

Program Name : Diploma in Automobile Engineering
Program Code : AE
Semester : Sixth
Course Title : Automotive Electrical and Electronic Systems
Course Code : 22651

1. RATIONALE

Modern automobiles have increased use of electrical, electronic and microprocessor based systems. Lots of new accessories and components are introduced in automobiles for passengers safety and comfort. Advanced tools and equipments are available for fault finding in automobile electrical and electronic systems. This course will help students to maintain electrical and electronic systems. The student will develop the ability to use the advance instruments to check the performance of electrical and electronic circuits and components.

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 automobile electrical and 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 the automobile electrical and electronic systems.
- Test battery and charging systems.
- Troubleshoot starting and ignition systems.
- Use advanced automobile accessories for passenger safety and comfort.
- Use diagnostic tools and instruments.

4. TEACHING AND EXAMINATION SCHEME

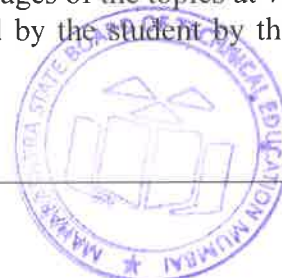
Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
			Max		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA; Out of 30 marks, 10 marks of theory PA is for micro-project assessment to facilitate attainment of COs and the remaining 20 marks is for tests and assignments given by the teacher.

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, Learning Outcomes i.e. LOs 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.

