

Program Name : All Branches of Diploma in Engineering and Technology.
Program Code : CE/CR/CS/CH/CM/CO/IF/CW/DE/EJ/EN/EQ/ET/EX/IE/
 MU/EE/EP/EU/IS/IC/AE/FG/ME/PG/PT/DC/TX/TC
Semester : Sixth
Course Title : Capstone Project – Execution & Report Writing
Course Code : 22060

1. RATIONALE

This course on 'Capstone Project–Execution and Report Writing' is the continuation of the previous semester course on 'Capstone Project–Planning'. So, in this semester, the students are to implement the detailed Capstone Project Plan, which they have prepared in the preceding semester. Therefore, to successfully complete this Capstone Project by the end of this semester, it is necessary to incorporate the suggestions of the guide/examiners of the preceding semester. Hence, it is of utmost importance for the student to again re-capitulate and comprehend the importance, concept and need of the 'Capstone Projects' which are well explained in the 'Capstone Project–Planning' course in the previous semester.

Often, the jobs in the industry, which the diploma holders will come across when they join it and will be in the form of small or large projects. Such projects are generally an integration of the various types of skills which cut across the three major domains of learning i.e. cognitive, psychomotor and affective domain which must have acquired during their journey from first semester to the last semester. Hence, it is essential that students are also given an opportunity to do large projects which require more time compared to the micro-projects in order to develop and integrate the highly essential industry oriented competencies and associated skills in the students. Therefore, in this semester the 'Capstone Project – Execution and Report Writing' will continue to integrate some more additional competencies along with those in the previous semester and hence build up greater confidence to face such situations in the world of work.

2. COMPETENCY

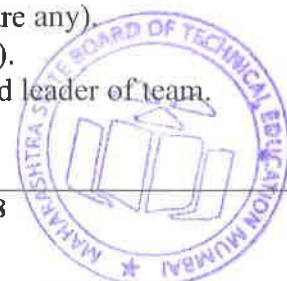
The course should be taught and implemented with the aim to develop the required course outcomes (COs) so that students will acquire following competency needed by the industry:

- **Implement the Capstone Project Plan to solve the identified problem/task faced by industry/user related to the concerned occupation by integrating the various types of skills acquired during the programme.**

3. COURSE OUTCOMES (COs)

Depending upon the nature of the projects undertaken, the following could be some of the major course outcomes that could be attained, although, in case of some projects few of the following course outcomes may not be applicable.

- a) Implement the planned activity individually and/or as team.
- b) Select, collect and use required information/knowledge to solve the identified problem.
- c) Take appropriate decisions based on collected and analysed information.
- d) Ensure quality in product.
- e) Incorporate energy and environment conservation principles.
- f) Consider the ethical issues related to the project (if there are any).
- g) Assess the impact of the project on society (if there is any).
- h) Communicate effectively and confidently as a member and leader of team.



- i) Prepare project report after performing due plagiarism check using appropriate tools.

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
-	-	4	4	--	--	--	--	--	--	50#	20	50~	20	100	40

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

5. Course details

As the implementation of the Capstone project progresses and which has to be submitted at the end of project work, one of the outputs of this course is a detailed **Project Report** that is continuously prepared by the student. There will also be regular progressive assessment by the teacher as per the criteria no 7 on the basis of rubrics mentioned in **Appendix –C** and in the formats as shown in **Appendix-B** and also for the end-of-semester examination.

5.1 Guidelines for Capstone Project–Execution and Report Writing

- The students would like to revise the ‘Capstone Project – Plan’ based on the feedback received in the fifth semester examination.
- This revised ‘Capstone Project – Plan’ would be again approved by the project guide. As soon as the revised plan is approved by the teacher, the student will begin to work according to it and would also continue to maintain a dated ‘**Project Diary**’ for the whole semester. This is a sort of a ‘weekly diary’ indicating all the activities conducted by the student every week in the semester to complete the project. This ‘Project Diary’ should be got signed by the teacher at regular intervals for progressive assessment. If this is maintained sincerely and truthfully by the student, it will be very helpful in compiling the **Final Project Report** at the end of the semester by him/her.

6. Project report

During the final Semester, the student will prepare a ‘Project Report’ in continuation with the activities conducted in fifth semester under Project Planning having following sub-titles:

Suggested contents of the Project report

- Title page (with name of team members and mentor teacher)
- Certificate (in the Format given in this document as annexure A)
- Acknowledgements (this may need revision at the end of the final semester)
- Abstract (in one paragraph not more than 150 words)
- Content Page

Chapters

- Chapter–1 Introduction (background of the Industry or User based Problem/Task)
- Chapter–2 Literature Survey (to finalise and define the Problem Statement)
- Chapter–3 Scope of the project
- Chapter–4 Methodology
- Chapter-5 Details of designs, working and processes



6. Chapter-6 Results and Applications
7. Chapter-7 Conclusions And future scope
8. Appendix (if any)
9. References and Bibliography

Note:

- i. The report should contain as many diagrams, figures and charts etc as relevant for the project.
- ii. Originality of the report (written in own words) would be given more importance rather than quality of printing and use of glossy paper or multi-colour printing

7. ASSESSMENT OF PROJECT WORK

Project work has two components, first is Progressive Assessment (PA), while another is End Semester Examination (ESE).

7.1. Progressive Assessment (PA) Guidelines and Criteria

Project guide is supposed to carry out this assessment. It is a continuous process, during which for developing desired qualities in the students, faculty should orally give **informal feedback** to students about their performance and interpersonal behaviour while guiding them on their project work every week. Following criteria should be considered while assessing students informally or formally during different stages of the project work.

The following factors need consideration for both Capstone Project-Planning and Capstone Project-Execution and Report Writing.

- a) Students should be assessed during the project work so that students can also get feedback for further improvement.
- b) It should be kept in mind that project work is mainly experiential learning and it is not the research work, so emphasis should be on work based learning or learning from experience and development of attitudes and skills as mentioned in course outcomes. So focus of assessment should also be on learning from the process of completing project work rather than on novelty or innovation in the project work.
- c) For progressive assessment at the end, students should be asked to give the power point presentation before group of teachers and junior students (so that junior students may also get awareness about the major project work they have to carry out in future)
- d) The students would be awarded marks for their efforts (In some cases it may happen that due to some reasons such as unavailability of some material or component or some other resources, students may not be able to complete the project, but they have tried their best, in such cases students would be given appropriate marks if they have done enough efforts.)
- e) The students would not be awarded marks if they have completed the project by getting done the work from market or some professionals (taking some help and guidance is different as compared to getting the work or maximum part of the work completed from others on payment basis).
- f) Originality of the report (written in own words) would be given more importance.
- g) The Project Guide will assure the quality of project done by his group.



Criteria of Marks for PA for Capstone Project -Execution and Report Writing.

S. No.	Criteria	Marks
1	Project Proposal /Identification	10
2	Punctuality and overall contribution	
3	Project Diary	
4	Execution of Plan during sixth semester	20
5	Project Report including documentation	15
6	Presentation	05
Total		50

7.2 END SEMESTER EXAMINATION (ESE)

Evaluation shall be carried out according to following criteria. For each project, students from the concerned group should be asked to make presentation of their project , in front of the external and internal examiners which should be followed by question answer session to ascertain the contribution made by each student.

Criteria of Marks for ESE for Capstone Project -Execution and Report Writing

S. No.	Criteria	Marks
1	Project Proposal	05
2	Punctuality and overall contribution	
3	Project diary	
4	Execution of Plan during sixth semester	10
5	Project Report including documentation	10
6	Presentation	10
7	Question and Answer	15
Total		50

8. SPECIAL TEACHING STRATEGIES (If any)

- a) Teacher's should not spoon feed the students and let them try on their own at different stages of the project work and even first let them strive hard and only when efforts of students have failed, then teacher should guide them. Guidance should be in initially in the form of clues or hints rather than complete explanation, detailed explanation should be given only when students are not able to work based on clues/hints. The role of teacher should be limited to guide and facilitator
- b) Teachers should help students in selecting a topic which is relevant and challenging (but within capacity) for students according to their abilities.
- c) *Teachers should come out of the mindset that there should be compulsorily some innovation and novelty in the project work. Because as discussed earlier, project is mainly opportunity for work based or experiential learning, the aim of which is to develop higher order cognitive skills and attitudes. Project at diploma level is not research or innovation.* The main thing teachers have to ensure is that students choose a task or problem for their project work which is challenging but according to their capability i.e. a task which they can complete on their own without getting it done from market.



- d) Teachers should ensure that students prepare the project plan in as much detail as possible, since this way only they would learn the importance of planning and how to do the detail planning. Teachers should allow students to proceed ahead only when they have detailed plan with them.
- e) Teachers should motivate students to maintain project document project diary and project report. They should explain benefits of these activities to students and also train them in these activities, because most of them may be doing this first time.
- f) Project Guide should ensure that students submit chapter of report one by one to him/her as per schedule and should check the content of the chapters. The Project guide should monitor that schedule is maintained and report writing is not left till last few weeks. It should not be a problem since first three chapters of the report should have been written in fifth semester itself.
- g) Teachers should also encourage students to openly discuss their weaknesses and shortcomings .Teachers should develop confidence in students that admitting mistakes and weaknesses helps in improving them.
- h) Teachers should continuously discuss with students about working of group and progress in the project and from this discussion should identify their personal qualities (both strengths and weaknesses) and suggest to them ways for improving those qualities.
- i) Internal as well as external examiners should reward students for original work and efforts of students even if they are not fully successful or not able to complete the project in comparison to those students who have taken paid help from others to complete their project.

Appendix–A

CERTIFICATE

This is to certify that Mr./Ms.....
 fromInstitute having Enrolment No:
 has completed project of final year having title during the
 academic year20__-20__. The project completed by individually/ in a group consisting
 of..... persons under the guidance of the Faculty Guide.

.....

Name & Signature of Guide:

Telephone:.....



Appendix-B

PROGRESSIVE ASSESSMENT (PA) OF CAPSTONE PROJECT – EXECUTION AND REPORT WRITING

Evaluation Sheet for Internal Assessment

Name of Student:

Name of Programme:..... **Semester: Sixth**

Course Title: Capstone Project : Execution and Report Writing **Code:22060.**

Title of the Capstone Project:

.....

A. POs addressed by the Capstone Project (Mention only those predominant POs)

a)

b)

c)

d)

B. COs addressed by the Capstone Project (Mention only those predominant POs)

a)

b)

c)

d)

C. OTHER LEARNING OUTCOMES ACHIEVED THROUGH THIS PROJECT

1. Unit Outcomes (Cognitive Domain)

a)

b)

c)

d)

2. Practical Outcomes (in Psychomotor Domain)

a)

b)

c)

d)

3. Affective Domain Outcomes

a)

b)

c)

d)



PROGRESSIVE ASSESSMENT (PA) Sheet		
S. No.	Criteria	Marks
1	Project Proposal /Identification	10
2	Punctuality and overall contribution	
3	Project Diary	
4	Execution of Plan during sixth semester	20
5	Project Report including documentation	15
6	Presentation	05
Total		50

Appendix–B

Suggested Rubric for Capstone Project – Execution and Report Writing

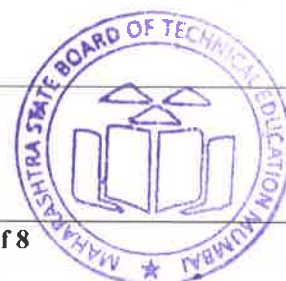
S. No.	Characteristic to be assessed	Poor	Average	Good	Excellent
1	Problem/Task Identification (Project Title)	Relate to very few POs Scope of Problem not clear at all	i. Related to some POs ii. Scope of Problem/Task vague	i. Take care of at-least Three POs ii. Scope of Problem/task not very specific	• Take care of more than three POs ii. Scope of problem/task very clear
2	Literature Survey /Industrial Survey	Not more than ten sources (primary and secondary), very old reference	At-least 10 relevant sources, at least 5 latest	At –least 15 relevant sources, most latest	About 20 relevant sources, most latest
3	Project proposal	Methods are not appropriate, All steps not mentioned, Design of prototype not started (if applicable).	Appropriate plan but not in much detail. Plan B for critical activities not mentioned. Time line is not developed. Design of Prototype is not complete. (if applicable)	Appropriate and detailed plan with Plan B for critical activities mentioned, but clarity is not there in methods, time line is given but not appropriate. Design of prototype is not detailed (if applicable)	Appropriate and detailed plan with Plan B for critical activities mentioned, clarity in methods with time line, Detailed design of prototype (if applicable)
4	Project Diary	Entries for most weeks are missing. There is no proper sequence and details are not correct.	Entries for some weeks are missing, details are not appropriate, not signed regularly by the guide.	Entries were made every week but are not in detail. Signed and approved by guide every week	Entries were made every week in detail, signed and approved by guide every week
5	Final Report Preparation	Very short, poor quality sketches, Details about methods, material, precaution and conclusions	Detailed, correct and clear description of methods, materials, precautions and	Conclusions. Sufficient Graphic Description.	Very detailed, correct, clear description of methods, materials, precautions and conclusions. Enough tables,



S. No.	Characteristic to be assessed	Poor	Average	Good	Excellent
		omitted, some details are wrong			charts and sketches
6	Presentation	Major information is not included, information is not well organized .	Includes major information but not well organized and not presented well	Includes major information and well organized but not presented well	Well organized, includes major information ,well presented
7	Defense	Could not reply to considerable number of question.	Replied to considerable number of questions but not very properly	Replied properly to considerable number of question.	Replied to most of the questions properly

Appendix C
Suggestive Project Diary format

Week no:
Activities planned:
Activities Executed:
Reason for delay if any
Corrective measures adopted
Remark and Signature of the Guide



Program Name : Diploma in Automobile Engineering
Program Code : AE
Semester : Sixth
Course Title : Vehicle Systems Maintenance
Course Code : 22065

1. RATIONALE

Vehicle system maintenance is a technology course deals with Automobile workshop, Trouble-shooting, Servicing and Repair of Engine and related systems, Transmission system, Brake system, Steering and Suspension system etc. Prerequisites for this course are Automobile Engines, Advanced Automobile Engines, Automobile Transmission System and Automobile Control Systems which are studied adequately in previous semesters. There is huge opportunity for Diploma Engineers in Automobile Service Sector and Entrepreneurship.

