

Program Name : Diploma in Automobile Engineering
Program Code : AE
Semester : Sixth
Course Title : Autotronics (Elective-II)
Course Code : 22654

1. RATIONALE

The modern cars are as much electronic as they are mechanical, thus creating a new AUTOTRONIC area (AUTOMobile + electRONIC). The Autotronics is referred to as modern automotive technology in the field of automobile engineering. Significantly, it has many applications in motor vehicles technology. Autotronics as an aspect of automobile engineering presents basics, advantages, layout and components and functional operation of various computer controlled motor vehicle systems. In addition, it clarifies how to use recent diagnostic tools and equipment for fault finding and analysis. It deals with computer controlled systems like; engine management, suspension control, anti-lock braking, airbag control, GPS-based navigation system, stability control system, steering systems instrumentation, collision avoidance systems. Therefore this course is useful to understand working and diagnostic of different autotronics systems.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain automotive electronic systems.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

- Maintain electronic control system components.
- Maintain different automotive computer control and communication systems.
- Maintain automotive sensors and actuators.
- Diagnose faults vehicle control systems.
- Troubleshoot using diagnostic trouble code.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
			Max		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment



5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

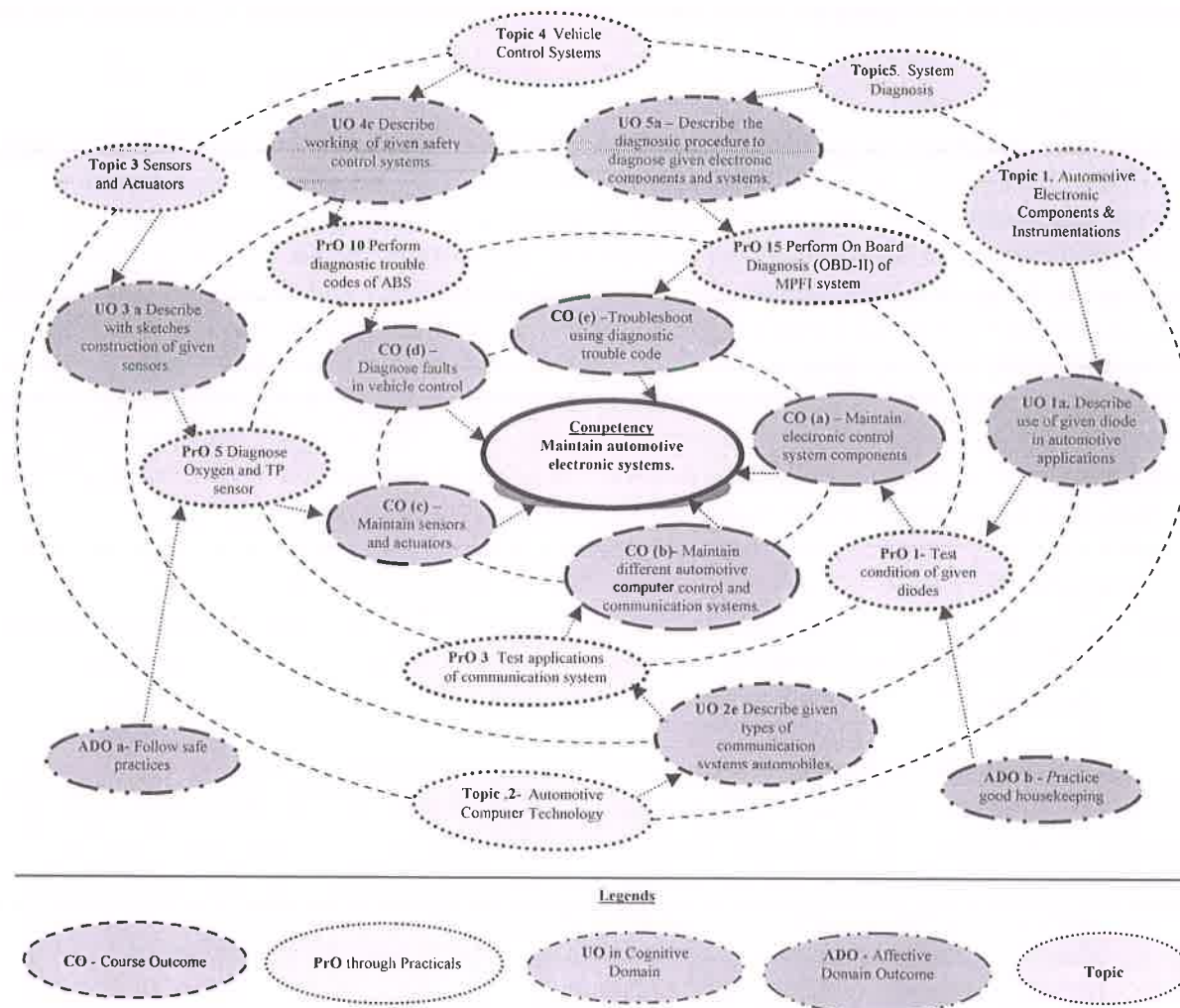


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practical's in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1.	Test condition of given diodes (Zener, LED, Power, P-N diode) using multimeter.	I	02*
2.	Perform flash code analysis of malfunction indicator lamp on vehicle dashboard.	I	02*
3.	Test applications of communication system like Bluetooth, Wi-Fi etc in automobile.	II	02*
4.	Test signal conditioning Analogue-Digital Converter and Digital-Analogue Converter using demonstration kit and Oscilloscope.	II	02*
5.	Diagnose (waveform, resistance and voltage output) Oxygen sensor	III	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	and Throttle position sensor using oscilloscope.		
6.	Diagnose (waveform, resistance and voltage output) Engine Coolant Temperature sensor and Manifold Absolute Pressure Sensor using oscilloscope.	III	02*
7.	Diagnose (waveform, resistance and voltage output) Wheel Speed Sensor using oscilloscope.	III	02
8.	Test Idle Speed actuator and Solenoid operated Fuel Injector.	III	02*
9.	Test EGR actuator and Purge control actuator.	III	02*
10.	Perform diagnostic trouble codes for ABS system.	IV	02*
