

**Program Name** : Diploma in Automobile Engineering  
**Program Code** : AE  
**Semester** : Fourth  
**Course Title** : Automobile Systems and Body Engineering  
**Course Code** : 22442

### 1. RATIONALE

This is Core Technology course of Automobile Engineering programme. Apart from engine and transmission system automobile chassis includes control systems such as steering, braking and suspension. This course provides the knowledge of automobile control systems and body which forms basis for learning automobile component design and vehicle maintenance courses. This course will help the students for analyzing the performance of automobile during inspection, installation, operation and maintenance.

### 2. COMPETENCY

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

- Select relevant automobile control system parts and vehicle bodies.

### 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:

- Select relevant steering gear-boxes and linkages for different vehicles.
- Select suitable braking system and elements for different types of vehicles.
- Select relevant suspension system for different types of vehicles.
- Select relevant materials for components used in manufacturing of vehicle bodies.
- Select relevant car air conditioning systems for human comfort.
- Test the on-road performance of different types of vehicles.

### 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		
4	-	2	6	3	70	28	30*	00	100	40	25#	10	25	10	50	20

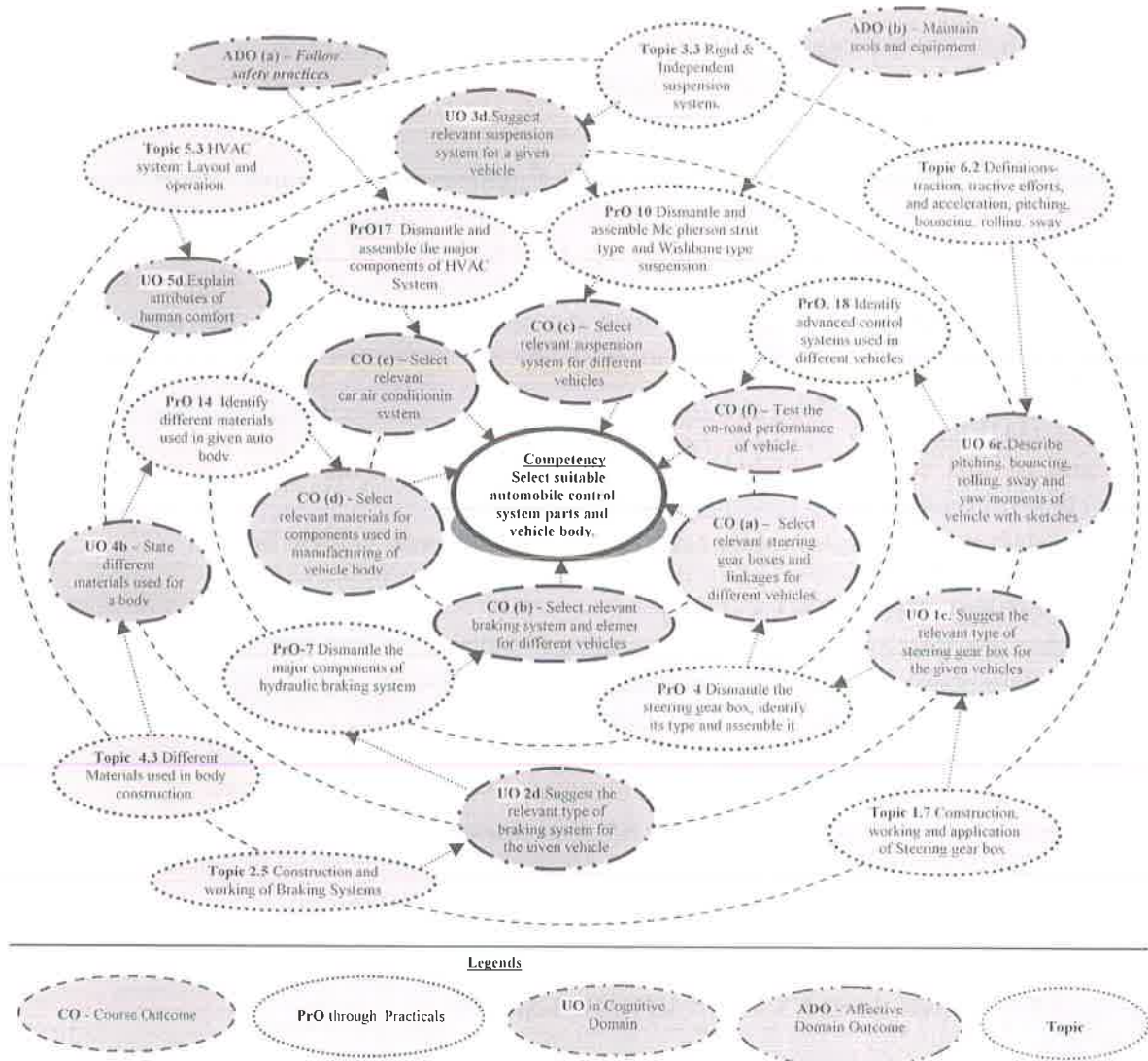
(\*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