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 engine, transmission, control and comfort systems of vehicles.

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:

- Use relevant tools and equipment required for maintenance of vehicle.
- Maintain different types of engine systems.
- Troubleshoot major assemblies of transmission system of vehicles.
- Maintain automobile braking, steering and suspension systems.
- Maintain automobile HVAC system.

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	
2	-	4	6	--	--	--	--	--	--	--	--	75#	30	75~	30	150	60

(#): No theory Exam; (~¹): For the *practical only* courses, the PA has two components under practical marks i.e. the assessment of practicals (seen in section 6) has a weightage of 60% (i.e. 45 marks) and micro-project assessment (seen in section 12) has a weightage of 40% (i.e. 30 marks). This is designed to facilitate attainment of COs holistically, as there is no theory ESE.

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.

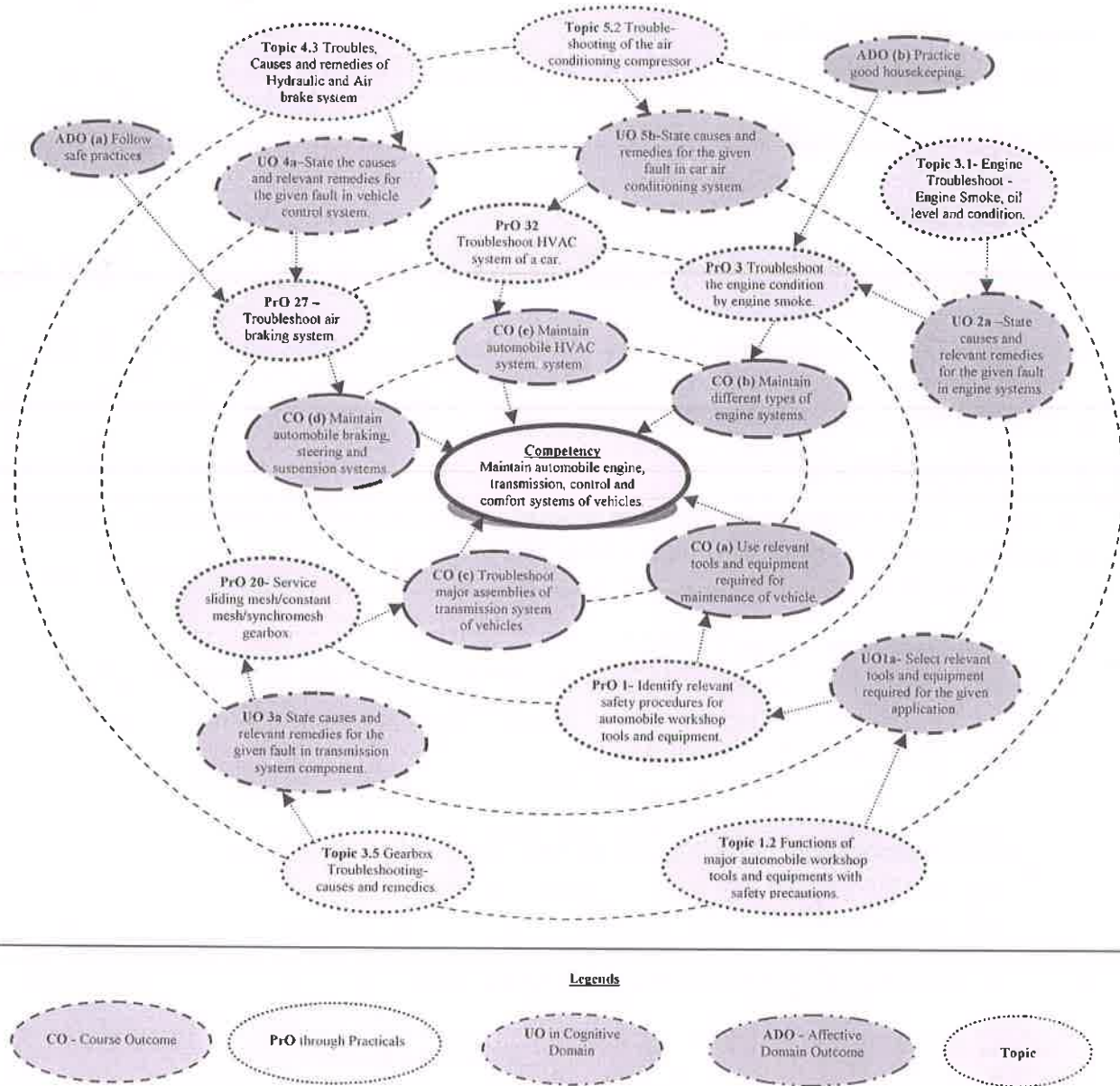
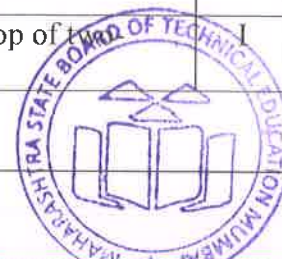


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals 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.	Identify relevant safety procedures for automobile workshop tools and equipment- Wheel Aligner, Wheel Balancer, Engine Analyzer, Hydraulic Lift, Air Compressor, Fuel Injector Tester, Engine Compression Tester, Cylinder Bore Gauge, Battery Tester, Pneumatic Gun, Timing Gun.	I	02*
2.	Prepare records maintained in automobile workshop of t wheeler/LMV/HMV.	I	2



S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
3.	Troubleshoot the engine condition by engine smoke.	II	2*
4.	Troubleshoot the engine lubrication system.	II	2
5.	Troubleshoot the engine fuel feed system.	II	2
6.	Troubleshoot the engine cooling system.	II	2
7.	Perform the compression test on petrol/diesel engine.	II	2
8.	Service petrol/diesel engine lubrication system.	II	2*
9.	Test mechanical fuel injector for efficient delivery.	II	2*
10.	Perform Calibration and Phasing of Fuel Injection pump of multi-cylinder engine.	II	2
11.	Test the MPFI fuel injector.	II	2
12.	Service engine cooling system.	II	2*
13.	Service Radiator of LMV/HMV.	II	2
14.	Service cylinder head of multi-cylinder petrol/diesel engine.	II	2*
15.	Service cylinder block of multi-cylinder petrol/diesel engine.	II	2*
16.	Service piston and connecting rod assembly of multi-cylinder petrol/diesel engine.	II	2
17.	Service crank shaft and camshaft of multi-cylinder petrol/diesel engine.	II	2
18.	Perform tune-up procedure on petrol/diesel engine.	II	2
19.	Service single plate dry coil spring/diaphragm type clutch assembly with relevant clutch adjustments.	III	2*
20.	Service Sliding mesh/Constant mesh/Synchromesh gearbox.	III	2*
21.	Service Transfer case/gearbox used in 4WD vehicle.	III	2
22.	Service Final drive and differential assembly with relevant adjustments.	III	2*
23.	Service propeller shaft and universal joint assembly.	III	2*
24.	Perform wheel hub greasing.	III	2
25.	Service hydraulic brake system with brake adjustments.	IV	2*
26.	Perform bleeding of hydraulic brakes on vehicle.	IV	2
27.	Troubleshoot air braking system.	IV	2
28.	Perform wheel alignment of vehicle.	IV	2*
29.	Perform wheel balancing of vehicle on balancing machine.	IV	2
30.	Service steering gear box and steering linkages of Car/LMV/HMV.	IV	2*
31.	Service Suspension system of Car/LMV/HMV	IV	2*
32.	Troubleshoot HVAC system of a car for general faults.	V	2*
	Total		64

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 24 or more practicals 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. 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	Follow safety rules and adopt standard practices for handling tools and equipment's.	30
2	Refer workshop manual and include relevant data in the journal.	20
3	Sketching layouts, components and conclusion.	20
4	Answer to sample questions	20
5	Submit 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.	<p>a) Wheel Aligner: Equipped with Variable Height Camera Support, Vehicle Orientation directional Indicator, located on camera beam, Advanced Customer Database, Advanced Alignment Measurements, Custom Vehicle Specifications, Front/Rear/All/Zoom Readings, Individual Camber, Caster & Toe, Initial/Final Print outs in Graphical & Text. Parameter, Range, Accuracy: Camber: $\pm 10^\circ$, $\pm 2'$; Caster: $\pm 20^\circ$, $\pm 6'$; Kingpin Inclination: $\pm 20^\circ$, $\pm 6'$; Toe-in & Toe-out: $\pm 20^\circ$, $\pm 2'$; Set back: $\pm 5^\circ$, $\pm 2'$; Thrust angle: $\pm 5^\circ$, $\pm 2'$.</p> <p>b) Wheel balancer- Max power consumption: 1.1KW, Balancing Speed: <100rpm, Balancing Accuracy: 10g for trucks, Cycle time for wheel: 20sec, Diameter setting range: 10" to 30", Max wheel diameter: 1300mm, Max wheel weight: 250Kg, Max air pressure: 10 bar.</p> <p>c) Engine analyzer: Generic OM123 OBD2 CAN Hand-held Engine Analyzer Code Reader Russian Portuguese Auto Scan Tool Automotive Scanner</p> <p>d) Hydraulic lift- Capacity-2 Ton</p> <p>e) Air Compressor- 1.5H.P, 24 liter, 1300w</p> <p>f) Injector tester – Pressure range-0-60 Mpa, fuel tank volume-1L</p> <p>g) Compression tester- MT-6565</p>	1, 29,31,



S. No.	Equipment Name with Broad Specifications	PrO No.
	h) Cylinder bore gauge - Resolution: 0.01mm, Range: 250-450mm, Depth: 1-250mm i) Battery charger - Input-220-240VAC 50HZ 270W; 220-240VAC 50HZ 350W. Output- 6/12/24V 2/8/4.5A starting current 70A; 6/12/24V 2/10.5/5.5A, starting current 100A j) Pneumatic nut runner -Maximum Torque:10-20 Nm No-Load Speed:10-20 rpm	
2.	Actual Working engine (Multi-cylinder four stroke S.I. and C.I. engines above 1000cc) set up with all accessories.	3-8 & 12-18
3.	Mechanical fuel injector tester: Pressure range 0-60 Mpa, fuel tank volume-1L	9
4.	MPFI fuel injector Testing and cleaning machine: Power supply: AC220V~50/60Hz, AC110V~50/60Hz, Input power: 350W Pressure: 0~6.5bar, Flow test accuracy:±2%, Simulated RPM range: 0~9999 rpm	11
5.	Single plate dry coil spring/diaphragm type clutch of LMV/HMV	19
6.	Light Motor Vehicles: A modern Car and Jeep of any make and model like Maruti, Mahindra, TATA, Force Motors along with all relevant accessories and systems.	All
7.	Sliding mesh/Constant mesh/Synchromesh gearbox of LMV/HMV in good running condition.	20
8.	Final drive and Differential assembly of LMV/HMV in good running condition.	22
9.	Propeller Shaft and Universal joint assembly LMV/HMV in good running condition.	23
10.	Actual working model of Air brake system.	27
11.	Wheel alignment gauges: Combination gauge, toe in - toe out gauge, KPI gauge.	28
12.	Actual steering gear boxes of LMV/HMV in good working condition: Rack and pinion type, Recirculating ball and Nut type, Worm and roller type.	30

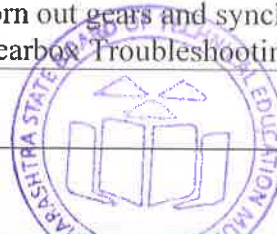
8. UNDERPINNING THEORY COMPONENTS

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 Automobile workshop tools, equipment and Maintenance management	1a Select relevant tools and equipment required for the given application. 1b Explain the use of the given tool/equipment with justification. 1c Explain the safety precautions to be taken while using the given tool/equipment with justification. 1d Select relevant maintenance procedure for the given	1.1 General safety precautions in automobile workshop. 1.2 Functions of major automobile workshop tools and equipments with safety precautions- wheel aligner, wheel balancer, engine analyzer, hydraulic lift, Compressor, Injector tester, compression tester, cylinder bore gauge, battery tester, pneumatic gun, timing gun. 1.3 Safety procedure for using power tools and equipments (electrically).



