Southern Illinois University at Carbondale
College of Applied Sciences and Arts
Department of Automotive Technology
AUT 340 section 101 CRN 20224, Spring 2015 Course Syllabus

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, 1-3:00 PM or by appointment

Class meeting time: 8:00 AM-11:50 AM, T, R, F with Wednesdays as flex days as needed.

Credit Hours: 6.0

Start date: Tuesday, January 20th **End date:** Friday April 3rd
(Note: Final exam conducted the last day of this 10 week course.)

SIUC Holidays: Martin Luther King Birthday Monday January 19th, Spring Break Saturday March 7th to Sunday March 15th

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. Indentify 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:

Automotive Fuel and Emissions Control Systems, Third Edition; Authors: James D Halderman and Jim Linder; Publisher: Pearson Prentice Hall; Copyright: 2012; ISBN: 978-0-13-254292-0

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 1840

Laboratory portion: Approximately 840 points

A. **24 Lab sheets worth 20 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 session grade for every lab session, 10 points each (see lab handout)**

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 200 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

Obviously, you cannot succeed in class if you are not here. More than 4 unexcused absences will result in a grade of F. Three late arrivals equal an unexcused absence

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, Department of Public Safety's website 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.

If necessary, the instructor may have to revise the syllabus. You will be informed of any revisions.

Class #	Class	Shop	Assignment
1	Introduction and Safety/Drivability Diagnosis introduction/Pretest D2L Quiz 1	Shop Tour/clean-up expectations	Combustion chemistry online quiz 1 D2L/ Homework chapter 11 questions from text on D2L
2	On Board diagnosis review	OBD II Testing in shop	Discussion board/ what are your goals in this class?
3	Emission Control systems	PCV Valve Worksheets	Lab presentation assignment approval
4	Emission control systems	Converter work sheets	
5	D2l Quiz 2 over previous Emissions control systems	Fuel trim Worksheet/Input sensor testing	*Assignments from week 1 due today* D2L quiz assigned Chapter 15/MAP/ BARO sensors homework assignment
6	Input sensors MAP/BARO/TP	MAP/BARO Worksheets	
7	Input sensors	TP sensor worksheets	
8	Speed Density Systems Composite vehicle project coverage assignments/ Oxygen sensors	Lab Presentation assignment	
9	Speed Density Systems / D2L Quiz 3	Speed Density worksheet	D2L quiz assigned Chapter 15/MAP/ BARO sensors homework assignment due
11	MAF sensors	MAF sensor worksheets	
12	A/F ratio sensors- Critical Current	A/F sensor worksheets	D2L Quiz/Homework due
13	Composite vehicle draft due from each team for approval/ corrections/ D2L Quiz/review for midterm	Wrap up of lab presentations in shop as necessary	D2L Quiz /Homework assignment
14	A/F ratio Sensors-dual cell	A/F sensor worksheets	

15	**Throttle body Injection systems-du**	**Lab presentations group 1 and 2**	
16	**Midterm Exam over previous material**	**Lab presentations group 3 and 4**	**D2L Quiz Due/Homework Assignment due**
17	**Port fuel injection systems**	**Lab Presentations group 5 and 6**	**D2L Quiz /Homework assignment**
18	**Direct fuel injection/ Check on progress of composite vehicle**	**Lab Sheets**	
19	**Ignition systems/conventional**	**LS edit lab set-up/ Research Lab sheets**	
20	**Ignition systems/ COP**		**D2L Quiz Due/Homework Assignment due**
21	**Turbo/Supercharging LS Edit usage**	**LS edit shop testing group 1**	**D2L Quiz /Homework assignment**
22	**Variable Valve timing/ camshaft sprocket systems**	**LS edit shop testing group 1**	
23	**Variable valve timing/ valve train systems**	**LS edit shop testing group 2**	
24	**Diesel Exhaust treatment**	**LS edit shop testing group 2**	
25	**LS edit software**	**LS edit shop testing group 3**	**D2L Quiz Due/Homework Assignment due**
26	**Tier 2 emissions/Fuel economy**	**LS edit shop testing group 3**	**D2L Quiz /Homework assignment**
27	**Fuel composition Rating and blends**	**LS edit shop testing group 4**	
28	**Diesel fuel systems**	**LS edit shop testing group 4**	
29	**Diesel emissions treatment**	**LS edit shop testing group 5**	**D2L Quiz Due/Homework Assignment due**
30	**RVP (Reid Vapor Pressure) and alcohol content**	**LS edit shop testing group 5/ Individual Research Lab Sheets**	**D2L Quiz Assignment /Homework assignment**
31	**Refining process**	**LS edit shop testing group 6/ Individual Research Lab Sheets**	
32	**Developments in fuel technology**	**LS edit shop testing group 6/ Individual Research Lab Sheets**	
33	**Hybrid development**	**LS edit shop testing make up day/ Individual Research Lab Sheets**	**D2L Quiz Due/Homework Assignment due**