**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	Identify the parts of a given type of steering system linkages.	1	01*
2	Identify the components of power steering.	1	01*
3	Identify the parts of the Front Axles arrangement.	1	02
4	Dismantle the steering gear box. identify its type and assemble it.	1	02*
5	Dismantle the front wheel from the axle.	1	
6	Measure and analyze steering geometry parameters in given vehicle.	1	



S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
7	Dismantle the major components of hydraulic braking system and assemble it.	II	02*
8	Dismantle and assemble the components of Air braking system/vacuum assisted braking system.	II	02
9	Dismantle and assemble the components of disc brake.	II	02
10	Dismantle and assemble Mc pherson strut type suspension and Wishbone type suspension.	III	02
11	Dismantle and assemble semi elliptical leaf spring type rigid axle suspension system.	III	02*
12	Dismantle and assemble telescopic type hydraulic shock absorber.	III	02
13	Identify the type of relevant auto bodies according to purpose.	IV	01*
14	Identify different materials used in the given auto body.	IV	01
15	Identify safety devices used in a given vehicle.	IV	02*
16	Identify tools and equipment required for painting and denting.	IV	02
17	Identify the components of Heating, Ventilation and Air Conditioning system of the given vehicle.	V	02*
18	Identify advanced control systems used in different vehicles.	VI	02*
	<b>Total</b>		<b>32</b>

**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. 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
	<b>Total</b>	<b>100</b>

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 safe 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 1<sup>st</sup> year
- 'Organising Level' in 2<sup>nd</sup> year
- 'Characterising Level' in 3<sup>rd</sup> 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.

Sr No.	Equipment Name with Broad Specifications	PrO. No.
1	<b>Demonstration model of automotive steering system.</b> Cut section working model of steering of jeep/car with stub axle. The model should be made out of full size original used parts, suitably sectioned and arranged to demonstrate the internal construction details such as steering gear box, bell assembly, tie rod, linkages, stub axle and working of the same can be shown by steering the steering wheel provided. The entire model is mounted on a sturdy iron frame and be suitably painted.	1, 2
2	<b>Different types of steering gear boxes-</b> Rack and pinion, Recirculating ball and nut type, Worm and roller type; Full size original used above mentioned types of gear boxes of any Car/LMV/HCV in good working condition, mounted on powder coated M.S. stand.	4
3	<b>Front axle of LMV, HMV, transaxle of FWD car.</b> Full size original front axles of above mentioned vehicles of Make Mahindra/TATA/ Ashok Leyland/ Maruti or alike in good working condition, mounted on powder coated M.S. stand.	2
4	<b>Demonstration model of front wheel assembly of car/heavy motor vehicle.</b> Cut section model made out of original used parts of car/heavy motor vehicle, suitably sectioned and arranged to demonstrate the internal construction details showing the minute information with suspension strut with spring and shock absorber, disc brake, calliper, wishbone drive shaft etc. , and working of the same can be shown. The entire model is mounted on a sturdy powder coated M.S. frame.	5
5	<b>Demonstration model of power assisted steering.(Hydraulic/Electric)</b> The complete working model of Hydraulic/Electric power assisted steering system made out of new/used original parts of Car/LMV/HCV and suitably mounted on powder coated M.S. stand and working of the same can be shown.	3
6	<b>Running model of car/jeep.</b> Original full size used car or Jeep in good working condition of make Maruti/TATA/Mahindra or alike.	6,15,18
7	<b>Working model of hydraulic braking system and its components.</b> The model made out of Used TATA Indica brake aggregates which will be suitably sectioned, Left Front disc and Left rear drum will be made working using necessary hydraulic connection from the Master cylinder. By operating	