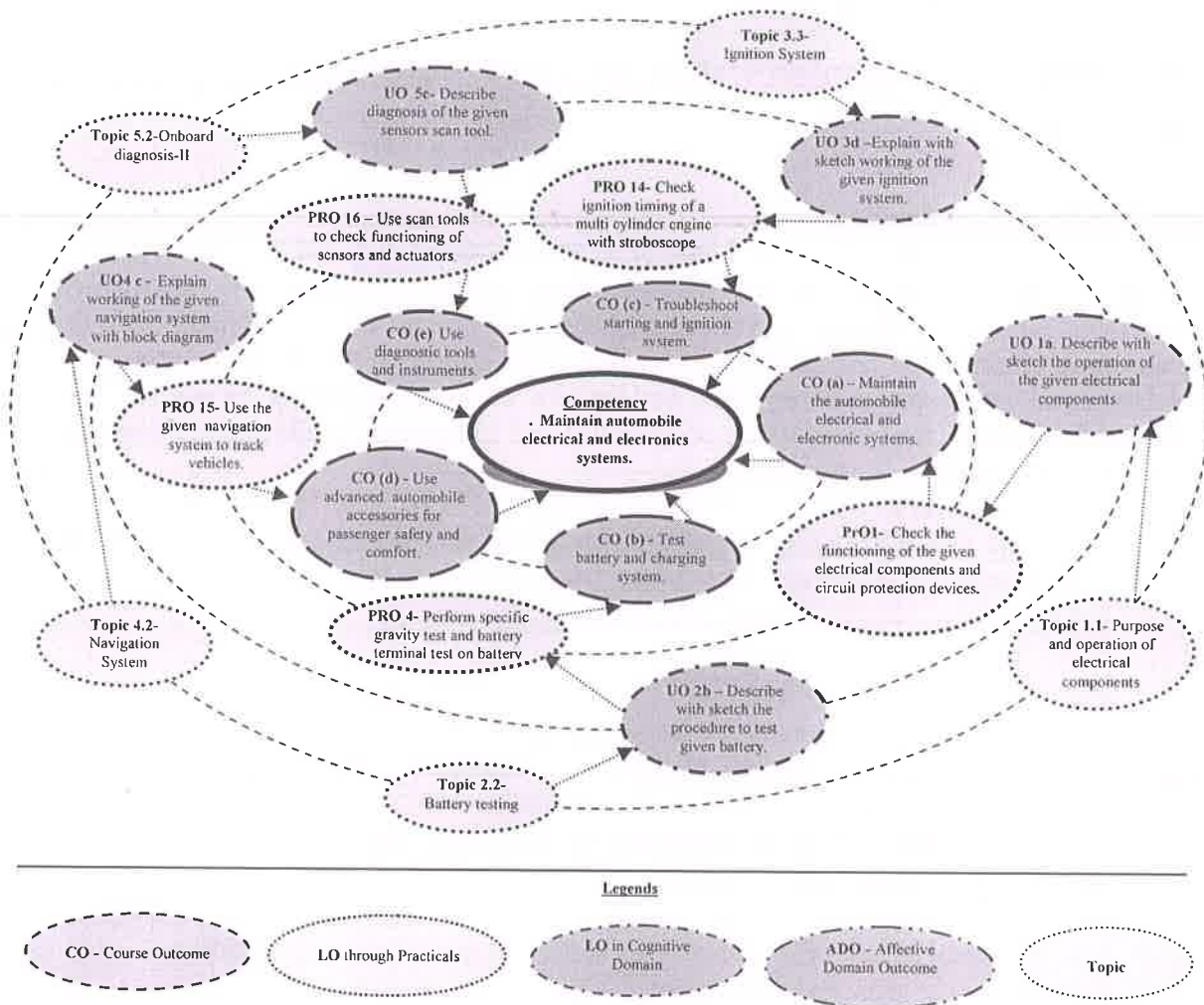


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals/exercises/tutorials in this section are psychomotor domain LOs (i.e. sub-components of the COs) are to be developed and assessed in the student to lead to the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1.	Check the functioning of the given electrical components and circuit protection devices using multimeter.	I	2*
2.	Troubleshoot the faults in electrical circuits.	I	2*
3.	Troubleshoot the faults in automobile wiring harness.	I	2
4.	Perform specific gravity test and battery terminal test on battery.	II	2*
5.	Perform battery leakage test and battery drain test on battery.	II	2
6.	Perform open circuit test and regular maintenance of battery.	II	2*
7.	Dismantle/assemble the given alternator.	II	2*
8.	Check continuity of alternator components using multimeter.	II	2*
9.	Perform current output test and field current draw test on	II	2*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	alternator.		
10.	Perform Regulator output test and charging circuit resistance test on alternator.	II	2*
11.	Dismantle/assemble the given Starter motor.	III	2*
12.	Perform Current draw test, Insulated circuit resistance test on starter motor.	III	2
13.	Perform Ground circuit test, No crank test and free speed test on starter motor.	III	2*
14.	Check ignition timing of a multi cylinder engine with stroboscope.	III	2
15.	Use the given navigation system to track vehicles.	IV	2
16.	Use the scan tool for fault diagnosis in ECU.	V	2*
17.	Use scan tools to check the functioning of sensors and actuators.	V	2
	Total		34

Note

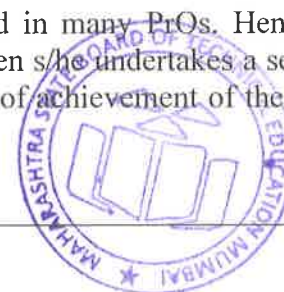
- i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- ii. Assessment of the 'Process' and 'Product' related skills in the laboratory/workshop/field work should be done as per suggested sample 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	Wiring harness of two and four wheeled vehicle.	1,2,3
2	Digital Multimeter: 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.	1,2,3,4,5 6,8,9,10
3	Direct Current Clamp meter: Make: MECO/ FLUKE and alike, Current measurement – 400 Amperes DC / AC.	1,3
4	Trainer electrical circuits of two and four wheeled vehicle.	1,3
5	Battery – 12V, 100Amp or above.	4,5,6
6	Hydrometer bulb type or digital 1.100-1.300 Sp.gravity at 27°C	4
7	Autoelectrical Test bench – 3 phase, 5 HP	9,10,12, 13
8	Alternator – 12V, 40A	7,8,9,10
9	Battery Charger. 2A-10A, 12V-24V ,	4,5
10	Starter Motor – 12V , 0.7KW. Over running clutch type.	11
11	Timing gun: Make: ESEL/ ASAL/ Kennedy and alike; Ignition Advance: 0 to 45°, 12V DC system, Reverse polarity protection, Bright flash for daylight use	14
12	Scan tool : Make: BOSCH and alike; On Board Diagnostics (OBD) II Ind 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;	16,17
13	Multiport Fuel Injection engine with sensors, actuators and Electronic Control Module, Exhaust Gas Regulation valve and Positive Crankcase Ventilation valve; Make: Maruti/ Tata/ Ford/ Honda/ Hindustan Motors and alike Power: 25 KW @ 5000 rpm to 55KW @ 5000 rpm, Cubic Capacity: 800 CC to 2000 CC	16, 17

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below 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	1a. Describe with sketch the	1.1 Purpose and operation of electrical