11.	Perform diagnostic trouble codes for Electronic Power Steering system.	IV	02
12.	Perform diagnostic trouble codes for Air Bag system.	IV	02
13.	Perform diagnostic trouble codes for Park Assist system in vehicle.	IV	02
14.	Test collision avoidance system in vehicle.	IV	02
15.	Perform On-Board Diagnosis (OBD-II) of the MPFI engine using scan tool.	V	02*
16.	Perform On Board Diagnosis (OBD-II) of the CRDI engine using scan tool.	V	02*
17.	Test injection waveform using oscilloscope.	V	02
18.	Test waveform of speed sensor using oscilloscope.	V	02*
	Total		36

Note

- i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 16 or more practical need to be performed, out of which, the practical's marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	100

The above PrOs also comprise of the following social skills/ attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/ field based experiences:

- a) Follow safety practices.
- b) Practice good housekeeping.
- c) Practice energy conservation.
- d) Work as a leader/a team member.
- e) Follow ethical Practices.



The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organisation Level' in 2nd year
- 'Characterisation Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Multiport Fuel Injection engine with sensors, actuators and Electronic Control Module, Exhaust Gas Regulation valve and Positive Crankcase Ventilation valve; Make: Reputed manufacturers; Power: 25 KW @ 5000 rpm to 55KW@ 5000 rpm; Cubic Capacity: 1000 CC to 2000 CC	2,5,6,7,8,9
2	Scan tool: Make: Reputed manufacturers On Board Diagnostics (OBD) IInd Generation Scan Tool, Controller area network enabled, Colour Display, Operating Temperature: 0 to 50°C, Internal Storage: 4 AAA batteries, External Power: 7 to 18 volts; Generic tool; Accessories: Extender cable, OBD II Cable; Relevant optional accessories	3,15,16
3	Common Rail Direct Injection Engine with sensors, actuators and Electronic Control Module; Make: Reputed manufacturers Cubic Capacity: 1300 cc to 2200 cc; Power: 55 KW to 100 KW @ 4000 rpm.	5,6,7,8,9
4	A car equipped with modern automotive power train control, motion control and safety control system; Make: Reputed manufacturers Cubic Capacity: 1000 cc to 2200 cc; Power: 55 KW to 100 KW @ 4000 rpm.	10,11,12,13,14
5	Digital multi-meters; Make: Reputed manufacturers Measure Voltage and Current AC and DC, Resistance, Capacitance, diodes, continuity, frequency, min-max functions; LCD Display, 0 to 50°C Operating Temperature, DC voltage- 200mV to 1000 V DC, 2 to 1000 V Alternating Current, Current: 2mA to 20 A DC, Diode Test, Continuity Test- Audible buzzer, Resistance: 200 Ω to 200 MΩ; Accessories: Test leads, Current Clamp 300 A, Current Clamp Adapter.	1,5,6,7,8
6	Automotive Diagnostic Oscilloscope; Type- PC based or hand held Analog Channel: 8; Bandwidth: 100kHz; Input Impedance: Resistance: 1MΩ, Input Sensitivity: 10mV/div to 5V/div	4,5,6,7,17,18