34	**New and developing technologies/mechanical**	**Individual Research Lab Sheets**	**D2L Quiz/Homework assignment**
35	**Lab Practical**	**Lab Practical on an individual basis**	**D2L Quiz Due/Homework Assignment due**
37	**Composite Vehicle presentations**	**Composite Vehicle presentations**	**D2LQuiz/Homework assigned**
38	**Composite Vehicle presentations**	**Composite Vehicle presentations**	
39	**Necessary review /finishing of work/clean-up**		
40	**Lab Books due/ Final Written Exam**	**Final Day of class**	**Final exam**

Rubrics for major projects AUT 340 Spring 2015

Composite Vehicle Project rubric/ same rubric for each presentation

Rubric based on percentage of / each team graded separately/participation grade is individual

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

Project completeness/accuracy/works cited/effort presented	25%
Does document complete assignment	25%
Professional in appearance	25%
Class presentation	25%

Individual presentation = 50 Points

Group presentation = 100 Points

Final presentation = 150 points with participation points

Group lab research project

Rubric based on 100 points/each team graded separately/participation grade in individual

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

Component		Up to
Project completeness/accuracy/works cited APA style/effort shows		25 points
Professional in appearance Student produced video up to +5 points		10 points
Class presentation/supporting materials Excel based graphs and charts inserted into document up to +5 points		10 points
Associated monitors covered for each system		10 points
Procedure explained to verify system performance/diagnosis		10 points
Evaluation of each system individually/comparatively		10 points
Participation as judged by team members		25 points
Research document		50 points
>93 points A	>92.99 points B	
>76 points C	>70 points D	
< 70 points F		

Lab Groups for Spring 2015

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Ames	**Elayan**	**Guenther**	**Horne**	**Leopold**	**Medrano**
Bouras	**Fries**	**Hayse**	**Kokkelenberg**	**Liedberg**	**Melander**
Bunag	**Geick**	**Hofstetter**	**Kossakowski**	**Lotsof**	**Mukahhal**

Group 7

Mulcahy

Ochs

Smith

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:

Each group will do a research project, present the project in a 30-45 minute presentation (PowerPoint is OK) 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**

Group 1 Wiring	**Group 2 Specifications**	**Group 3 PCM**	**Group 4 Regulatory**	**Group 5 Serviceability**
Ames	Bouras	Geick	Mukahhal	Leopold
Elayan	Fries	Hofstetter	Melander	Ochs
Guenther	Hayse	Kossakowski	Liedberg	Smith
Horne	Kokkelenberg	Lotsof	Bunag	Mulcahy
Ames				

Composite Vehicle Project Groups

Five groups assigned by the instructor.

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, Picture(s) 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, transistors, diodes, amplifiers, zener diodes, capacitors, 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: Provide all part numbers for 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.

DUE DATES

Individual presentations due January 30

Individual groups presentation is February 26-27

Group document is due on March 27

Formal presentation with visual aids will take place March 31. Business formal attire

Self evaluation due start of class April 2

Group Evaluations of members and of other group's documents: April 2