Sr No.	Equipment Name with Broad Specifications	PrO. No.
	the brake pedal connected to the Master cylinder through booster, the functioning of disc and drum brake can be demonstrated. The aggregates on the other side will be suitably sectioned to show the internal details and will be kept dummy. All the aggregates should be paint finished. The entire setup will be mounted on a sturdy iron frame.	
8	<b>Working model of air braking and its components.</b> The model made out of original parts such as Air compressor, Unloader valve, foot valve, Booster, Wheel assembly, air tank, control valve etc The Brake system will be fitted with two front wheel assembly complete ( with out axle) and the drum will be suitably sectioned to show the working of the brake shoe. Other system will be mounted as it is and will be made to function ( foot brake, hand brake etc will be functional). The entire system will be mounted on a sturdy iron frame. A F.H.P Single phase 220/230 V AC motor will be coupled to the compressor for generation of the air, which is used for the operation of the model.	8
9	<b>Working model of vacuum assisted braking system and its components</b> TATA, LEYLAND, MAHINDRA any other reputed automobile manufacturer.	8
10	<b>Disc brake assembly.</b> The Model made out of Original parts such as Two Brake disc, two Caliper assembly (one sectioned), two master cylinder (one sectioned) etc, the model is mounted on a sturdy iron frame and can be demonstrated by operating the lever provided.	9
11	<b>Suspension systems - Mac-pherson, wishbone, leaf spring.</b> <u>Mac-pherson suspension</u> - Cut section model of complete both side macpherson suspension strut with drive shaft, disk brake. This model is made out of original used parts, will be suitably sectioned And Arranged to demonstrate the internal construction details showing the minute information With Suspension Strut with spring and shock absorber, disc brake, calipers, drive shaft etc., and working of the same can be shown, the model will be suitably painted and The entire model is mounted on a sturdy iron frame. <u>Wishbone Suspension</u> - Cut section model of complete both side with double wishbone suspension with drive shaft. This model is made out of original used parts, will be suitably sectioned And Arranged to demonstrate the internal construction details showing the minute information With Suspension Strut with spring and shock absorber, disc brake, calipers drive shaft etc., and working of the same can be shown, the model will be suitably painted and The entire model is mounted on a sturdy iron frame. <u>Leaf Spring</u> - Cut section model of complete leaf spring suspension system with rear axle. This model is made out of original used parts, will be suitably sectioned And Arranged to demonstrate the internal construction details showing the minute information With leaf spring is arranged along with shock absorber etc., and working of the same can be shown, the model will be suitably painted and the entire model is mounted on a sturdy iron frame.	10,11
12	Working model of telescopic type hydraulic shock absorber. The working model of original used telescopic type hydraulic shock absorber of mounted on powder coated M.S. Stand.	12
13	Body of car/jeep. Body of used car/ Jeep of Make Maruti/ Mahindra/TATA	13,14



Sr No.	Equipment Name with Broad Specifications	PrO. No.
	etc.	
14	HVAC system- <b>Cut section working model of air conditioning system of a car.</b> This model is made out of original used parts, will be suitably sectioned and arranged to demonstrate the internal construction details showing the minute information such as AC compressor, condenser, radiator, its pipe lining, blower/fan assembly etc., the model will be suitably painted and The entire model is mounted on a sturdy iron frame.	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
<b>Unit – I Front Axle and Steering</b>	1a. Identify the given types of front axle and stub axles in the given figure with justification. 1b. Name the parts of the steering geometry in the given figure. 1c. Suggest the relevant type of steering gearbox for the given vehicle(s) with justification. 1d. Explain with sketches the working principle of the given type of power steering. 1e. Describe with sketches the salient features of the given type of steering.	1.1 Types of front axle- Dead axle, Live axle. 1.2 Types of stub axle arrangements- Elliot, Reverse Elliot, Lamoine and Reverse Lamoine; Front wheel assembly. 1.3 Steering linkages- for the vehicle with rigid axle, independent suspension system. 1.4 Ackerman steering gear mechanism. 1.5 Steering geometry parameters: Caster, Camber, King-pin inclination, Toe in-Toe out, Correct steering angle, Understeering and Oversteering, Turning radius. 1.6 Construction, working and application of Steering gear box: Rack and pinion type, recirculating ball type and worm and roller type steering gear box. 1.7 Power assisted steering and its types (Hydraulic and electrical).
<b>Unit-II Brakes</b>	2a. Explain with sketches the construction and working of the given brake(s). 2b. Describe the different characteristics of the specified friction material(s) with sketches. 2c. Describe the various properties of the given brake fluid. 2d. Suggest the relevant type of braking system for the given	2.1 Necessity of brakes. 2.2 Classification of brakes. 2.3 Construction and working: Disc brake and drum brake. 2.4 Friction materials and its characteristics: Brake fade, coefficient of friction, dry friction and wet friction. 2.5 Construction and working of Braking Systems: Mechanical