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	automobile component. 1e Explain the given type of workshop record with relevant justification.	hydraulically, pneumatically operated) 1.4 Necessity and types of maintenance - Preventive maintenance, Scheduled maintenance, Breakdown maintenance. 1.5 Decision to repair or replace the components during maintenance. 1.6 Record Keeping: Necessity and Types of workshop records - History sheet, Work orders /Job cards, Activity file, Service manual, Spare part register, spares procurement register.
Unit II- Engine Maintenance	2a State causes and relevant remedies for the given fault in the engine systems. 2b Explain with sketch the procedure of engine compression test with justification. 2c Explain the working of the specified fuel injection pump with justification. 2d Describe with sketch servicing of the given engine component. 2e Describe with diagram engine tune up procedure for the given engine.	2.1 Engine Troubleshoot - Engine Smoke, oil level and condition, coolant level and condition, oil pressure testing, compression test, vacuum test, Cylinder Leakage test. 2.2 Lubrication system service: Change oil filter, Check oil pump. Diagnose causes for excessive oil consumption, external oil leakage, and low oil pressure in an engine. 2.3 Fuel feed system service - Injector cleaning and testing, FIP phasing and calibration, MPFI injector testing and cleaning. 2.4 Cooling system servicing - Refilling of radiator, Pressure testing, thermostat checking, Leakage testing, Fan belt tension checking and adjusting. 2.5 Engine Servicing: Checking and servicing of engine components-cylinder head, cylinder block, cylinder liners, piston, piston ring, crank-shaft, Connecting rod, valves, Tuning of engine.
Unit-III Transmission System Maintenance	3a. State causes and relevant remedies for the given fault in transmission system component. 3b. Explain the servicing procedure for the given transmission system component with justification. 3c. Explain with sketch backlash adjustment in the given pair of final drive and differential assembly. 3d. Describe with sketch lubrication of transmission	3.1 Maintenance of Clutch and Gearbox: Checking clutch plate for thickness, run out, rivet depth, torsion spring weakness. Pressure plate for wear, scratches, scoring and warpage, free and seated height of pressure springs, Clutch shaft for bent and distorted splines, Clutch adjustment – types and procedure; Clutch troubleshooting: Causes and remedies for clutch slip, clutch noise, clutch grab and chatter. 3.2 Checking gearbox for run out of main shaft and lay shaft, oil seals, bearings, worn out gears and synchromesh unit. 3.3 Gearbox Troubleshooting- Causes and



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	system.	<p>remedies for Gear box noise, Hard gear shifting.</p> <p>3.4 Maintenance of propeller shaft and universal joint assembly.</p> <p>3.5 Maintenance of rear axle: Checking and adjusting final drive for ring gear run-out, backlash in ring gear and bevel pinion, tooth contact between ring gear and pinion, backlash in differential gears, Bearing preload –necessity and procedure.</p> <p>3.6 Troubles, Causes and remedies of propeller shaft, differential and rear axle.</p> <p>3.7 Lubrication of transmission system.</p>
Unit –IV Maintenance of Vehicle Control Systems	<p>4a. State the causes and relevant remedies for the given fault in vehicle control system.</p> <p>4b. Explain servicing procedure for brakes of the given vehicle with justification.</p> <p>4c. Describe with sketch wheel alignment/balancing procedure for the given vehicle.</p> <p>4d. Describe the routine maintenance procedure of the given automotive system.</p>	<p>4.1 Maintenance of Brakes- Inspection of master cylinder, wheel cylinder, brake drum, brake linings, brake disc and brake pads. Adjustment of hydraulic brakes – shoe clearance, brake pedal free travel, pedal to floor clearance, parking brake adjustment.</p> <p>4.2 Types of brake bleeding. Procedure for bleeding of hydraulic brakes.</p> <p>4.3 Troubles, Causes and remedies of Hydraulic and Air brake system.</p> <p>4.4 Troubleshooting of suspension system.</p> <p>4.5 Troubleshooting of steering system.</p> <p>4.6 Maintenance of wheels and tyres- Care of wheels and tyres, Procedure of wheel alignment by wheel alignment gauges, Procedure of wheel balancing.</p>
Unit –V Maintenance of HVAC System	<p>5a. Explain safety rules for servicing of the given air conditioner component.</p> <p>5b. State causes and remedies for the given fault in car air conditioning system.</p> <p>5c. Describe with sketch procedure for leakage testing of refrigerant for the given vehicle.</p> <p>5d. Describe the troubleshooting procedure of the given part of the air conditioner.</p>	<p>5.1 Air conditioner service safety rules.</p> <p>5.2 Trouble shooting of the air conditioning Compressor.</p> <p>5.3 Trouble shooting of the air conditioning Blower and condenser.</p> <p>5.4 Trouble shooting of the air conditioning evaporator, valves and filters.</p> <p>5.5 Refrigerant Leakage testing.</p> <p>5.6 Evacuation and charging of air conditioner.</p>

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



9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER (INTERNAL DESIGN)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Automobile workshop tools, equipment and Maintenance management	03	2	4	4	10
II	Engine Maintenance	10	2	4	14	20
III	Transmission maintenance	10	2	4	14	20
IV	Maintenance of vehicle control systems	06	2	4	9	15
V	Maintenance of HVAC system	03	2	4	4	10
Total		32	10	20	45	75

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:

- Prepare journals based on practical performed in laboratory.
- Give seminar on relevant topic.
- Undertake micro-projects.
- Search latest advanced safety devices used in automobiles and collect their specifications.
- Collect data regarding different tools and equipments used in body repair shop.
- Collect data regarding different tools and equipments used in paint shop.
- Sketch the body shapes as per aerodynamic requirements.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning 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 COs through classroom presentations (see implementation guideline for details).
- With respect to item *activities*.
- Guide student(s) in No.10, teachers need to ensure to create opportunities and provisions for *co-curricular*
- Undertaking micro-projects.



- g) Demonstrate students thoroughly before they start doing the practice.
- h) Encourage students to refer different websites to have deeper understanding of the subject.
- i) Observe continuously and monitor the performance of students in Lab.

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) **Automobile Workshop Tools and equipment:** Follow the steps given below-
 - i. Identify tools and equipments required for automobile workshop of two wheeler/three wheeler/LMV/HGV dealer, roadside garage and modern workshop for specialized job.
 - ii. Collect specifications of the identified tools and equipment from market/internet.
 - iii. Search the manufacturer/supplier for procurement of above tools and equipment.
 - iv. Prepare the report for procurement of above tools and equipment.
(This fulfills CO-a, CO-b, CO-c, CO-d, CO-e)
- b) **Automobile workshop Layout:** Follow the steps given below-
 - i. Visit to automobile workshop of two wheeler/three wheeler/LMV/HMV dealer, roadside garage and modern workshop for specialized job.
 - ii. Identify the infrastructural facilities, tools and equipment required.
 - iii. Prepare the model of layout for the same.
(This fulfills CO-a CO-b)
- c) **Automobile workshop Records:** Follow the steps given below-
 - i. Visit to automobile workshop of two wheeler/three wheeler/LMV/HMV dealer, roadside garage and modern workshop.
 - ii. Collect workshop records maintained at two wheeler/three wheeler/LMV/HGV dealer's workshop.
 - iii. Observe the inventory control system used in automobile workshop.
 - iv. Prepare the report on record keeping.
(This fulfills CO-a CO-b, CO-c)
- d) **Automobile Lubricants:** Follow the steps given below-
 - i. Collect samples and data of various types of lubricants used in automobiles from Market/Internet.
 - ii. Compare the specifications, properties, applications and cost of above lubricants.
 - iii. Prepare the report.
(This fulfills CO-b, CO-c, CO-d)
- e) Any other micro-projects suggested by course faculty on similar line.



13. SUGGESTED LEARNING RESOURCES :

S. No.	Title of Book	Author	Publication
1	Automotive service	Gills, Tim	Delmar Publisher Inc ISBN-13: 9781401812355
2	Automotive Mechanics	Crouse, William, H; Anglin, Donald L	McGrawhill Education, New Delhi, 2016, ISBN-13: 978-0071125994
3	Automobile Engineering (Vol. III,IV)	Chikara, Anil	Satya Prakashan, New Delhi, 2016 ISBN:13:97881768400774
4	Automotive Engines- Theory and Servicing	Halderman, James, D.	Pearson Education, New Delhi, 2016 ISBN-13:9780133515008
5	Motor Automotive Technology	Schwaller, Anthony	Delmar Publisher Inc. ISBN-13:978-0827351004
6	Automotive Engine Performance	Layne, Ken	Prentice Hall Career Technology ISBN 13:9780471829911
7	Heavy Duty Truck System	Ian, Norman; Robert, Scharff; John, Corinchoke	Delmar Publisher Inc. ISBN-13:978-0766864962
8	Automobile Engineering	Gupta, R.B.	Satya prakashan, New delhi,2011 ISBN-9788176843799

14. SOFTWARE/LEARNING WEBSITES

- a) <https://www.youtube.com/watch?v=LGXfWdAZ0N4> –safety and health in motor vehicle shop
- b) <https://www.youtube.com/watch?v=-mhhDiz3bwk> – workshop tools and equipment
- c) <https://www.youtube.com/watch?v=5Efh-Y35Lcs> – safety procedure for power tools
- d) <https://www.youtube.com/watch?v=Yz-zh3N6AOo>- engine diagnosis
- e) <https://www.youtube.com/watch?v=h7wotCaA6kg>-engine noise
- f) <https://www.youtube.com/watch?v=8q6QP0PmHlg>-cylinder head crack
- g) <https://www.youtube.com/watch?v=O1jwgVhdMso>-automotive diagnostic equipments
- h) <https://www.youtube.com/watch?v=s73JEX6HG78>-engine overheating
- i) <https://www.youtube.com/watch?v=h7-WXFKZiXM>-engine servicing.
- j) <https://www.youtube.com/watch?v=qEyhsk0JTOo>-engine maintenance
- k) https://www.youtube.com/watch?v=0L4f4U_9lcU-change oil and filter.
- l) <https://www.youtube.com/watch?v=wGD0Wm7Smrw>-engine oil consumption.
- m) <https://www.youtube.com/watch?v=32wnnTgCJn8>-injector cleaning and testing
- n) <https://www.youtube.com/watch?v=QUSIEYfx5DM>-mechanical injector testing
- o) https://www.youtube.com/watch?v=_atSLfBIAOI-calibration of FIP
- p) <https://www.youtube.com/watch?v=D69Echdj2EU>-FIP phasing
- q) <https://www.youtube.com/watch?v=osnT0QqGP6I>-cooling system servicing
- r) <https://www.youtube.com/watch?v=3L0p1RGvZqk>-cooling system repair
- s) <https://www.youtube.com/watch?v=OJkFkdBQcGE>-thermostat checking
- t) <https://www.youtube.com/watch?v=-f1eE9U-khU>-fan belt tension checking and adjusting
- u) www.youtube.com/watch?v=iYpzeVNcEG4- cylinder bore inspection
- v) <https://www.youtube.com/watch?v=MHR9MeJKZTs>- inspection of piston and ring
- w) <https://www.youtube.com/watch?v=cQMYO-orBCU>- inspection of connecting rod
- x) <https://www.youtube.com/watch?v=qcWNgd1Vkhk>- tuning of engine
- y) https://www.youtube.com/watch?v=q5M7lbtI1_0- inspection of clutch



- z) <https://www.youtube.com/watch?v=REHQXqzdoa8>- clutch pedal adjustment
- aa) https://www.youtube.com/watch?v=RKp946w-_SQ- gear box inspection
- ab. <https://www.youtube.com/watch?v=YyobS4N8whw>- inspection of differential
- ac. <https://www.youtube.com/watch?v=dAqAqODmcj4>- differential backlash
- ad. <https://www.youtube.com/watch?v=-TspaTqk5Dc>-Brake inspection
- ae. <https://www.youtube.com/watch?v=JePOTERmApw>-brake adjustment
- af. <https://www.youtube.com/watch?v=oponMtCv-BU>-brake bleeding
- ag. <https://www.youtube.com/watch?v=BXTZURC5iQ0>-automotive a.c.diagnosis



Program Name : Diploma in Automobile Engineering / Civil Engineering Group /
Electronics Engineering Group / Diploma in Plastic Engineering /
Diploma in Production Engineering /Diploma in Fashion &
Clothing Technology/ Computer Engineering Group

Program Code : AE/CE/CR/CS/ DE/EJ/ET/EN/EX/EQ/IS/IC/IE/PG/PT/DC/
CO/CM/CW/IF

Semester : Sixth

Course Title : Management

Course Code : 22509

1. RATIONALE

An engineer has to work in industry with human capital and machines. Therefore, managerial skills are essential for enhancing their employability and career growth. This course is therefore designed to provide the basic concepts in management principles, safety aspects and Industrial Acts.

2. COMPETENCY

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

- Use relevant managerial skills for ensuring efficient and effective management.

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:

- Use basic management principles to execute daily activities.
- Use principles of planning and organising for accomplishment of tasks.
- Use principles of directing and controlling for implementing the plans.
- Apply principles of safety management in all activities.
- Understand various provisions of industrial acts.

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	Max	Min		
3	-	-	3	90 Min	70*#	28	30*	00	100	40	--	--	--	--	--	--

(*#) Online Theory Examination.

(*): 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. (COs) required for the attainment of the Cos. (*#): Online examination



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.