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Automobile Electrical and Electronic components.	<p>operation of the given electrical component.</p> <p>1b. Justify the use of the given electrical component in the given circuit.</p> <p>1c. Describe with sketch the test procedure of the given circuit.</p> <p>1d. Explain with sketch construction and working of the given automotive gauge.</p> <p>1e. Select with justification the relevant wire gauge for the given electrical circuit.</p> <p>1f. Describe the procedure of preventive maintenance of the given automobile electrical and electronic components.</p>	<p>components and circuit protection devices. Switches: SPST, SPDT, Ganged switch, mercury switch.</p> <p>a) Relays, Solenoids, Buzzers, Resistors.</p> <p>b) Fuses, Maxi fuses, Fusible links, Circuit breakers: Manual and automatic resetting types.</p> <p>1.2 Testing of circuit defects: Open circuit, Short circuit, Shorts to grounds, Voltage drop.</p> <p>1.3 Automotive Gauges: Temp Gauge, Fuel gauge, Engine oil pressure gauge, Speedo-meter gauge.</p> <p>1.4 Automotive wiring and lighting circuits: Symbols used in electrical circuits and wiring colour code, gauge of wire. Wiring diagrams: Headlight, turn indicators, Horn, Windshield wiper, Stop light.</p>
Unit-II Automobile battery and charging system.	<p>2a. Explain with sketch construction and working of the given type of battery along with its applications, ratings and specifications.</p> <p>2b. Describe with sketch the procedure to test the given battery.</p> <p>2c. Identify cause of battery failure based on given symptoms.</p> <p>2d. Explain with sketch working of the given charging system component.</p> <p>2e. Describe with sketch the procedure to test the given type of alternator.</p> <p>2f. Explain with sketch the working of given alternator regulation system.</p> <p>1g. Describe the procedure of preventive maintenance of the given automobile battery and charging system.</p>	<p>2.1 Battery: Types of Batteries, Construction and Working of following types: Lead acid battery, Maintenance free battery, Hybrid Battery, Dry cell battery, Lithium ion battery, Battery rating and specifications.</p> <p>2.2 Battery testing: Battery terminal test, Leakage test, Specific Gravity Test, Open circuit test, Battery drain test.</p> <p>2.3 Factors affecting Cycle failure, internal short circuit, overcharging and sulphation.</p> <p>2.4 Factors affecting Battery maintenance and safety precautions.</p> <p>2.5 Charging system: alternator. Initial excitation and self excitation.</p> <p>2.6 Alternator testing: Current output test, Field current draw test. Regulator output test, charging circuit resistance test.</p> <p>2.7 Regulation: Electronic, Computer Regulation.</p>
Unit- III Starting and ignition system.	<p>3a. Explain with sketch working of the given starting system aggregates.</p> <p>3b. Describe testing procedure of</p>	<p>3.1 Starting system: layout, components and their function. Types of starter drive: Bendix and overrunning clutch, Integrated starter generator system.</p>



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	starting system for the given parameter. 3c. Select remedial measures for given starting system trouble with justification 3d. Explain with sketch working of the given ignition system. 3e. Describe the procedure of preventive maintenance of the given type of starting or ignition system system	3.2 Testing of starting system: Quick testing, Current draw test, Insulated circuit resistance test, Ground circuit test, No crank test, free speed test 3.3 Ignition System: a) Electronic ignition system: Use of Transistor, Methods of triggering: Magnetic pick up, Optical, Hall effect. b) Computer controlled ignition system: operation and block diagram. c) Distributorless ignition system: operation and block diagram.
Unit- IV Advanced Automobile Accessories.	4a. Explain with block diagram the working of the given automobile accessory. 4b. Select the relevant accessory for given application / system with justification 4c. Explain with block diagram working of the given navigation system. 4d. Explain using block diagram.working of the given electric two wheeler accessory.	4.1 Advanced automobile accessories: automatic headlight dimming, on/off headlight with time delay, Keyless entry system, door lock system, Park assists system. 4.2 Navigation system: GPS, GPRS. 4.3 Electric two wheeler: layout and functions of components, charging system.
Unit No.V Electronic Diagnostic Tools	5a. Explain with sketch working of the specified sensor / actuator of engine. 5b. Describe with sketch the testing procedure of the given sensor / auctuator of engine. 5c. Describe diagnosis procedure of the given sensors using the scan tool. 5d. Explain the standard diagnostic trouble codes for the given sensor.	5.1 Sensors - construction, working and Testing using scan tool: Oxygen sensor, Engine coolant temperature sensor, Throttle position sensor, Manifold absolute pressure sensor.Mass air flow sensor. 5.2 Electronic fuel Injector testing: Sound test, Ohmmeter test. 5.3 Onboard diagnosis II: Function, Terminology: Drive cycle, Trip, Warm up cycle. 5.4 Flash codes of Malfunction indicator light, SAE J2012 standards diagnostic trouble Code(DTC) :5 digits only

Note: To attain the COs and competency, above listed Learning Outcomes (LOs) need to be undertaken to achieve the 'Application Level' 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	Automobile Electrical and Electronic components.	14	04	06	06	16
II	Automobile battery and charging system	14	04	06	06	16
III	Starting and ignition system	14	04	06	06	16
IV	Advanced Automobile Accessories	10	04	06	--	10
V	Electronic Diagnostic Tools.	12	---	04	08	12
Total		64	16	28	26	70

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

Note: This specification table provides general guidelines to assist students for their learning and to teachers to teach and assess students with respect to attainment of LOs. 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:

- Prepare journals based on practical performed in laboratory.
- Follow the safety precautions.
- Use various meters to test electric/electronic equipment and component.
- Library /Internet survey of electrical circuits and network.
- Prepare power point presentation or animation for understanding different circuits behavior.