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	vehicle with justification.	braking system, Hydraulic Braking system, Air braking system, Vacuum assisted braking system, parking brake, Exhaust brake. 2.6 Properties of brake fluids. 2.7 Operation of Antilock braking system.
<b>Unit– III Suspension Systems</b>	3a. Name the components of the given automobile suspension system. 3b. Explain with sketches the construction, working and applications of the given suspension system. 3c. Describe with sketches the working of the given air suspension system with sketches. 3d. Suggest relevant suspension system for the given vehicle with justification.	3.1 Necessity of suspension system. 3.2 Classification of suspension system. 3.3 Rigid suspension system. 3.4 Independent suspension system- Front end and rear end. 3.5 Damper (Shock absorber) construction and working: Telescopic and Gas filled. 3.6 Different types of spring – Leaf spring, Coil spring, Torsion bar, Air spring, Hydrodynamic spring. 3.7 Anti roll bar or stabilizer bar. 3.8 Air Suspension System. 3.9 Linked suspension System.
<b>Unit– IV Body Engineering and Safety Devices</b>	4a. List the different types of auto bodies used for the given chasis. 4b. State different materials used for the given body construction with justification. 4c. List the different body accessories used for a given vehicle. 4d. Describe painting and denting procedure for the given auto body with sketches . 4e. Select glass, door and body insulation trims for the given body with justification.	4.1 Functions of auto body. 4.2 Types of Auto bodies. 4.3 Different Materials used in body construction. 4.4 Body accessories and its functions. 4.5 Protective and anticorrosive treatments, painting and denting procedure. 4.6 Streamlining of vehicle body and its effect. 4.7 Miscellaneous Body services- Interior trim and upholstery, Glass and door service, Body insulation and sealing, Exterior trim. 4.8 Safety devices – Air bags, Seat belt, Central locking, Collapsible steering, Keyless entry, Traction control, Reverse parking sensor and Rear view camera.
<b>Unit –V Car Heating Ventilation</b>	5a. Draw a layout of the given car air conditioning system with labeled components. 5b. Describe the layout of the given	5.1 Fundamentals of Refrigeration and air conditioning; Introduction to Vapour compression cycle 5.2 Car Heating Ventilation and Air



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
<b>and Air Conditioning System</b>	HVAC system. 5c. Explain properties of the given refrigerant. 5d. Select relevant car air conditioning system for human comfort in the given vehicle with justification.	Conditioning System (HVAC): Layout and operation 5.3 Refrigerants:Types and their properties. 5.4 Human comfort conditions: Temperature control system, humidity control.
<b>Unit –VI Vehicle Performance</b>	6a. Describe the given resistance(s) faced by vehicles at rest and in moving conditions with sketches. 6b. Explain the following terms related to vehicle performance. 6c. Describe with sketches the pitching, bouncing, rolling, sway and yaw moments of vehicle. 6d. Explain with sketches the procedure to test on-road performance for the given vehicle.	6.1 Resistance faced by the vehicle- Air resistance , rolling resistance, gradient resistance 6.2 Definitions- traction, tractive efforts, drawbar pull, gradeability and acceleration, pitching, bouncing, rolling, sway and yaw. 6.3 Stability of vehicle on turn and slopes (No mathematical treatment).

*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	Front axle and steering	14	06	04	06	16
II	Brakes	14	02	06	06	14
III	Suspension system	10	02	04	06	12
IV	Body engineering and safety devices	12	02	08	04	14
V	Car heating, ventilation and air conditioning system	08	00	04	04	08
VI	Vehicle performance	06	04	00	02	06
<b>Total</b>		<b>64</b>	<b>16</b>	<b>26</b>	<b>28</b>	<b>70</b>

**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. Prepare journals based on practical performed in laboratory.
- b. Follow the safety precautions.
- c. Use various tools to remove, dismantle, assemble and refit components.
- d. Library /Internet survey of automobile systems and components.
- e. Prepare power point presentation or animation for understanding different automobile control systems and Body components.
- f. Visit to automobile service station of heavy vehicle to observe air suspension system, air brakes, power steering system and draw layout. Write a report on it.
- g. Visit to Automobile Body Building shop and Prepare a report.