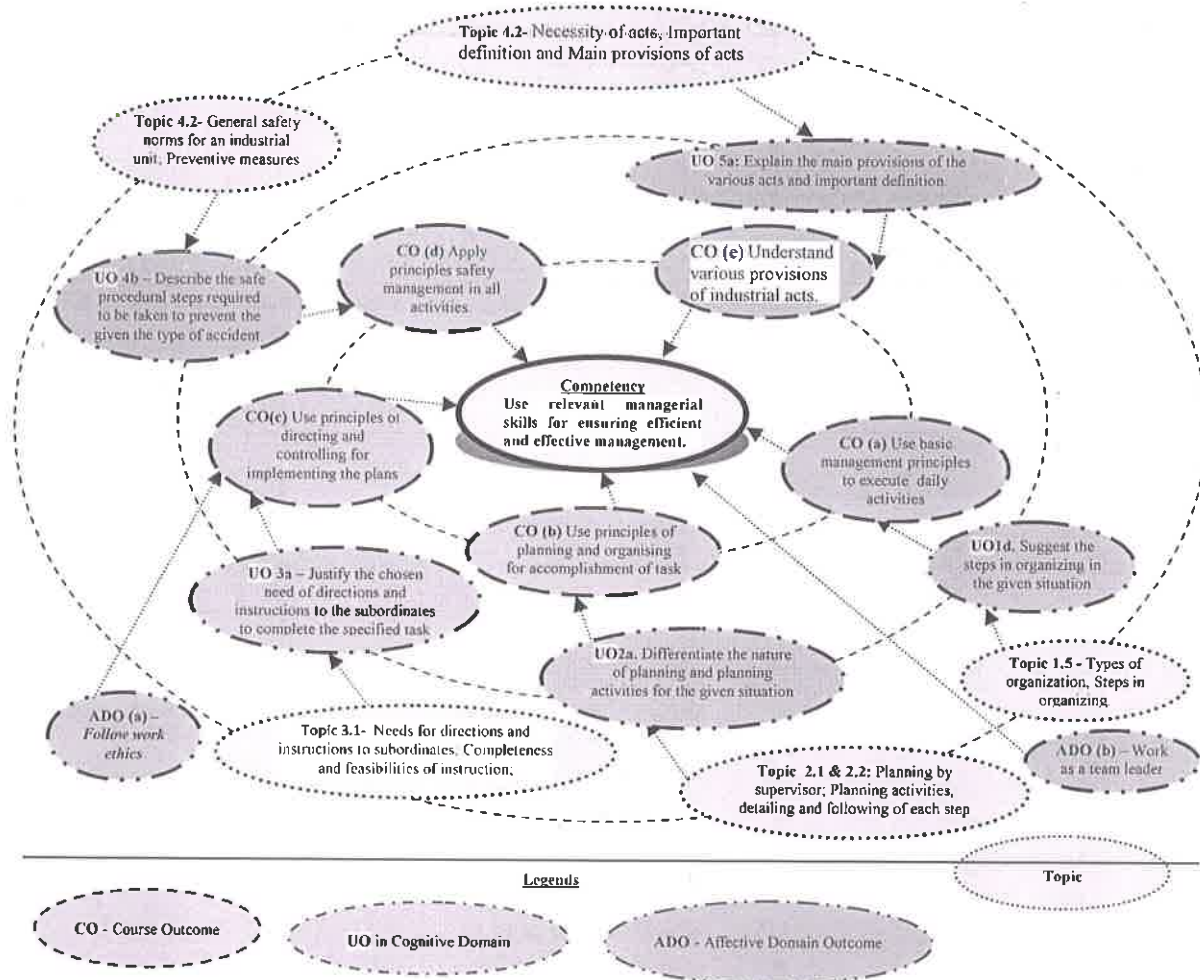


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

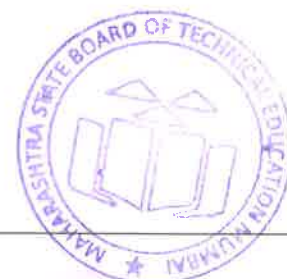
- Not applicable -

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

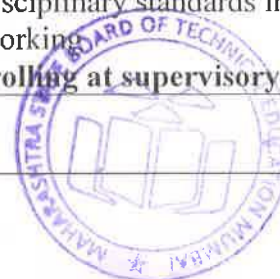
- Not applicable -

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 Introduction to management concepts and managerial skills	1a. Differentiate the concept and principles of management for the given situation. 1b. Explain functions of management for given situation. 1c. Compare the features of the given types of planning 1d. Suggest the steps in organizing in the given situation. 1e. Suggest suitable type of organization for the given example. 1f. Identify the functional areas of management for the given situation 1g. Suggest suitable managerial skills for given situation with justification	1.1 Definitions of management, role and importance of management. 1.2 Management characteristics and principles, levels of management and their functions; management, administration and organization, relation between management and administration. 1.3 Functions of management: planning, organizing, leading/directing, staffing and controlling. 1.4 Types of planning and steps in planning 1.5 Types of organization, Steps in organizing 1.6 Functional areas of management. 1.7 Managerial skills.
Unit – II Planning and organizing at supervisory level	2a. Differentiate the nature of planning and planning activities for the given situation. 2b. Suggest the step wise procedure to complete the given activity in the shop floor. 2c. Prepare materials and manpower budget for the given production activity. 2d. Describe with block diagrams the organization of the physical resources required for the given situation. 2e. Describe the human needs to satisfy the job needs for the specified situation. 2f. List the tasks to be done by the concerned individuals for completing the given activity.	Planning at supervisory level 2.1 Planning by supervisor. 2.2 Planning activities, detailing and following of each step. 2.3 Prescribing standard forms for various activities. 2.4 Budgeting for materials and manpower. Organizing at supervisory level 2.5 Organizing the physical resources. 2.6 Matching human need with job needs. 2.7 Allotment of tasks to individuals and establishing relationship among persons working in a group
Unit– III Directing and Controlling at supervisory level	3a. Justify the chosen need of directions and instructions to the subordinates to complete the specified task. 3b. Select the feasible set of instructions to complete the given simple task, with justification 3c. Predict the possible mistakes for completing the given simple activity. 3d. Describe the managerial control	Directing at supervisory level 3.1 Needs for directions and instructions to subordinates; Completeness and feasibilities of instructions 3.2 Personal counselling advanced predictions of possible mistakes. 3.3 Elaborating decisions, laying disciplinary standards in overall working Controlling at supervisory level



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	actions and remedial measures required to be taken for completing the given task successfully.	3.4 Managerial control; Understanding team and link between various departments in respect of process and quality standards; Steps in control process 3.5 Controlling methods; Control over the performance in respect of quality, quantity of production, time and cost. Measuring performance, comparing with standards, correcting unfavorable deviations.
Unit – IV Safety Management	4a. State the general safety norms required to be taken in the given case. 4b. Suggest preventive measures of plant activities in the given situation. 4c. Describe the safe procedural steps required to be taken to prevent the given the type of accident. 4d. Prepare a work permit in to conduct the given maintenance activity. 4e. Explain the causes of the specified type of accident in the given situation. 4f. Prepare the specifications of the firefighting equipment required for the given type of fire.	4.1 Need for safety management measures 4.2 General safety norms for an industrial unit; Preventive measures. 4.3 Definition of accident, types of industrial accident; Causes of accidents; 4.4 Fire hazards; Fire drill. 4.5 Safety procedure 4.6 Work permits.
Unit – V Legislative Acts	5a. Explain the purpose of the act 5b. Explain the main provisions of the various acts and important definition.	5.1 Necessity of acts, Important definition and Main provisions of acts. 5.2 Industrial Acts: a. Indian Factory Act b. Industrial Dispute Act c. Workman Compensation Act d. Minimum Wages Act

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	Introduction to management	12	06	06	04	16

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
	concepts and managerial skills					
II	Planning and organizing at supervisory level	08	04	06	04	14
III	Directing and controlling at supervisory level	08	04	06	04	14
IV	Safety Management	08	04	06	04	14
V	Legislative Acts	12	02	06	04	12
Total		48	20	30	20	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:

- Write assignments based on the theory taught in classrooms. Assignments consist of ten questions having long answers including charts, symbols, drawing, observations etc.
- Prepare/Download information about various industrial acts.
- Visit to any Manufacturing industry and prepare a report consisting of:
 - Organization structure of the organization/ Dept.
 - Safety measures taken in organization.
 - Mechanism to handle the disputes.
 - Any specific observation you have noticed.
- Give seminar on relevant topic.
- Undertake micro-projects.

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 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*.
- Guide student(s) in undertaking micro-projects.
- Demonstrate students thoroughly before they start doing the practice.



- g. Encourage students to refer different websites to have deeper understanding of the subject.
- h. Observe continuously and monitor the performance of students in Lab.

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. Study of management principles applied to a small scale industry.
- b. Study of management principles applied to a medium scale industry.
- c. Study of management principles applied to a large scale industry.
- d. Prepare case studies of Safety measures followed in different types of organization.
- e. Study of measures to be taken for ensuring cyber security.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Management and entrepreneurship	Veerabhadrappa, Havinal	New age international publishers, New Delhi, 2014: ISBN: 978-81-224-2602-1
2	Principles of management	Chaudhry omvir Singh prakash	New Age international publishers, 2012, New Delhi ISBN: 978-81-224-3039-4
3	Industrial Engineering and management	Dr. O. P. Khanna	Dhanpath ray and sons, New Delhi
4	Industrial Engineering and management	Banga and Sharma	Khanna Publication, New Delhi

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

- a. <https://www.versesolutions.com/>
- b. <https://www.books.google.co.in/books?isbn=817758412X>
- c. <https://www. www.educba.com> › Courses › Business › Management



Program Name : Diploma in Automobile Engineering
Program Code : AE
Semester : Sixth
Course Title : Hydraulic and Pneumatic Controls
Course Code : 22650

1. RATIONALE

There is hardly any automobile as well as manufacturing and service industry without Hydraulic and Pneumatic systems. Hydraulic, pneumatic and hydro-pneumatic systems offer ease of power transmission, enhancement of force and torque; and higher degree of automation. This is a core technology course. It provides insight to construction of Hydraulic and Pneumatic circuits, their applications in industrial and automobile systems and maintenance thereof.

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 different types of hydraulic and pneumatic 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:

- Use principles of fluid mechanics for energy conservation.
- Prepare a troubleshooting chart for centrifugal, reciprocating and other pumps used in fluid power system.
- Evaluate capacities of simple hydraulic and other pumping devices.
- Construct hydraulic and pneumatic circuits for relevant applications.
- Maintain components of hydraulic, pneumatic and hydro-pneumatic systems..
- Maintain hydraulic, pneumatic and hydro-pneumatic circuits and systems.

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.

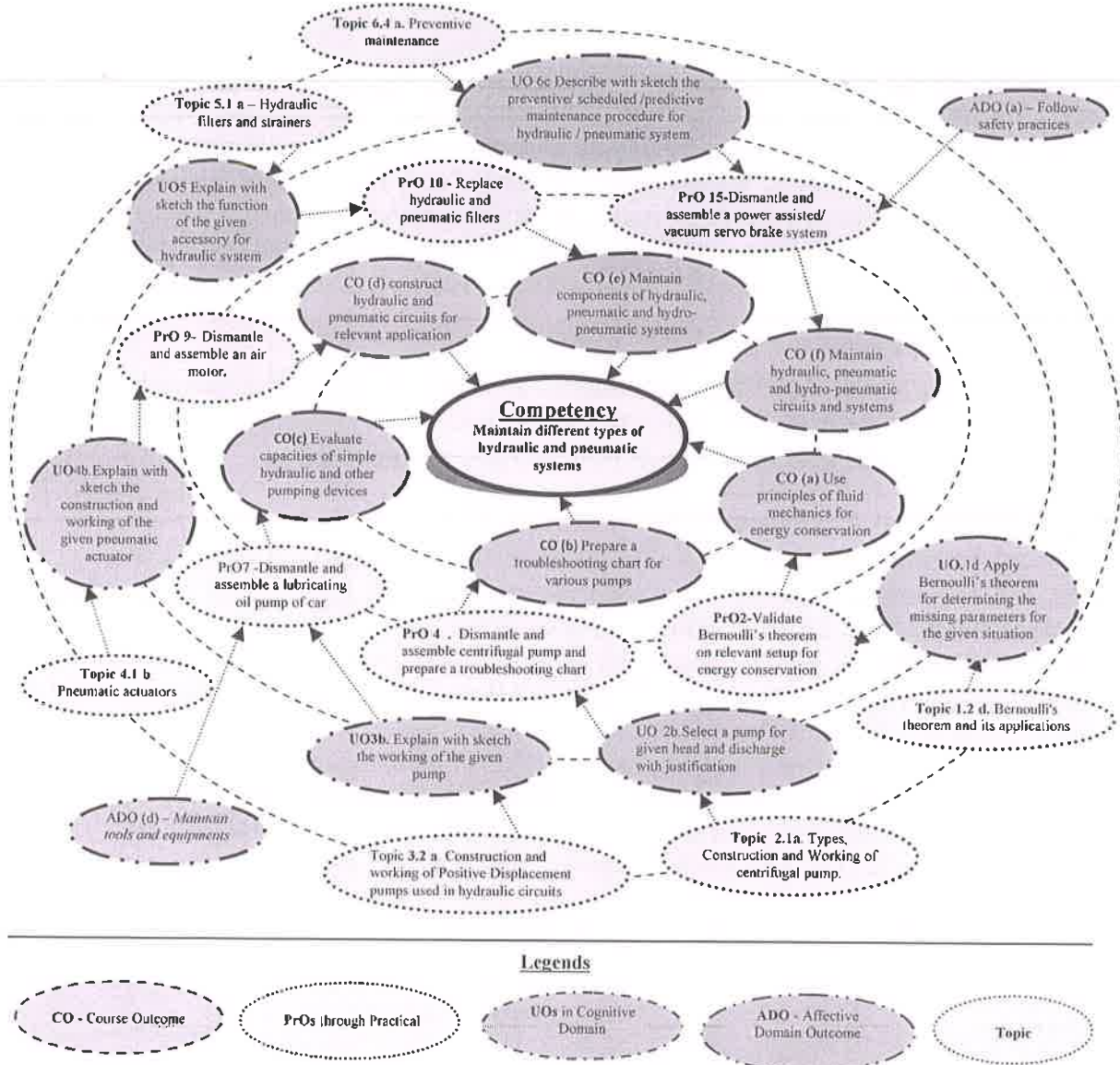


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals 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:

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1.	Trace hydraulic circuit and components of automobile hydraulic brakes relevant to Pascal's law.	I	02*
2.	Validate Bernoulli's Theorem on relevant setup for energy	I	02*



Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	conservation.		
3.	Assess the performance of a centrifugal pump by using centrifugal pump test rig.	II	02*
4.	Dismantle/assemble centrifugal pump to prepare a troubleshooting chart.	II	02*
5.	Assess the performance of a reciprocating pump by using reciprocating pump test rig.	II	02
6.	Dismantle/assemble reciprocating pump to prepare a trouble shooting chart.	II	02
7.	Dismantle/assemble a lubricating oil pump of car.	III	02*
8.	Dismantle/assemble an air motor.	IV	02*
9.	Dismantle/assemble hydraulic and pneumatic system valves.	IV	02*
10.	Replace hydraulic and pneumatic filters.	V	02
11.	Operate double acting cylinder on a hydraulic trainer using meter-in and meter-out circuit.	VI	02*
12.	Operate two double acting cylinders using sequencing circuit.	VI	02*
13.	Dismantle/assemble a double acting hydraulic cylinder.	VI	02
14.	Troubleshoot hydraulic circuits and systems.	VI	02*
15.	Dismantle/assemble a power assisted/ vacuum servo brake system	VI	02*
16.	Troubleshoot pneumatic circuits and systems.	VI	02*
	Total		32

Note

- 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.
- 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.	Follow safety rules and adopt standard practices for handling tools/ equipment and systems.	20
2.	Refer manufacturer specification, workshop/ operation manual and include relevant data in the journal.	20
3.	Sketching layouts, interpret results and conclusion.	30
4.	Answer to simple questions.	20
5.	Timely completion of the task and term-work.	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:

- Follow safety practices.
- 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	Venturimeter Test Rig (Venturimeter - Cast iron/ Brass/ PVC) 25 mm and 50 mm).	1
2	Practical Set-up of Bernoulli's Theorem (apparatus for verification of Bernoulli's Theorem complete with tank).	2
3	Centrifugal Pump Test rig (Constant Speed- Centrifugal pump, provided with electric motor, vacuum gauge at suction and pressure gauge on discharge pipe, gate valve on discharge). Motor suitable for main and operating characteristics.	3
4	Centrifugal pump- 1/2HP (370W) ,1400rpm.	4
5	Reciprocating pump test rig (re-circulating type unit with reciprocating pump and vacuum gauge, pressure gauge at discharge) three speed drive arrangement- pulley.	5
6	Reciprocating pump- Max. Flow rate: Up to 3728 L/Hr Max. Pressure: Up to 150 Kg/cm ² . Single acting.	6
7	Gear pump of lubrication system of a vehicle.	7
8	Maintenance kit (Maintenance tool kit for hydraulic and pneumatic system).	6 to 16
9	Hydraulic and pneumatic valves- Direction control valves: Operating pressure min 10 bar Operating pressure max 50 bar, Nominal flow 80 l/min. Flow control valve: Valve size 1/4" to 2", Pressure 500bar Pressure relief valve: Flow Rate (60 l/min) Material -Brass, Pressure- 350bar.	9
10	Compressor (Two stage- two cylinder air cooled, with intercooler and after-cooler, receiver mounted, 30 to 40 m ³ /hr, 3.5 KW with pressure switch, pressure gauge and safety valve mounted).	8,10,15 and 16
11	Hydraulic trainer kit consisting of power pack (motor, pump, tank, filter, breather, pressure relief valve and pressure gauge), basic components- valves- direction control valve, flow control valve, sequencing valve, bleed-off valve, pressure gauge, actuators, accumulator, rigid pipes, hoses and connectors).	11 and 12



S. No.	Equipment Name with Broad Specifications	PrO. No.
12	Pneumatic trainer kit consisting of compressor, basic components- FRL unit, valves- direction control valve, flow control valve, safety valve, sequence valve, connectors and hoses.	16

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– Overview of Fluid mechanics.	1a. Define the given property of fluid. 1b. Graphically represent relation between given pressures. 1c. Select a device for measurement of pressure for the given condition with justification. 1d. Apply Bernoulli's theorem for determining the missing parameters for the given situation. 1e. Calculate coefficient of velocity/ discharge of liquid in the given section under steady flow in given device.	1.1 Fluid Fundamentals. a. Classification of fluids, properties of fluids like specific weight, specific gravity, viscosity. Specifications of hydraulic oil b. Pascal's law. c. Types of fluid flow- steady, unsteady, laminar, turbulent, one, two and three dimensional flow, uniform and non uniform flow, Pressure Measurement. d. Concept of atmospheric pressure, gauge pressure, vacuum and absolute pressure. e. Pressure gauges - Piezometer tube, simple and differential manometer. Bourdon's tube pressure gauge. 1.2 Hydrodynamics. a. Basic principles of fluid flow, Law of continuity and its applications. b. Energy possessed by the liquid in motion. c. Bernoulli's theorem and its applications such as Venturimeter, orifice-meter and Pitot tube.
Unit – II Hydraulic Devices	2a. State limitations of suction head for given NPSH. 2b. Select a pump for given head and discharge with justification 2c. Differentiate the given pumps on the basis of the given parameter 2d. Explain with sketches the construction, working and application of the given pump.	2.1 Centrifugal Pumps a. Types, construction and working of centrifugal pump, Types of casing. Need of priming. b. Heads, losses and efficiencies of centrifugal pump, Cavitation and net positive suction head (NPSH) c. Fault finding and remedies. d. Pump selection. 2.2 Reciprocating Pumps a. Construction and working of single and double acting reciprocating pump. b. Positive and negative slip. c. Air vessels - function and advantages. d. Power and efficiencies of reciprocating pump. (No analytical treatment)



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		e. Reasons of cavitation and separation. f. Comparison between reciprocating and centrifugal Pump. 2.3 Submersible pump- Construction working and application.
Unit– III Miscellaneous Fluid Machines	3a. Explain with sketch the working of the given hydraulic device. 3b. Explain with sketch the working of the given pump. 3c. Differentiate the given pumps on the basis of the given characteristics. 3d. Differentiate the given pumps on the basis of the given applications.	3.1 Simple Hydraulic Devices. a. Working principles, construction and applications of hydraulic jack, hydraulic crane, hydraulic lift, hydraulic press. 3.2 Other Pumping Devices a. Construction and working of positive Displacement pumps used in hydraulic circuits: gear type, vane type, plunger types (swash plate, bent axis, axial and radial). Comparison of above pumps for various characteristics and their applications.
Unit– IV Basic Components of Hydraulic and Pneumatic Systems	4a. Explain with sketch the construction and working of the given hydraulic actuator 4b. Explain with sketch the construction and working of the given pneumatic actuator 4c. Select the relevant valves for given hydraulic circuit with justification 4d. Select the relevant valves for given hydraulic system with justification	4.1 Hydraulic and Pneumatic actuators a. Hydraulic actuators - hydraulic cylinders (single, double acting and telescopic) – construction and working, hydraulic motors (gear and piston type) –construction and working. b. Pneumatic Actuators - Pneumatic cylinders (single and double acting) -construction and working, air motors (vane and piston type) - construction and working. 4.2 Valves for Hydraulic and Pneumatic systems a. Classifications of valves, poppet, ball, needle, throttle, pressure control, directional control, sequencing, rotary spool, sliding spool two position, multi position, non-return valves and proportionating valve. b. Construction and operation of above valves.
Unit– V Accessories of Hydraulic and Pneumatic Systems	5a. Explain with sketch the function of the given accessory for hydraulic system. 5b. Explain with sketch the function of the given accessory for pneumatic system 5c. Compare the given	5.1 Filters a. Hydraulic filters and strainers – full flow and proportional types, function and working, difference between filters and strainers. b. Pneumatic filters –screen type and mechanical type, function and working, FRL unit. 5.2 Hoses and connectors for hydraulic and pneumatic systems- - Types, construction



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	<p>accessories of pneumatic / hydraulic systems on basis of the given parameters.</p> <p>5d. Classify the given hydraulic/pneumatic accessories on the given parameters</p> <p>5e. Explain with sketches the construction and application of the given pneumatic / hydraulic system accessory.</p>	<p>and applications.</p> <p>5.3 Seals and gaskets for hydraulic and pneumatic systems-Types, function and construction of commonly used seals and gasket materials.</p>
<p>Unit- VI Hydraulic, Pneumatic and Hydro-pneumatic Circuits and Systems</p>	<p>6a. Explain with sketches the symbols used in the construction of the given circuits.</p> <p>6b. Explain with sketch the working of the given system.</p> <p>6c. Describe with sketch the specified maintenance procedure for the given system.</p> <p>6d. Sketch specified circuit using the given components for the given application.</p>	<p>6.1 Hydraulic Circuits and Systems</p> <p>a. Hydraulic symbols</p> <p>b. Meter in, meter out, bleed off, sequencing.</p> <p>c. Introduction to electro-hydraulics – concept, principles and applications</p> <p>d. Applications of hydraulic circuits – hydraulic power steering, hydraulic brakes, milling machine, hydraulic press,</p> <p>6.2 Simple Pneumatic Circuits and Systems</p> <p>a. Pneumatic symbols</p> <p>b. Speed control circuit, Sequencing circuit and time delay circuit.</p> <p>c. Applications of pneumatic circuits – air brake, low cost automation in industries, pneumatic power tools (drill, nut runner, hammer and grinder).</p> <p>d. Comparison of hydraulic and pneumatic circuits.</p> <p>6.3 Hydro-pneumatic circuit and system</p> <p>a. Hydro-pneumatic rams.</p> <p>b. Brake booster of truck/ bus</p> <p>c. Pin lift of pneumatic moulding machines</p> <p>6.4 Maintenance of hydraulic, pneumatic and hydro-pneumatic systems.</p> <p>a. Preventive maintenance</p> <p>b. Scheduled maintenance</p> <p>c. Predictive maintenance</p>

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	Overview of Fluid mechanics	08	06	06	--	12
II	Hydraulic Devices	08	--	04	06	10
III	Miscellaneous Fluid Machines	06	--	04	04	08
IV	Basic Components of Hydraulic and Pneumatic Systems	10	04	04	08	16
V	Accessories of Hydraulic and Pneumatic Systems	04	--	04	04	08
VI	Hydraulic, Pneumatic and Hydro-pneumatic Circuits and Systems	12	04	04	08	16
Total		48	14	26	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:

- Prepare journal of practicals.
- Undertake micro-projects.
- Collect specifications of pump and compressor for specific applications.
- Collect specifications of different types of valves for specific applications.
- Collect specifications, and material relevant information for different hoses.
- Collect specifications and material relevant information for fittings/connectors.
- Collect scheduled maintenance data relevant to hydraulics and pneumatics from MSRTC/ Bus depot/ Workshop.
- Collect data of various hydraulic jacks used for specific application.
- Collect specifications of hydro-pneumatic / pneumatic ram.
- Collect specifications for pneumatic tools like nut runner, hand drill, grinder.

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 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*.
- e) Guide student(s) in undertaking micro-projects.
- f) Demonstrate students thoroughly before they start doing the practice.
- g) Encourage students to refer different websites to have deeper understanding of the subject.
- h) Observe continuously and monitor the performance of students in Lab.

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:

Note: Material required for the following micro-projects may be obtained from scrap yard/ garage/ service center.

- a) Prepare a chart for selection of pump/ compressor for given application while ensuring energy conservation and high productivity; referring to the different manufacturers' catalogues including different characteristics- main and operating; machinery handbooks and IS codes. (This micro-project fulfills CO a, CO b and CO c).
- b) Make an exploded view board model of the given aggregate from the following. Following steps should be strictly followed. (This micro-project fulfills CO b and CO d)
 - i. Centrifugal pump of cooling system of an automotive engine enlisting the details of heat carried away by the cooling system, pressure, flow rate, temperature range and rotational speed.
 - ii. Lubricating pump of an automotive engine- enlisting the details of pressure, flow rate, rotational speed and service limits relevant to component dimensions referring service manual.
 - iii. Air compressor of truck braking system- enlisting the details of free air displacement (FAD), maximum pressure, rotational speed and service limits relevant to component dimensions referring service manual.
 - iv. Wheel cylinder/ tandem master cylinder of a vehicle braking system- enlisting the details of operating pressure, force developed and service limits relevant to component dimensions referring service manual.
- c) Prepare a board mounted kit of hoses and connectors used in hydraulic/ pneumatic system. (This micro-project fulfills CO d and CO f).
- d) Prepare a troubleshooting chart for different defects of the centrifugal pump. (This micro-project fulfills CO b and CO c)



- e) Prepare demonstration model of hydraulic jack/ hydraulic press/ hydraulic crane/ earth moving machines- using water and injection syringes of different sizes. (CO d and CO e).

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Hydraulic and Fluid Mechanics	Modi, P. N.; Seth , S.M.	Standard Book House, Delhi, 2017 ISBN-13: 978-8189401269
2	Industrial Hydraulics	Pippenger, Hicks	McGraw Hill Int.Mumbai,1979 ISBN-13: 978-0070501409
3	Introduction To Hydraulics And Pneumatics	Ilango, S. Soundararajan, V.	PHI Learning Private Limited, New Delhi, 2011 ISBN: 978-8120344068
4	Fluid Power	Esposito, Anthony	PEARSON Education, Noida, Delhi, ISBN-13: 978-8177585803
5	Hydraulic and Pneumatic Controls	Sundaram, S.K.	S. Chand, Pune, 2006. ISBN-13: 978-8121926355
6	Industrial Hydraulics Manual	Vickers	Vickers system international Ltd. Pimpri, Pune – 411018, 1999. ISBN-13: 978-0963416209

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

- <http://nptel.ac.in>
- <https://www.youtube.com/watch?v=06hWnWnNOFE>
- <https://www.youtube.com/watch?v=c6gwU7IHtlo>
- <https://www.youtube.com/watch?v=8CRMUKwrhUQ>
- <https://www.youtube.com/watch?v=KgphO-u7MIQ>
- <https://www.youtube.com/watch?v=YeYd0htafwo>
- <https://www.youtube.com/watch?v=jsMJbJQkGTs>
- <https://www.youtube.com/watch?v=K5B7uZpOHNQ>
- https://www.youtube.com/watch?v=b0_bGKHHHPM
- <https://www.youtube.com/watch?v=t6RiX5HDKQg>
- <https://www.youtube.com/watch?v=z1gVxYfiSr0&pbjreload=10>
- <https://www.youtube.com/watch?v=BEpQFZ5BG8c>
- <https://www.youtube.com/watch?v=RjLaU8nFnzE>
- https://www.youtube.com/watch?annotation_id=annotation_2640300455&feature=iv&src_vid=O_ktD2pRghQ&v=iLAcfiIXsQw



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.

