit protection after consultation with PCM and other groups. I would suggest many pictures for this group document/presentation: connector pin outs, schematics by system: ignition, fuel delivery, emission control, actuators, sensor inputs, ground locations, drawings of harness routing, J1962 data link design and wiring, layout of PDC including any fuses relays etc. This group will have less text in the document limited to explanation of circuits naming/connector/splice/ground numbering and briefly defend why things are designed/routed the way they are.

**Group 2 Specification**: Explains in detail engine design: firing order, displacement, metallurgy, dimensions, figures compression ratio, figures cam drive and lift/duration/timing requirements, describes location of components. Provide defensive reasoning of why materials and designs were selected. Explain how you figured out criteria such as firing order, compression ratio etc. Determines
resistance of sensors such as TPS: Determines type of CKP and CMP sensors, air gap, designs tone ring patterns. Also determines ignition system type, coil resistance, injector flow rate, injector resistance, fuel rail design including injector seals and placement into engine, determines exhaust design and converter type and placement, determines throttle body type and size (dimensions), determines fuel tank size (volume and dimensions), pump type, pressure and regulation, sending unit type and resistance, must determine and share fuel pressure spec. and injector flow rate etc. with PCM. Specify location and orifice size for PCV, purge solenoid, EGR if applicable: all details: resistance, how pulsed, frequency etc.

**Group 3 PCM:** Designs PCM appearance and mounting location in the vehicle. Determines number of connectors and connector pin outs (must share applicable information with wiring group) and if connectors are keyed. Determines spark strategy: base timing and timing advance/retard; Determines idle strategy: How target idle is set and implemented? Determines fuel strategy: How is air mass measured, which sensors are needed and what are their authorities to determine pulse-width, Basic pulse-width formula, Determine fuel trim strategy and range of adjustment. Determines default or limp in strategy for major sensors. Determines supply voltages (such as 5 volt supply and grounds for sensors) (share with wiring group) Determines what other tasks PCM might do: converter clutch, A/C compressor operation, speed control, etc. Determine rev limiter set point and how it is obtained; determine maximum speed shut off if any, Design basic PCM internal layout: B+, Ignition, and Grounds, i.e. what supply voltages are run off of Ignition etc. Network communication resistor and voltage supply, drivers for injectors, coils, relays, solenoids, throttle body etc, determine pull up or pull down resistors in sensing devices; determine interaction with traction control and stability and anti-theft systems. Determines if VIN and mileage are stored in PCM. Describe basics of how PCM flash is accomplished (work with regulatory on J2534 compliance)

**Group 4 Regulatory compliance:** Develop a numbering scheme for part numbers including vehicle fuel, ignition, and emission components; come up with a part numbering scheme, write a mock compliance letter to the EPA, create a VECI label, Group has control over MIL function (work with PCM ): when does light come on?; when does it flash? , when does it go out? You control all OBD 2 functions: Readiness indicators, all component/monitor ID numbers, Test ID numbers, min and max failure thresholds, when tests are run (enabling criteria or drive cycles) describe in detail how misfire monitor works, how misfire is detected, how and when failures and DTC’s are flagged. Designate when monitors are disabled for conflict, pending or global reasons. Also get to describe in detail how and when once per trip monitors are run: what pressures, temperatures, times or voltage changes are being used to judge component criteria: catalyst, evaporative, O2 sensor, EGR, VVT? You ensure other groups stay within industry guidelines and standards, J1962, J2012, J1979, J2284, J2534, FMVSS 126, You also determine the estimated economy and CAFE compliance of this vehicle.

**Group 5: Serviceability:** You design the appearance of the service website. You determine levels of access and fees to be charged. You get to design the scan tool including the name, screen layouts and menus. You need to keep tabs on the other group’s plans on design for serviceability: For example is a Shraeder valve placed on the fuel rail? You also get to make a list of all applicable P codes that will set on this vehicle. You create diagnostic procedures or trouble trees for P codes on the following components:
APPS, TPS, Electronic Throttle body, CKP, CMP, ECT, IAT, MAF or MAP/BARO, Oxygen or A/F sensor, Fuel injectors, ignition coils, PCM controlled relays.

**Caution:** Be very careful in copying ideas diagrams and such from the web. It is OK to get an idea, but the work must be yours. I would rather have simple drawings well done than something taken from the net, matter of fact this could be construed as academic dishonesty. I am actually looking for new ideas, not copying someone else’s work. If copied work is found, or is even identifiable, it will be penalized in the final document.

**Team effort:** This project should be something to be placed in your portfolio. Take the project seriously. Every member of the team is expected to be an equal player.

**DUE DATES**

Individual groups’ presentation is February 16- worth 50 points

Group document is due on March 29th- worth 100 points

Formal presentation with visual aids will take place Business formal attire March 31st - worth 100 points

Evaluation of team members due March 31st -worth 50 points to each member