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to develop UOs for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Automotive Electronic Components	1a. Describe use of given diodes in automotive applications with sketches. 1b. Compare digital visual display and	1.1 Automobile Electronics. 1.2 Diodes i. Zener diode - Voltage regulator in charging system.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
and Instrumentations	<p>analog visual display on basis of the given parameters.</p> <p>1c. Convert the given decimal numbers into binary numbers and vice versa.</p> <p>1d. Explain with block diagram working of given vehicle instrumentation system.</p> <p>1e. State the causes of specified errors with justification.</p> <p>1f. Describe the procedure to maintain the given automotive electronic components.</p>	<p>ii. Photo Diode and LED Ignition and display system.</p> <p>iii. Power Diode – Alternator (Charging System)</p> <p>iv. Clamping diode- as circuit protector</p> <p>1.2 Digital visual display and analog visual display.</p> <p>1.3 Binary number system.</p> <p>1.4 Instrumentation</p> <p>i. Vehicle instrumentation and measurement of parameters – fuel quantity, coolant temperature, vehicle speed</p> <p>ii. Types of errors in measurements.</p>
Unit-II Automotive Computer Technology	<p>2a. Explain the functions of the specified sections using block diagram of an automotive computer.</p> <p>2b. Select the relevant type of computer memory (s) for a particular situation with justification.</p> <p>2c. Compare open loop and closed loop control system in automotive application on basis of given parameters.</p> <p>2d. Recommend the type of signal conditioning for the given type of sensor/actuator, control system with justification.</p> <p>2e. Describe the given type of communication systems to be used in the automobile subsystem with justification.</p> <p>2f. Describe the procedure to maintain the given automotive computer technology components.</p>	<p>2.1 Automotive computer.</p> <p>2.1 Types of computer memory</p> <p>i. Primary memory - Read only memory (ROM), Read/Write (R/W), PROM, EPROM, EEPROM.</p> <p>ii. Volatile memory - RAM (Random Access Memory)</p> <p>iii. KAM (Keep Alive Memory)</p> <p>2.2 Open loop and closed loop control systems.</p> <p>2.3 Signal conditioning: Excitation, Linearization, Amplification, Filtering, Isolation, Analog to Digital and Digital to Analog Conversion, RMS Signal Conditioning</p> <p>2.4 Communication Systems in Automobile - CAN Bus, LIN Bus, Wi-Fi, Bluetooth, GSM networks.</p>
Unit- III Sensors and Actuators	<p>3a. Describe with sketches the construction of the given automotive sensor(s).</p> <p>3b. Explain with sketches the working and output signals of given automotive sensor(s).</p> <p>3c. Describe with sketches the construction of the given automotive actuator (s).</p> <p>3d. Explain with sketches the working and input signals of given automotive actuator (s).</p>	<p>3.1 Sensors:</p> <p>Crank shaft position, Oxygen, Air flow measurement, Temperature, Pressure, Camshaft position, Speed, throttle position sensors, knock sensor</p> <p>3.2 Actuators - Idle speed actuator, Unit injector, EGR Valve, Purge control Valve</p>