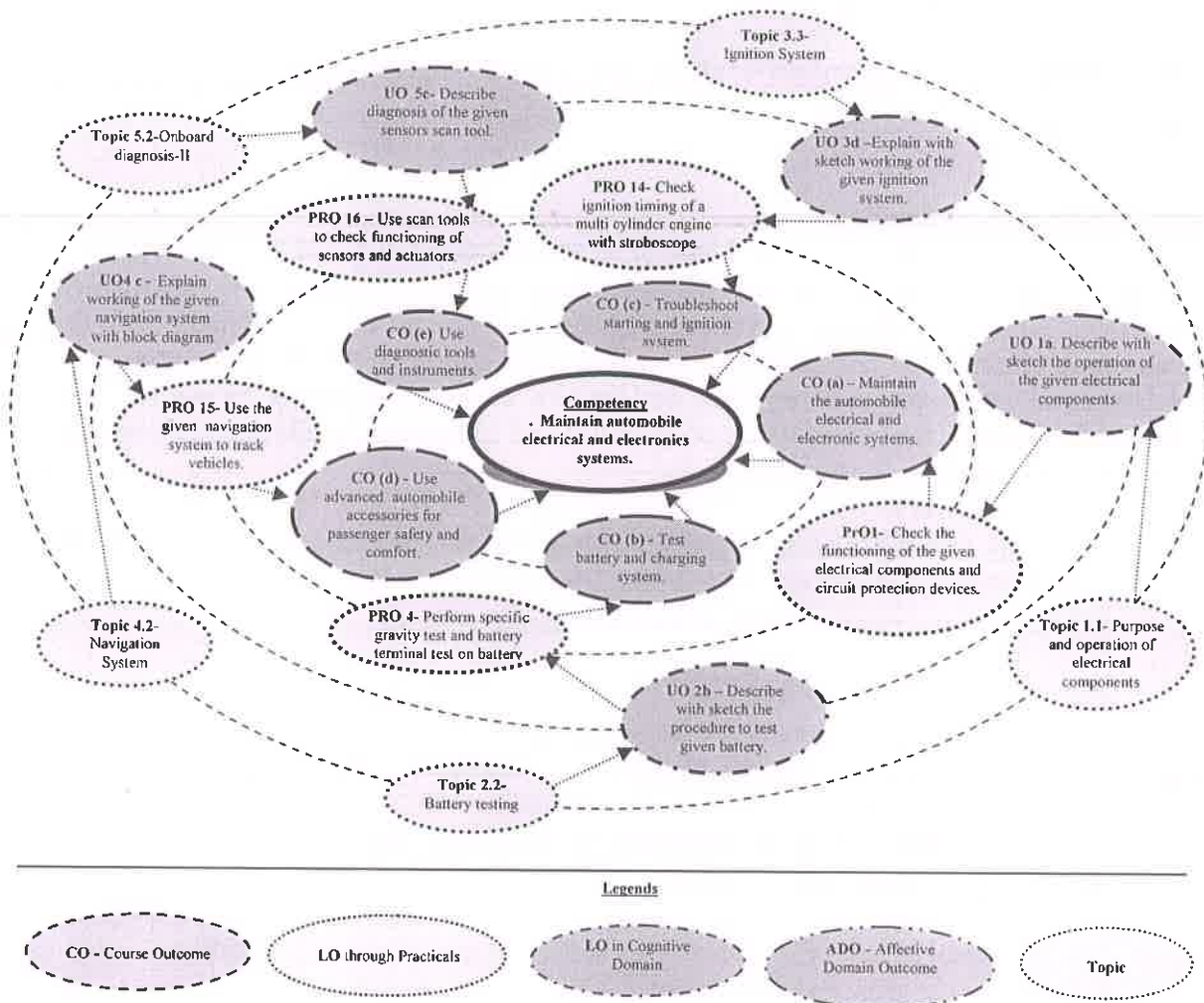


Figure 1 - Course Map

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

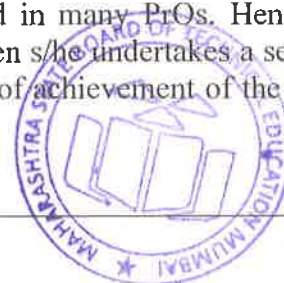
- i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' 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

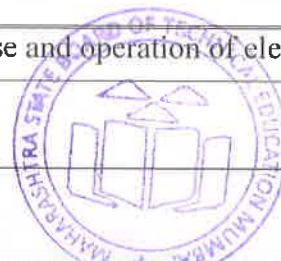
The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

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

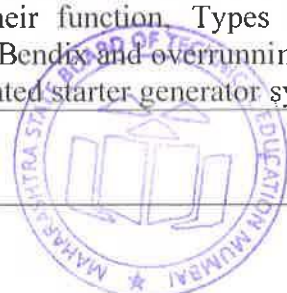
8. UNDERPINNING THEORY COMPONENTS

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 Batterys, 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=ueIF_CjtJ5g&list=PLPvqVA0h0J6h6aYnH2Spw-n7SK5OYXlpj&index=5



Program Name : Diploma in Mechanical Engineering
Program Code : ME/PG/PT/AE
Semester : Sixth
Course Title : Emerging Trends in Mechanical Engineering
Course Code : 22652

1. RATIONALE

Over the coming years, technological developments such as Robotics, IOT, Artificial intelligence, smart controls are likely to have a significant impact on the world of work and employment as well as to trigger far reaching changes. Looking towards the era in Technology advancement, Mechanical/Automobile/Production Engineering offers addition of new Dynamic subjects and new versions of core subjects. Diploma Mechanical/Automobile/Production Engineers should be familiar with new technologies from the fields of Automobile Engineering, Energy Management, Advanced Manufacturing Processes, Agriculture and Farm Machines and many more. This Dynamic course will give insight to the recent practices adopted by the Mechanical Industries and awareness of these techniques will enhance career opportunities of Diploma Mechanical/Automobile/Production Engineers.

2. COMPETENCY

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

- **Relate basic principles of Mechanical Engineering with Recent Technologies available in Industry.**

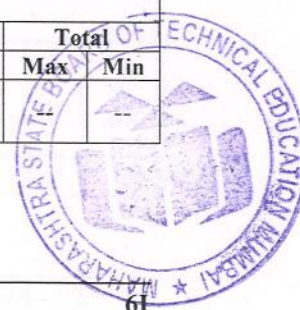
3. COURSE OUTCOMES (COs)

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:

- Identify different new Systems available in Automobile.
- Demonstrate automation systems in process industry.
- Cite examples of Modern manufacturing Technology in industry
- Use different standards for energy Management and Audit of a given system.
- Select recent agricultural equipment for farming operations.

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	Max	Min		
3	-	-	3	90 Min	70*#	28	30*	00	100	40	--	--	--	--	--	--



(*): 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 MULTI CHOICE QUESTION 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.

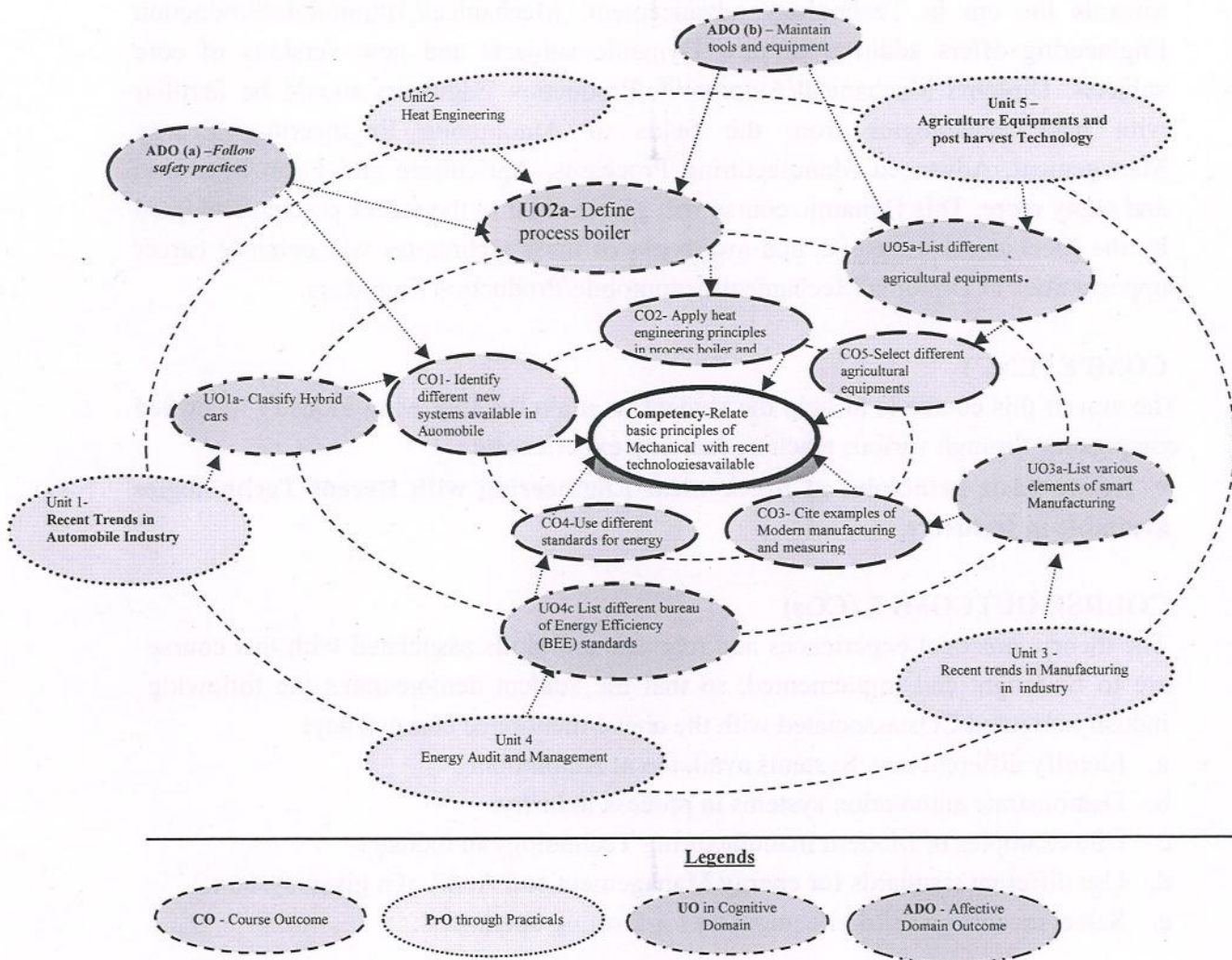


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals 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	NA		



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 24 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. 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 %
a.	NA	

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. Demonstrate working as a leader/a team member.
- e. Maintain tools and equipment.
- f. 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
- 'Organizing Level' in 2nd year
- 'Characterizing 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	LCD Projector	-

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.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit-I Recent Trends in Automobile Industry	1a. Classify Hybrid cars 1b. Use different batteries and charging methods for E-Vehicles 1c. Name different safety systems used in given	1.1 Hybrid cars-manufactures, Types- Micro Hybrid, Mild Hybrid, Full Hybrid, Series hybrid, Parallel Hybrid 1.2 E-vehicles- Manufacturers, specifications, Types of Batteries, Li-ion batteries, Sodium Nickel

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	vehicle. 1d. Interpret concept of autonomous vehicles.	Chloride Batteries ,Sodium Sulphor Batteries, Fuel Cell, Charging- Charging Methods and Modes. Issues with e-vehicles 1.3 Safety in Automobile- Air bags, , Electronic stability programmer, Anti Collision system. 1.4 Autonomous Vehicle- introduction, necessity, Level, Manufacturer
Unit- II Recent Trends in Process Industry	2a. Define process boiler and Combi Boiler 2b. List commerciality viable waste heat recovery devices. 2c. Interpret process layout of different process industry 2d. List different elements of process automation.	2.1 Process Boilers, Introduction to Combi Boilers 2.2 Waste heat recovery-process industry 2.3 Process layout of process industry a. Food Industry b. Pharmaceutical c. Textile 2.4 Process Automation – Need, Basic Elements, Types
Unit -III Recent Trends in Manufacturing industry	3a. List various elements of smart factory 3b. Select Robot for given application 3c. List applications of Industrial robot 3d. Interpret Immersive Technology	3.1 Smart Factory -introduction, Elements and applications 3.2 Industrial robotics : robot anatomy, robot control systems, end effectors, sensors in robotics, 3.3 Industrial Robot applications • Welding Robot • Assembly Robot 3.4 Introduction to Immersive Technology • Virtual Reality • Augmented Reality • Mixed Reality
Unit-IV Energy Audit and Management	4.a List different bureau of Energy Efficiency (BEE) standards. 4.b Describe methods of Energy Monitoring and Targeting 4.c Identify steps for conducting Energy Audit. 4.d State concept of Home energy audit.	4.1 Standards and labelling standard 4.2 Energy Monitoring and Targeting. 4.3 Energy Management and Audit 4.4 Home Energy Audit- Concept
Unit-V Agriculture Equipment and post-harvest Technology	5.a Explain working of different agricultural equipment. 5.b Name different elements of Cold Chain 5.c List the features of NCAP	5.1 Farms tools and equipments 5.2 Advanced Technology in Post Harvesting 5.3 Elements of Cold chain 5.4 National Cooling Action Plan (NCAP)



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
1	Recent Trends in Automobile Industry	14	06	10	04	20
2	Recent Trends in Process Engineering	08	02	06	04	12
3	Recent Trends in Manufacturing in industry	12	04	06	08	18
4	Energy Audit and Management	08	02	06	02	10
5	Agriculture Equipment and post-harvest Technology	06	02	06	02	10
Total		48	16	34	20	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

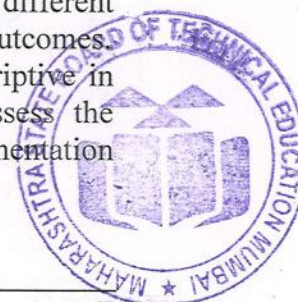
Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages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

- Visit any industry and collect information of recent trends in Industry.
- Undertake a market survey of local dealers for agricultural equipments, machineries, HVAC equipments and prepare a report.
- Visit to any Industrial press shop and prepare a report consisting
 - Safety precautions observed.
 - Identify problems related to energy conservations faced by industry

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 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*.
- e. Guide student(s) in undertaking micro-projects.
- f. Demonstrate students thoroughly before they start doing the practice.
- g. Encourage students to refer different websites to have deeper understanding of the subject.
- h. Observe continuously and monitor the performance of students in Lab.
- i. Demonstrate students thoroughly before they start doing the practice.
- j. Encourage students to refer different websites to have deeper understanding of the subject.
- k. Guide student(s) in undertaking micro-projects.
- l. Arrange visit to nearby industries for understanding various tool engineering operations
- m. Show video/animation films to explain tool design processes.
- n. Give Micro projects.
- o. Use different instructional strategies in classroom teaching.
- p. In respect of item no.10 above the teachers need to ensure to create opportunities and pursue for such 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*.

