Program Name : **Diploma in Automobile Engineering**

Program Code : **AE**

Semester : **Fifth**

Course Title : **Automobile Component Design**

Course Code : **22558**

1. RATIONALE

The function carried out in the Design and Drawing Department of Automobile Industries is multifarious. Some of these functions are planning, selecting materials, deciding specification, determining design factors, computing and providing dimensions, coordinating with production, designing job fixtures and tools, specifying materials, evaluating design. The diploma engineer should possess some cognitive skill to assist the designers in performing the above-referred functions. This course therefore provides such experiences to the students where they can apply their knowledge from various courses. This course also aims at developing the ability to analyze the given problem, weight alternatives and find the suitable solution. This course would also reinforce the understanding of the basic features of different automobile components since designing would help them in better appreciation of relations between different parameters of 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:

- **Design simple automobile components.**

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:

a. Apply design requirements while designing simple Automobile Components.
b. Use measures to reduce stress concentration in component design.
c. Design simple chassis components using available data.
d. Design simple engine components using available data.
e. Design simple axles using available data.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
				Theory							Practical						
L	T	P		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 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 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.

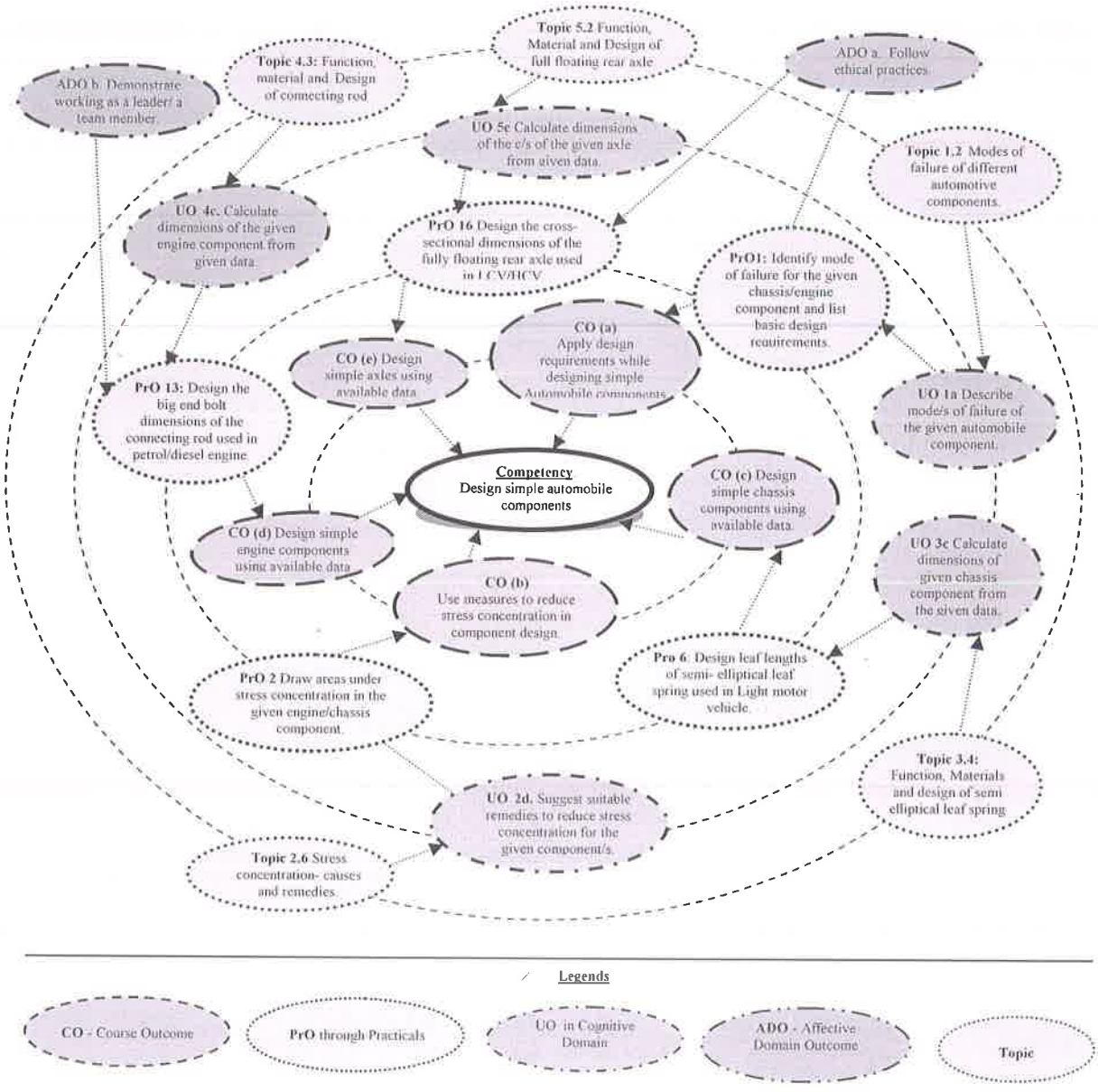

Figure 1 - Course Map

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 mode(s) of failure for the given chassis/engine component(s) and list basic design requirements for the components. (Refer videohttps://www.youtube.com/watch?v=-DXXtpPwbUE)	I	02
2.	Draw the areas under stress concentration in the given engine/ chassis component(s). (Refer video https://www.youtube.com/watch?v=eRQH0SgpoWE)	II	02
3.	Design the friction lining face width of a single plate dry clutch used in light/heavy motor vehicle and compare the same with commercially available vehicles. (Refer video https://www.youtube.com/watch?v=9uJh1WLcL4E)	III	02
4.	Design the friction lining face width for a multi plate clutch used in two-wheelers and compare the same with commercially available two-wheelers.	III	02
5.	Design the cross section of leaves of semi-elliptical leaf spring used in light motor vehicle and compare the same with commercially available light motor vehicles. (refer video https://www.youtube.com/watch?v=T4IgtIkBnOo)	III	02
6.	Design leaf lengths of semi-elliptical leaf spring used in light motor vehicle and compare the same with commercially available light motor vehicles. (refer videohttps://www.youtube.com/watch?v=CD136cE6rMI)	III	02
7.	Design the head thickness of the piston used in petrol/diesel engine and compare the same with commercially available petrol/diesel engines. (refer video: https://www.youtube.com/watch?v=XT169YkNzIQ	IV	02
8.	Design the compression ring, ring zone dimensions of the piston used in petrol/diesel engine, and compare the same with commercially available petrol/diesel engines.	IV	02
9.	Design the skirt length of the piston used in petrol/diesel engine and compare the same with commercially available petrol/diesel engines.	IV	02
10.	Design the piston pin cross section and its length, for the piston used in petrol/diesel engine and compare the same with commercially available petrol/diesel engines.	IV	02
11.	Design the cross-sectional dimensions of the connecting rod used in petrol/diesel engine and compare the same with commercially available petrol/diesel engines.	IV	02
12.	Design the small end dimensions of connecting rod used in petrol/diesel engine and compare the same with commercially available petrol/diesel engines.	IV	02