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	3e. Describe the procedure to maintain the given automotive sensors and actuators.	
Unit- IV Vehicle Control Systems	4a. Explain with sketches the working of given power train control systems with block diagram. 4b. Explain with sketches the working and of given motion control System with block diagram. 4c. Explain with sketches the working of given safety control systems with block diagram. 4d. Explain the necessity of given safety/motion control system with justification. 4e. Describe the procedure to maintain the given vehicle control system.	4.1 Power train control system: Electronic control system used in MPFI/GDI and CRDI system. 4.2 Motion Control System: ABS, Electronic Stability Program. Electronic suspension, Electronic power steering. 4.3 Safety systems: Air bags, Collision avoidance, Low pressure warning system, Park assists.
Unit –V System Diagnosis	5a. Describe the diagnostic procedure to diagnose given electronic components and systems. 5b. Recommend stand alone diagnosis of the given electronic components. 5c. Describe with flow chart the six step approach in testing the given automotive component. 5d. Select type of measuring instrument in testing signals of given sensors and actuators with justification.	5.1 On board diagnostic (OBD-II) procedure of MPFI/ CRDI system. 5.2 Stand alone diagnosis: diodes, sensors and actuators 5.3 Six step approach for Component Testing. 5.4 Measuring Instruments: Digital multi-meters, Oscilloscope, Thermometers, Scan tool, Frequency meters

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Automotive Electronic Components and Instrumentations	8	4	4	4	12
II	Automotive Computer Technology	10	4	4	6	14
III	Sensors and Actuators	11	4	4	8	16
IV	Vehicle Control Systems	11	4	4	8	16
V	System Diagnosis	8	4	4	4	12
Total		48	20	20	30	70

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)



Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- a) Observe videos to operate various testing equipments. Prepare a list of appropriate equipments considering its range/ application.
- b) Prepare power point presentation or animation for working of different components and systems.
- c) Collect videos relevant to MPFI, GDI, CRDI, control and operation.
- d) Convert the given Decimal numbers into Binary numbers and Binary numbers into Decimal numbers.
- e) Collect specifications and features of control systems of any modern Automobile with reference to any system such as MPFI or GDI and prepare a report of the same.
- f) Collect specifications and features of control systems of any modern Automobile with reference to any system such as TDI and CRDI system used in a vehicle and prepare a report of the same.
- g) Collect specifications and features of control systems of a vehicle, such as: ABS, ESP, Electronic Power Steering system and prepare a report of the same.
- h) Collect specifications and features of control systems of a vehicle, such as: Electronic Suspension and Navigation Systems and prepare a report of the same.
- i) Visit a modern Service Station for observing Automobile Electronic and Computer controlled systems and prepare a report of the same.
- j) Prepare one block diagram for Detonation control using microprocessor, and detonation sensor. Similar controls like Fuel Injection Control, Ignition timing Control, Lambda Control, Antilock Braking System, and Electronic Stability Programme may be shown using a block diagram.

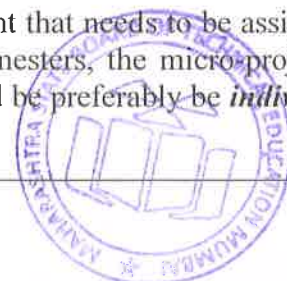
11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- a. Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.
- b. '*L*' in item No. 4 does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- c. About **15-20% of the topics/sub-topics** which is relatively simpler or descriptive in nature is to be given to the students for *self-directed learning* and assess the development of the COs through classroom presentations (see implementation guideline for details).
- d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be *individually*



undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should *not exceed three*.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