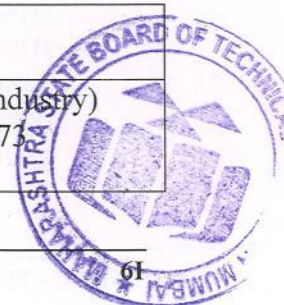
The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual 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 are given here. Similar micro-projects could be added by the concerned faculty:

- a. Prepare energy audit report of any one Lab rotary.
- b. Collect data with respect to safety systems available in Modern cars
- c. Identify different heat losses in Furnace available in workshop.
- d. Compile the different products manufactured by 4-D printing Technology
- e. Prepare report of pre and post harvesting using recent agricultural equipment
- f. Collect information of District cooling.
- g. Collect information of Robotics
- h. Visit the local industry nearby and study the manufacturing systems. Thereby prepare the low cost automation plan for improvement in the productivity and quality of the industry

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Electric and Hybrid Vehicles	Tom Denton	IMI (Institute of Motor Industry) ISBN-13: 978-1138842373 ISBN-10: 1138842370



S. No.	Title of Book	Author	Publication
2	The Electric car	M H Westbrook	IET,2001 ISBN-0852960131
3	Hybrid, Electrical and Fuel Cell Vehicles	Jack Erjavec	Cengage Learning,2012 ISBN-1285415051
4	Boilers for Power and process	Kumar Rayaprole	CRC Press,2009 ISBN-1420075373
5	Steam generators and Waste heat Boilers	V Ganpathy	CRC press, ISBN 1482247127
6	Introduction to process Technology	C.E Thomas	Cengage Learning,2009 ISBN 1435454251
7	Industry 4.0 Smart manufacturing for the future	William MacDougall	Germany trade and Investe,2014
8	Energy Management and Conservation	K V Sharma	I K International Publishing House Pvt ltd, 2011 ISBN- 9381141290
9	Energy Management, Audit and Conservation	B K De	Vrinda Publication, Indiana University,2007 ISBN-8182810930
10	Farm Tools and Equipments for Agriculture	Surendra Singh	New India Publishing,2015 ISBN-9385516221
11	Cold storage, cold chain, ware houses	NPCS Board of Consultant	3 rd Edition,2018 ,NIR project consultancy services, Delhi ISBN-978-93-81039-66-3
12	Automation, Production Systems, and Computer Integrated Manufacturing	Groover, Mikell. P.	PHI ISBN-13: 978-8120334182
13	Computer based Industrial Control	Kant, Krishna.	PHI Learning ISBN 13: 9788120339880

SOFTWARE/LEARNING WEBSITES

1. <https://www.youtube.com/watch?v=MdFWgat9ddA>(Agri Equipments)
2. <https://www.chargepoint.com/about> (Electrical Vehicle)
3. <http://www.plugndrive.ca/ev-models> (Electrical vehicle)
4. <http://www.oorja.in/what-is-radiant-cooling/types-of-radiant-cooling-systems/>(Cold Chain)
5. <https://www.beeindia.gov.in/content/standard-labeling> (Energy audit)
6. www.beestarlabel.com/ 9energy audit)



Dear Sir,

I am writing to you regarding the matter of the...

As per the information received from the...

The details of the same are as follows...

1. The first item is...

2. The second item is...

3. The third item is...

4. The fourth item is...

5. The fifth item is...

6. The sixth item is...

7. The seventh item is...

8. The eighth item is...

9. The ninth item is...

10. The tenth item is...

11. The eleventh item is...

12. The twelfth item is...

13. The thirteenth item is...

14. The fourteenth item is...

15. The fifteenth item is...

16. The sixteenth item is...

17. The seventeenth item is...

18. The eighteenth item is...

19. The nineteenth item is...

20. The twentieth item is...

21. The twenty-first item is...

22. The twenty-second item is...

23. The twenty-third item is...

24. The twenty-fourth item is...

25. The twenty-fifth item is...

26. The twenty-sixth item is...

27. The twenty-seventh item is...

Program Name : Diploma in Automobile Engineering
Program Code : AE
Semester : Sixth
Course Title : Automobile Air Conditioning (Elective-II)
Course Code : 22653

1. RATIONALE

This is a core technology course. All automotive vehicles are equipped with air conditioning. Hence the fundamental knowledge of air conditioning is most essential for an auto technologist. This course will help in understanding the procedure of inspection, diagnosis and testing of air conditioning, ducts and ventilation systems. The student will develop the ability to use the different tools and equipment to diagnose and perform servicing of HVAC system in vehicles.

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 vehicle air conditioning and heating 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 automotive Heating, Ventilation and Air-conditioning systems.
- Select relevant duct system for vehicles.
- Service various components of automobile Air Conditioning Systems.
- Troubleshoot air conditioning control systems.
- Repair Air-conditioning Systems.
- Maintain comfort heating systems.

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.

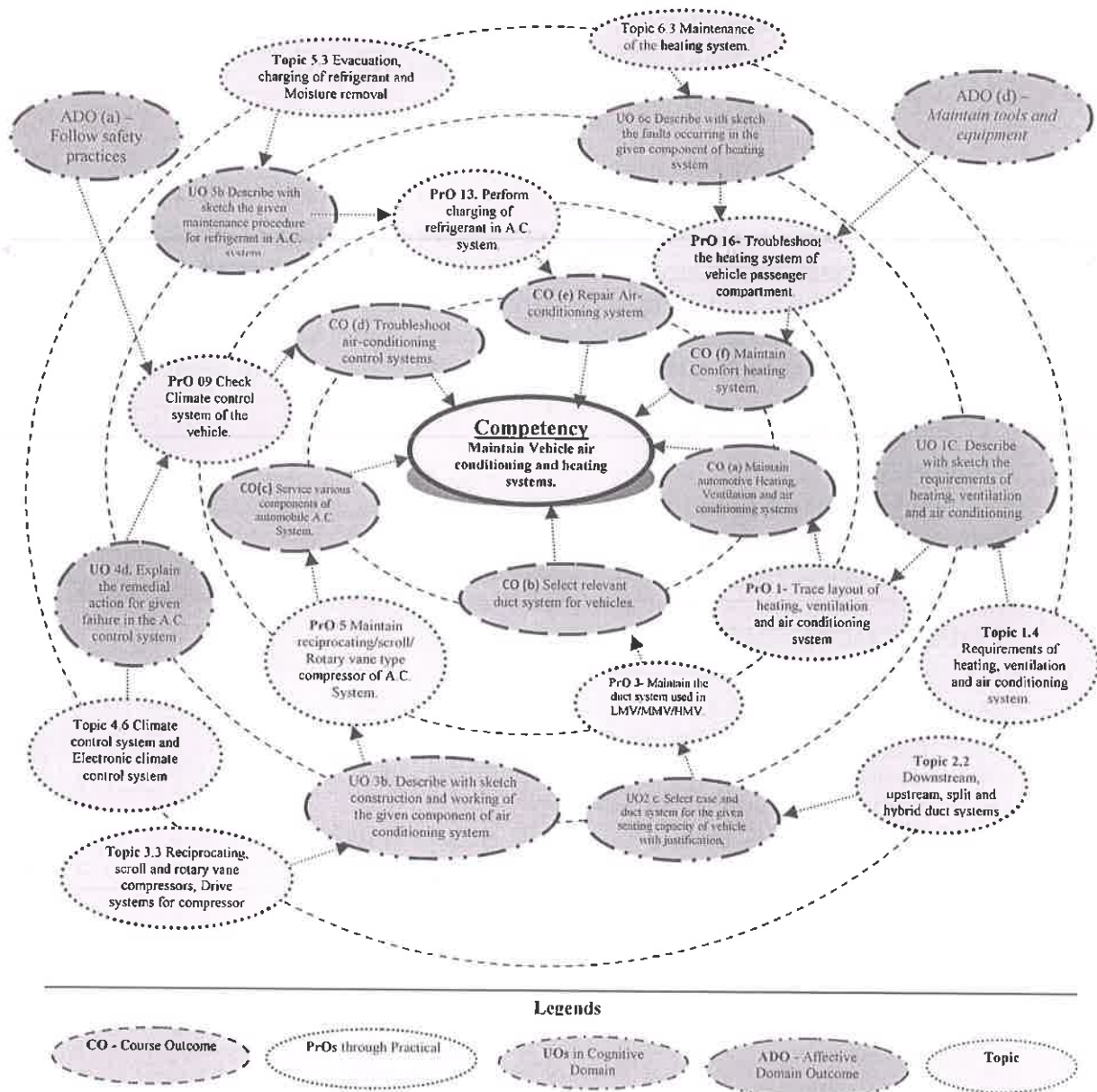


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals 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.	Trace layout of heating, ventilation and air conditioning system used in LMV/ MMV/HMV.	I	02
2.	Identify the parts of duct system used in LMV/MMV/HMV.	I	02*
3.	Maintain the duct system used in LMV/MMV/HMV.	II	02
4.	Service air blower and air filter.	II	02*
5.	Maintain reciprocating/Scroll/Rotary vane type compressor of A.C. System	III	02*
6.	Service the Electromagnetic clutch.	III	02



S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
7.	Maintain drive system of A.C. Compressor.	III	02*
8.	Perform purity test of refrigerant.	III	02
9.	Check Climate control system of the vehicle.	IV	02*
10.	Troubleshoot the AC control system.	IV	02*
11.	Troubleshoot automobile air conditioning system components.	V	02*
12.	Perform refrigerant evacuation from A.C. system.	V	02*
13.	Perform charging of refrigerant in A.C. system.	V	02*
14.	Perform leak detection test of A.C. System.	V	02*
15.	Test the condition of hoses, pipes, and connectors of A.C. system.	V	02*
16.	Troubleshoot the heating system of vehicle passenger compartment.	VI	02*
Total			32

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 24 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. 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.	Follow safety rules and adopt standard practices for handling tools	20
2.	Refer workshop manual and include relevant data in the journal.	20
3.	Sketching layouts, components and conclusion	30
4.	Answer to simple questions	20
5.	Timely completion of the task and term-work.	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:

- a. 'Valuing Level' in 1st year
- b. 'Organisation Level' in 2nd year
- c. '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	General purpose tools (Spanners, ring spanner and socket set)- 6mm to 32 mm	All
2	Air conditioning service tool kit, with refrigerant tester	8, 14 15
3	Working model of Automobile HVAC system of any Car model Make: car manufacturer in India Power supply: 220 V AC 50 Hz 110 V AC 60 Hz Compressor wobble plate type Condenser parallel flow type suitable for car Evaporator serpentine type with a thermostatic expansion valve, blower motor, and grill. Receiver with sight glass and other accessories. All ideal controls and safety controls for car ac. Single phase electric motor 2 HP Suitable 12volt battery to run condenser fan, evaporator fan and to operate magnetic clutch of the compressor. Battery Charger to recharge Battery.	2, 3, 4, 9
4	Refrigerant Recovery, Recycling, and recharging Machine Power supply: 220 V AC 50 Hz 110 V AC 60 Hz Evacuating air speed of vacuum pump: 4.5 CFM Compressor power: 3/8 HP Accuracy of electronic scale: 5 g Maximum weight of the electronic scale: 50 Kg Drying filter: 500 cc, 3/8 connecting port Capacity of refrigerant tank: 23.5 L 13.6 L Maximum working pressure: 17.5 bar Maximum recovery speed: 0.5 Kg/Min Maximum recharging speed: 2 Kg/Min	12, 13
5	Reciprocating/Scroll/Rotary vane type Compressor. (For Dismantling)	5
6	Evaporator of commonly used car A.C. System	6
7	Condenser of commonly used car A.C. System	6
8	Accumulator of commonly used car A.C. System	6
9	Receiver drier of commonly used car A.C. System	6,
10	Electromagnetic clutch of commonly used car A.C. System	6, 7
11	Refrigerant tank for R-134a(Capacity 13.6 kg)	12, 13
12	Halide and Fluorescent Refrigerant Leak Detector (HFC Halogen Gas Refrigerant Leak Detector in automobile air conditioning for R-134a)	14
13	Thermostatic expansion valve of commonly used car A.C. System	6
14	Vacuum pump (Single Stage Rotary Vane R134A, 1/3HP Deep Vacuum Pump of Car AC)	11,9,6
15	Digital Temperature gauge (Temperature range : -20 to 70 °C)	11
16	High-Low Pressure (Vacuum) gauge for R134A Temperature Scale: Celsius Max Working Pressure: 500PSI Burst pressure: 2500PSI Hose Length: around 55" (inches) Quick disconnect couplers for High/Low fittings included	11



S. No.	Equipment Name with Broad Specifications	PrO. No.
	Each coupler have a shut off valve to prevent loss of refrigerant Blue gauge (low): 2-1/2" diameter, 0-240 PSI with 0-40 VAC Red gauge (high): 2-1/2" diameter, 0-500 PSI Celsius C degree reading Red & Blue 5 feet long charging hose (1/4" FFL x 60 " with knurled fittings) Yellow 5 feet long charging hose (1/4" ACME x 60" with knurled fittings)	
17	Car Heater Blower assembly	16