### 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.

### 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. **Collect the information of steering gear boxes and compare it:** Collect the information of steering gear boxes of any four vehicles from the market/internet. Compare the data and write report on the same.
- b. **Collect the data of steering geometry parameters and compare them :** Collect the data of steering geometry parameters of any four different vehicles from internet/service manuals. Compare this data. Describe the effects of these parameters on vehicle performance.



- c. **Develop a demonstration model of hydraulic braking system:** Develop a demonstration working model of hydraulic braking system with old used parts and describe its working .
- d. **Collect information of anti lock braking system:** Prepare power point presentation and deliver a seminar.
- e. **Collect different types of brake pads and brake shoes:** Collect different forms of used brake shoes and brake pads from the market. Analyze their construction and materials and prepare a report on it.
- f. **Collect different types of shock absorbers:** Collect different types of used shock absorbers from the market. Analyze their use and working. Make a cut-section of any one type to know the internal parts.
- g. **Collect the information of types leaf springs:** Collect the information of leaf springs from different types of vehicles and compare these on the basis of load carrying capacity. Describe the purpose of helper spring alongwith its application.
- h. **Collect the information of different types of auto bodies:** Collect the information of different types of auto bodies available in the market. Classify these according to their purpose and justify their use.
- i. **Collect the information of types of paints and painting equipments:** Collect the information of various types paints and painting equipments used in auto body manufacturing. Write a report on it.
- j. **Prepare to run a vehicle:** Analyse and check the automobile systems to prepare a vehicle for run. Apply the key, start the engine, analyze steering, clutch, gear box, brake etc. and stop the engine. Prepare a report regarding do's and don't's.

### 13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Automobile Engineering	Ramlingam, K.K.	Scitech Publication, Chennai, 2011 ISBN: 9788188429486
2	Automobile Engineering	Singh, Kirpal	Standard Publication, New Delhi, 2008 ISBN 13: 9788180141034
3	Automobile Engineering	Chikara, Anil	Satya Prakashan New Delhi, 2007, ISBN-13: 9788176843515
4	Automobile Engineering	Gupta, R.B.	Satya Prakashan New Delhi, 2016 ISBN: 9788176848589
5	Automobile Mechanics	Srinivisan, S.	McGraw – Hill, New Delhi, 2003 ISBN-10: 0070494916
6	Automobile Mechanics	Crouse / Anglin.	McGraw – Hill, Dallas, TX, U.S.A , 1984, ISBN 13: 9780070148604
7	Automobile Engineering	Narang, G.B.S.	Khanna Publication, New Delhi, 2007 ISBN-13: 1234567144518
8	Automobile Technology	Giri, N.K.	Khanna Publication. New Delhi, 2009 ISBN: 9788174091789

### 14. SUGGESTED SOFTWARE/LEARNING WEBSITES

- a. <http://nptel.ac.in/courses/107101001/>
- b. [https://www.youtube.com/watch?v=\\_D\\_vg8gnMms&list=PLZOnML5kZsJlzots8zExyijNjawWQ2qfy](https://www.youtube.com/watch?v=_D_vg8gnMms&list=PLZOnML5kZsJlzots8zExyijNjawWQ2qfy)- Steering geometry
- c. <https://www.youtube.com/watch?v=nMQxqsyuJKE> – suspension system



- d. <https://www.youtube.com/watch?v=Z7VBm8d8X84>- Rigid axle suspension
- e. <https://www.youtube.com/watch?v=CzEBVdZeyQs> – Hydraulic braking system
- f. <https://www.youtube.com/watch?v=OZ6l9J6NK5s> – Air braking system
- g. <https://www.youtube.com/watch?v=wkznwbKnIGM> – Telescopic shock absorber
- h. <https://www.youtube.com/watch?v=fKy9YwfLQ6U> – Painting procedure of a car
- i. <https://www.youtube.com/watch?v=ru4JIZ-x8yo> – Antilock braking system
- j. <https://www.youtube.com/watch?v=R4ekbB5EzZM> – Air bag and seat belt operation
- k. <https://www.youtube.com/watch?v=nHZE Ae08sE8> – HVAC system operation