- a. Prepare the display board/Chart for Microcontroller: Following steps to be strictly followed.: (This fulfills CO-b, CO-c and CO-d)
 - i. Refer Internet source/manual
 - ii. Identify relevant microcontrollers used in modern vehicles.
 - iii. Prepare a block diagram
 - iv. Write a report.
- b. Collect and mount automotive sensors on the board. Following steps to be strictly followed.: (This fulfills CO-c, and CO-e)
 - i. Visit a modern workshop for survey.
 - ii. Identify and observe various sensors.
 - iii. Refer manufacturer's workshop manual for sensors specifications.
 - iv. Use internet/ other sources to compare the various sensors.
 - v. Prepare a report.
- c. Collect and mount automotive actuators on the board or Prepare chart. Following steps to be strictly followed.: (This fulfills CO-c, and CO-e)
 - i. Visit a modern workshop for survey.
 - ii. Identify and observe various actuators.
 - iii. Refer manufacturer's workshop manual for sensors specifications.
 - iv. Use internet/ other sources to compare the various sensors.
 - v. Prepare a report.
- d. Prepare detailed report on Diagnosis of MPFI engine: Following steps to be strictly followed.: (This fulfills CO-a, CO-c, CO-d and CO-e)
 - i. Student should visit shops/garage for survey.
 - ii. Diagnose a system of an engine using scan tool/ multimeter/oscilloscope.
 - iii. List out the steps of diagnosis.
 - iv. State limiting conditions (Range of variables like voltage, resistance, pressure, temperature) for normal operation of the referred system.
 - v. Prepare a report.
- e. Prepare detailed report on Diagnosis of CRDI engine: Following steps to be strictly followed.: (This fulfills CO-a, CO-c, CO-d and CO-e)
 - i. Student should visit shops/garage for survey.
 - ii. Diagnose a system of an engine using scan tool/ multimeter/oscilloscope.
 - iii. List out the steps of diagnosis.
 - iv. State limiting conditions (Range of variables like voltage, resistance, pressure, temperature) for normal operation of the referred system.
 - v. Prepare a report.



13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Automotive Computer Controlled System	Bonnick, Allan W.M.	Butterworth-Heinemann, UK, 2001 ISBN 13:978-0750650892
2	Understanding Automotive Electronics	Ribbens, William B.	Butterworth-Heinemann, UK, 2017 ISBN 13:978-0128104347
3	Automotive Handbook	Bosch, Robert	Bentley Publishers, UK, 9 th Edition, 2014, ISBN 13:978-1119975564
4	Auto mechanic's Guide to Electronic Instrumentation And Microprocessor.	Mosher, Lynn	Prentice – Hall, Inc. USA, 1987 ISBN 13: 978-0130546869
5	Advanced Automotive Fault Diagnosis	Denton ,Tom	Routledge, New York, 2012 ISBN 13: 978-0415725767
6	Today's Technician Automotive Electricity and Electronics- classroom and shop manual	Hollembek, Barry	Cengage Learning, New York, 2011 ISBN 13: 978-1305178403
7	Automotive Electricity and Electronics	Santini, Al	Cengage Learning, New York, 2013 ISBN 13: 978-1133713432

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

- a) <https://www.youtube.com/watch?v=j07aaa6ORAU>
- b) <https://www.youtube.com/watch?v=UcawahSkDeA>
- c) <https://www.youtube.com/watch?v=IzhddkRFIqM>
- d) <https://www.youtube.com/watch?v=54mMaAK96EU>
- e) <https://www.youtube.com/watch?v=jAqC0qxliL8> for MPFI system
- f) <https://www.youtube.com/watch?v=LjJSbHxIvnM> for GDI system
- g) <https://www.youtube.com/watch?v=KzF8ieiJ9UY> for CRDI system
- h) <https://www.youtube.com/watch?v=M9dZUOr6n4g> for camshaft and crankshaft sensor testing
- i) <https://www.youtube.com/watch?v=8q6qZQJQEIU> for automotive sensors and actuators
- j) <https://www.youtube.com/watch?v=RR8LsMBwL2I> for Scan tool video
- k) <https://www.youtube.com/watch?v=NUvWnOd5IFw> for Common Rail Diesel Injector Working and Common Failure Points
- l) <https://www.youtube.com/watch?v=ZMa0nom1iwc> for cleaning a throttle body and Idle air control valve (iac)
- m) <https://www.youtube.com/watch?v=lnK00rtWf68> for Throttle Position sensor cleaning
- n) https://www.youtube.com/watch?v=_skVHdgtMTU for Throttle Position sensor testing with or without wiring diagram
- o) <https://www.youtube.com/watch?v=Jla0nsrQXI0> to read car fault codes and to clear them.