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 – 1 Heating, Ventilation and Air- conditionin g System	1a. Explain the specified human comfort parameters with justification. 1b. Explain with justification the process of controlling the given comfort factor. 1c. Describe with sketch the requirements of heating, ventilation and air conditioning in the given type of vehicle. 1d. Describe with sketch ventilation system of the given type of vehicle.	1.1 Environmental and safety aspects in heating, Ventilation and air conditioning systems. 1.2 Human comfort control: comfort zone, air movement, wind chill factor, odor problems and effects of humidity. 1.3 Modes of Heat transfer: convection, radiation, evaporation and conduction. 1.4 Requirements of heating, ventilation and air conditioning system in- light motor vehicle, Heavy goods vehicle and Heavy passenger vehicle 1.5 Controlled and uncontrolled ventilation 1.6 Vapour compression refrigeration cycle and basic components.
Unit – II Case and Duct System	2a. Explain with sketch the construction of the given section of case and duct. 2b. Describe with sketch the construction of the given type of duct. 2c. Select case and duct system for the given seating capacity of vehicle with justification. 2d. State remedial actions for the given symptoms relevant to case and duct aggregates with justification	2.1 Air intake section, core section, and distribution section. 2.2 Downstream, upstream, split and hybrid duct systems. 2.3 Rear heating and cooling system. 2.4 Air Filter and Air blower in A.C. system 2.5 A.C. System operational Precautions
Unit– III Air Conditioni ng System	3a. Redraw the given A.C. system layout including the missing components. 3b. Describe with sketch construction and working of the given component of air conditioning system. 3c. List precautionary measures	3.1 General layout of Automotive Air conditioning system. 3.2 Evaporator, condenser, accumulator. Receiver, and driers. 3.3 Reciprocating, scroll and rotary vane compressors, Drive systems for compressor. 3.4 Refrigerant: Properties, types,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	<p>required for packaging and storage of the given A.C. accessories.</p> <p>3d. Explain with sketch the construction and working of the given type of metering device of vehicle air conditioning system.</p>	<p>Packaging and storage, color code and purity test</p> <p>3.5 Electromagnetic clutch</p> <p>3.6 Metering devices: thermostatic Expansion valve, and its Types, i.e. H valve, block type, internally equalized, externally equalized and fixed orifice tube.</p> <p>3.7 Throttling action, modulating action and controlling action, remote bulb.</p> <p>3.8 Symptoms, Faults, causes and remedies in Compressor , Electromagnetic clutch</p>
Unit- IV A.C. System Control Devices	<p>4a. Select A.C. control system for the given vehicle with justification.</p> <p>4b. Describe with sketch the construction of the given components of vacuum control system.</p> <p>4c. Describe with sketch the working of the given sensor.</p> <p>4d. Explain the remedial action for given failure in the A.C. control system with justification.</p>	<p>4.1 System controls – Vacuum control system and electronic temperature control system</p> <p>4.2 Vacuum operated devices i.e. vacuum reserve tank, vacuum restrictor, vacuum motor, check valve and check relays.</p> <p>4.3 Switches - high- Side temperature switch, low-side temperature switch, high-pressure switch, low- pressure switch, Pressure regulator, ambient switch and superheat switch.</p> <p>4.4 Sensors- sun load sensor, outside temperature sensor and in-car temperature sensors.</p> <p>4.5 A.C. Control devices: Aspirator, blower clutch control, heater control, and time delay relay for heater control.</p> <p>4.6 Climate control system and Electronic climate control system</p>
Unit- V Maintenance of Air Conditioning System	<p>5a. Describe with sketch procedure for testing the given A.C. System.</p> <p>5b. Describe with sketch maintenance procedure for refrigerant in the given A.C. System.</p> <p>5c. List safety precautions while using type of tool/equipment for servicing the given A.C. System.</p> <p>5d. Describe with sketch the maintenance procedure of specified accessory of the given A.C. System.</p>	<p>5.1 Inspection of A.C. System: Visual and acoustic, sight glass,</p> <p>5.2 Leak test and Temperature test,</p> <p>5.3 Evacuation, charging of refrigerant and Moisture removal</p> <p>5.4 Service equipment and tools: Vacuum pump, Manifold and gauge i.e. Low side and high side, gauge calibration recovery unit and recycling unit, Halide (Freon) and Fluorescent leak detector, nitrogen leak tester.</p> <p>5.5 Hoses and connectors: System hoses, charging hose with shut off valve and connectors.</p>
Unit- VI Heating	<p>6a. Explain with sketch the given type of heating system in the</p>	<p>6.1 Heating system: Function, Heater core, Control Valve, Heater Hoses, Blower</p>

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
System	vehicle. 6b. Describe with sketch the maintenance procedure for the given component of heating System. 6c. Describe with sketch the faults occurring in the given component of heating system. 6d. Explain with sketch the remedial action for given fault in the heating system.	6.2 Types of heating system, 6.3 Maintenance of the heating system: Fault diagnosis, remedial action

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	Heating, Ventilation and Air-conditioning System	10	02	04	04	10
II	Case and Duct System	08	-	04	04	08
III	Air conditioning system	16	04	06	08	18
IV	A.C.System Control Devices	12	02	06	06	14
V	Maintenance of Air conditioning system	12	02	04	06	12
VI	Heating System	06	02	02	04	08
Total		64	12	26	32	70

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

Note: This specification table provides general guidelines to assist a 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:

- Prepare journal of practical.
- Undertake micro-projects.
- Collect the information on refrigerant and list essential properties of refrigerant.
- Visit the Automobile Service station and observe the servicing of AC system.
- Collect the information on different types of compressor used in AC System.
- Collect the catalog of various automotive manufacturers and write a report on Climate Control System in vehicles.

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*.
- e) Guide student(s) in undertaking micro-projects.
- f) Demonstrate students thoroughly before they start doing the practice.
- g) Encourage students to refer different websites to have a deeper understanding of the subject.
- h) Observe continuously and monitor the performance of students in the Lab.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her at 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 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 a chart showing the layout and construction details of all the components of automobile air conditioning system. Followings steps to be strictly followed (This fulfill CO-a and Co-c).
 - i. Visit Automobile service station.
 - ii. Collect information from internet, Manufacturer catalog, on air conditioning system, Human Comfort Parameters, Control Points.
 - iii. Specifications of components used in vehicle A.C. System.
 - iv. Collect videos of components on dismantling and assembling.
- b) Prepare a cut section model of A.C. Compressor. Followings steps to be strictly followed (This fulfill CO-c and Co-e)
 - i. Obtain used model of A.C. Compressor of any vehicle.
 - ii. Collect the technical specification of obtained Compressor from service manual/catalogue/manufacturer website.
 - iii. Prepare cut section model in college workshop.
 - iv. Prepare a proper display of cut section model.
- c) Perform a Market survey for different types of Refrigerants available in the market. Followings steps to be strictly followed (This fulfill CO-a and Co-e)
 - i. Survey Market and collect information on availability of refrigerants.
 - ii. List desirable properties of refrigerant.
 - iii. Find its effect on the environment.
 - iv. Compare refrigerants on the basis of its properties.



- d) Prepare a chart on aggregates of Climate Control System of car air conditioning system. Followings steps to be strictly followed (This fulfill CO-a and Co-d)
- Collect information on Climate control system.
 - Prepare the sketch of components of Climate control system.
 - Write function of each aggregate.
 - Refer Manufacturer/Service Manual to find the specification of each component.
 - Prepare a chart showing its construction and working.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Automobile Air Conditioning	Dwiggins, Boyce H.	Delmar Cengage Learning; 8th Revised edition, 1995 New Delhi ISBN: 978-0827358188
2	Automotive Heating & Air Conditioning Manual	Haynes, John H. ; Stubblefield, Mike	Haynes Manuals N. America, Incorporated, 2011, ISBN1563929139
3	Basic Refrigeration and Air Conditioning	Ananthanarayanan, P. N.	McGraw Hill Education; New Delhi n (2013), ISBN-10: 9781259062704
4	Automotive Heating and Air Conditioning	Halderman , J. D.	Pearson Prentice Hall; 7 edition (2014) ISBN: 978-0133514995
5	Textbook of Refrigeration & Air conditioning	Khurmi, R. S. ; Gupta , J. K.	S. Chand Limited, New Delhi (2008) ISBN: 8121927811, 9788121927819
6	Refrigeration and Air-Conditioning	Arora; Domkundwar	Dhanpatrai & Son's, New Delhi ISBN: 9780000229663

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

- <http://nptel.ac.in/courses/112105129/pdf/R&AC%20Lecture%2026.pdf> for selection of suitable refrigerant in a refrigeration
- <http://nptel.ac.in/courses/112105128/20> for Basic of Compressor
- <https://www.youtube.com/watch?v=nHZEae08sE8> for understanding working of HVAC system.
- <https://www.youtube.com/watch?v=I5rrZSu4PxQ> For Understanding the working of Car AC
- <https://www.youtube.com/watch?v=Pdq8JA1ct6s> For Procedure to Recharge refrigerant in AC System
- <https://www.youtube.com/watch?v=F5w3lR88fqQ> For Procedure to evacuate refrigerant from AC System
- <https://www.2carpros.com/articles/re-charge-an-air-conditioner-system> for evacuation and charging of A.C. System
- <https://www.youtube.com/watch?v=Yyf30wStUE4> for Leak Detection in A.C. System
- <https://www.youtube.com/watch?v=e31HCvckZAU> for Leak Detection in A.C. System
- <https://www.youtube.com/watch?v=WncHNLdU4EA> for trouble diagnosis of A.C. System
- <https://www.youtube.com/watch?v=FzbM0YoUZgo> for cleaning air conditioner evaporator
- <https://www.youtube.com/watch?v=rulXlnG2Unk> for Servicing of Compressor in car
- <https://www.youtube.com/watch?v=UW1GDiOa0kE> for how To Diagnose Car Air Conditioning Problems



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.

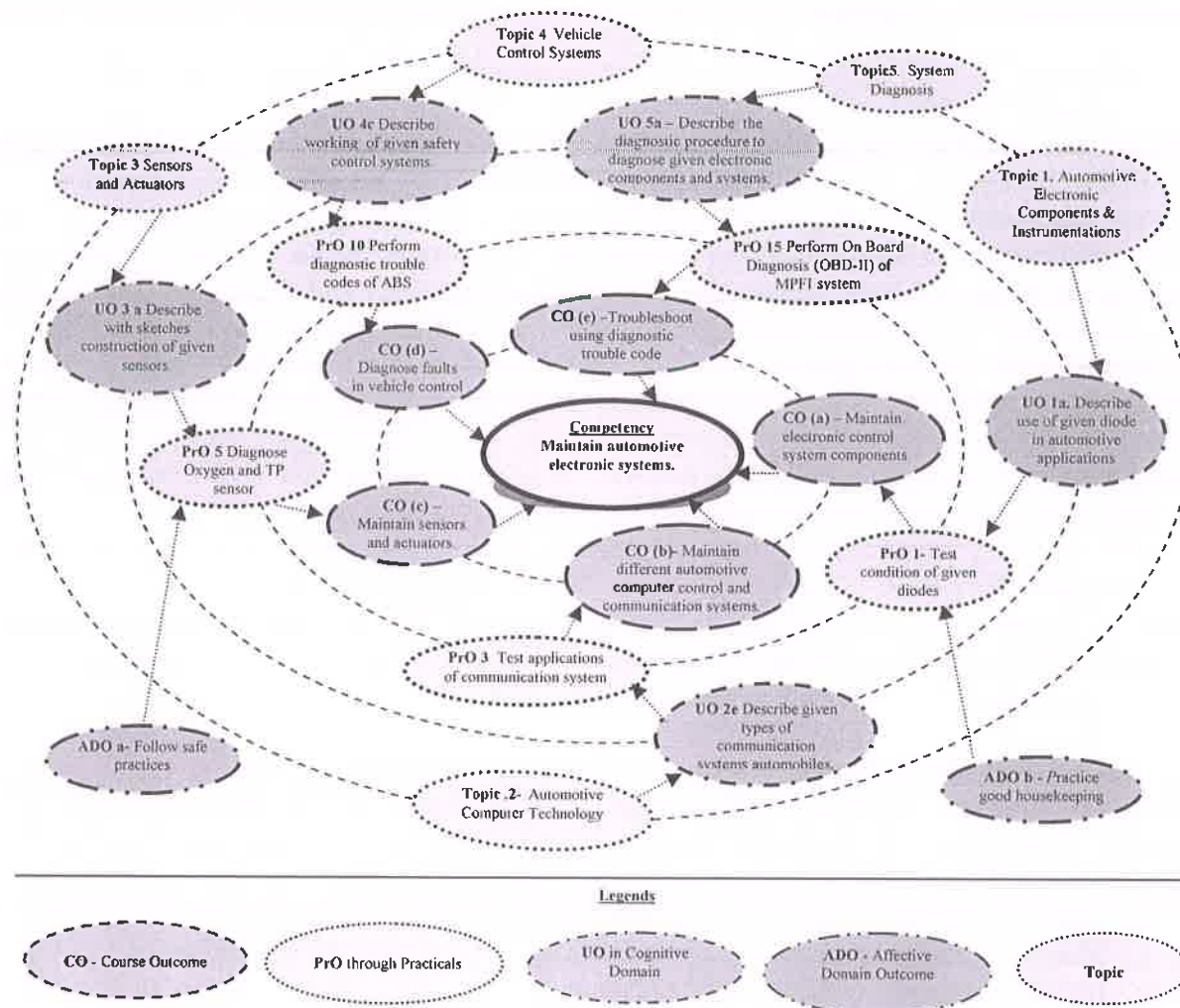


Figure 1 - Course Map

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.	10,11,1 2,13,14
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: 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>



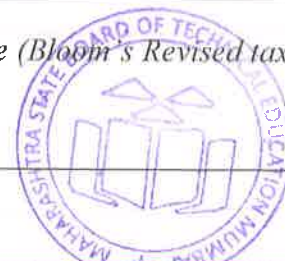
Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	3e. Describe the procedure to maintain the given automotive sensors and actuators.	
Unit- IV Vehicle Control Systems	4a. Explain with sketches the working of given power train control systems with block diagram. 4b. Explain with sketches 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.

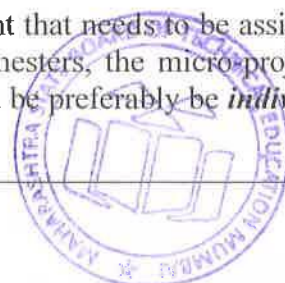
11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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=ZMa0nomliwc> 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=JIa0nsrQXI0> to read car fault codes and to clear them.