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:

- Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.
- '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.
- 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 LOs/COs through classroom presentations (see implementation guideline for details).
- With respect to item No.10, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.
- Use Flash/Animations to explain various theorems in circuit analysis
- Guide student(s) in undertaking micro-projects



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 are given here. Similar micro-projects could be added by the concerned faculty:

- a) Prepare the display board for electrical/electronic aggregates with specifications and relevant application. Following steps to be strictly followed. (This fulfills CO-a and CO-e)
 - i. Student should visit shops/garage for survey.
 - ii. Collect components and know the specification.
 - iii. Study application of component.
 - iv. Prepare the display board with labeled components and their applications.
- b) Prepare a demonstration kit to check the faults: short-circuit /open circuit/ ground circuit. Following steps to be strictly followed. (This fulfills CO-a and CO-e)
 - i. Student should select relevant wires and electrical loads.
 - ii. Draw layout of electrical mountings.
 - iii. Mount the components so as to demonstrate one of the above said fault.
 - iv. Study and note the effect of faults in the kit.
 - v. Prepare relevant document for results.
- c) Collect and mount starter motor/alternator components on the board. Following steps to be strictly followed. (This fulfills CO-a, CO-c and CO-e)
 - i. Student should visit shops/garage for survey.
 - ii. Collect components and know the specification.
 - iii. Study application of component.
 - iv. Prepare the display board and label components.
- d) Prepare charts relevant to diagnosis of sensors/actuators. Following steps to be strictly followed. (This fulfills CO-a, CO-d and CO-e)
 - i. Student should visit shops/garage for survey.
 - ii. Observe and note techniques used for diagnosis of sensors/actuators.
 - iii. Select one sensor/actuator for case-study.
 - iv. Prepare the chart for diagnosis of selected component.

13. SUGGESTED LEARNING RESOURCES

S.No.	Title of Book	Author	Publication
1	Automotive Technology: A Systems Approach	Erjavec, Jack Thompson, Rob	Cengage Learning, 6 th Edition, Delmar-USA (2014), ISBN-13:978-1-133-61231-5
2	Automotive Electrical	Babu, A.K.	Khanna Publishers, New-Delhi (2016)



S.No.	Title of Book	Author	Publication
	and Electronics		ISBN-13: 978-9382609698
3	Automobile Electrical Equipments	Kholi, P. L.	McGraw-Hill Education Pvt. Ltd, New Delhi, (2017), ISBN 13: 978-0074602164
4	Basic Automobile Engineering	Nakra, C. P.	Dhanpat Rai Publishing Company (P) Ltd- New Delhi (2016) ISBN-13: 978-9352160983
5	Automotive Mechanics	Crouse, W.H.; Anglin ,D.L.	McGraw Hill Education; New Delhi, 10 th edition (2017), ISBN-13: 978-0070634350
6	Automobile Electrical & Electronic system:	Denton, Tom	A Butterworth-Heinemann, Oxford UK, 4 th edition (2011) ISBN-13: 978-0080969428
7	Automotive Diagnostic Systems: Understanding OBD I and OBD II	McCord, Keith	CarTech Inc, Minnosota-US, (2011) ISBN 978-1-934709-06-1

14. SOFTWARE/LEARNING WEBSITES

S. No.	Name of Topic	Video URL Address
a)	Battery load testing	I. http://www.youtube.com/watch?v=3QiKyjWWiRo II. https://www.youtube.com/watch?v=1FQMajuQ6j4&list=PLPvqVA0h0J6h6aYnH2Spw-n7SK5OYXlpj&index=9
b)	Ignition coil testing	I. http://www.youtube.com/watch?v=c1zhgsnyZWw II. https://www.youtube.com/watch?v=vG3LzrlSYg&list=PLPvqVA0h0J6h6aYnH2Spwn7SK5OYXlpj&index=1
c)	Testing of starter motor	I. http://www.youtube.com/watch?v=UnmnWuuLfzE II. https://www.youtube.com/watch?v=FBUvYi-zlQ4&list=PLPvqVA0h0J6h6aYnH2Spw-n7SK5OYXlpj&index=6
d)	Alternator voltage test	I. http://www.youtube.com/watch?v=Bzz7P3qNHcE II. https://www.youtube.com/watch?v=uelf_CjtJ5g&list=PLPvqVA0h0J6h6aYnH2Spw-n7SK5OYXlpj&index=5