13.	Design the big end bolt dimensions of connecting rod, used in petrol/diesel engine and compare the same with commercially available petrol/diesel engines.	IV	02
14.	Design the big end dimensions of connecting rod, used in petrol/diesel engine and compare the same with commercially available petrol/diesel engines.	IV	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
15.	Design the cross sectional dimensions of the front axle beam, used in light/heavy motor vehicle and compare the same with commercially available light/heavy motor vehicle.	V	02
16.	Design the cross sectional dimensions of the fully floating rear axle, used in light/heavy commercial motor vehicle and compare the same with commercially available light/heavy motor vehicle.	V	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. All the above listed practical need to be performed compulsorily, so that the student reaches the 'Applying Level' of Blooms's 'Cognitive Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO are to be assessed according to a suggested sample given below:*

S. No.	Performance Indicators	Weightage in %
a.	Identification of loads and relevant data	10
b.	Selection of material	10
c.	Apply suitable design procedure.	40
d.	Use of standards	10
e.	Draw neat and precise sketches	20
f.	Answer to sample questions	05
g.	Timely completion	05
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. Demonstrate working as a leader/a team member.
d. 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
- 'Organising Level' in 2nd year and
- 'Characterising 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. S. No.
1.1	Computer system (Any computer system with basic configuration) Processor (CPU):Intel Core i5-6xxx or equivalent Operating System: Microsoft Windows 10 Professional x64 SP1 (free via Imagine. Restrictions may apply.), Memory: 8 GB RAM Storage: 512 GB internal Solid State Drive (SSD) or 1 TB internal HDD Sustainability EPEAT Silver rating (preferably EPEAT Gold) Monitor/Display: 24" " LCD monitor Network Adaptor: 802.11ac 2.4/5 GHz wireless adaptor Other: Webcam, lock, external drive for backups (software: Latest and Licensed version of Auto Cad/Any other drafting software)	All
1.2	**Chassis Components:** a. Tubular tie rod with ball joints at end – From Steering system of any Car/Jeep/Truck/Bus. b. Coil spring / diaphragm type single plate dry clutch used in LMV/HCV, Multi-plate wet clutch used in two wheelers. c. Single piece Propeller shaft with two Hooks joint, a Slip joint along with universal coupling used in LCV/HCV. d. Constant rate swing semi-elliptical leaf spring. **Engine components:** a. Cylinder block of petrol/diesel engine. b. Petrol/diesel engine piston (solid skirt/split skirt/ fully split T skirt) c. Plain faced piston rings d. Fully floating piston pin e. Central pivoted forged/cast rocker arm f. Petrol/diesel engine straight cut connecting rod with fitted bolt joint g. Petrol/diesel engine inlet/exhaust valve spring (constant pitch helical coil spring) h. Solid/hollow push rod of over head valve and side cam shaft etc.	1 to14
1.3	Dead type Front axle (I cross-section) with reverse Elliot type stub axle arrangement of Make Mahindra /TATA Sumo/Ashok Leyland Truck etc.	15
1.4	Full-floating rear axle: Rear live axle of bus or truck of any make and model.	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 Fundamentals of Automobile Component Design	1a. Describe mode(s) of failure of the given automobile component/s with sketches. 1b. List the standards used in design of the given automobile component/s. 1c. Explain use of preferred numbers in designing the	1.1 Component design - Concept. 1.2 Modes of failure of different automotive components. 1.3 Basic requirements of automobile components. 1.4 Basic automobile component design procedure. 1.5 Use of standards in component

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	given automobile component. 1d. Explain effect of ergonomics on the given automobile component design. 1e. Explain effect of aesthetics on the given automobile component design.	design. 1.6 Preferred numbers. 1.7 Ergonomic considerations in component design. 1.8 Aesthetic considerations in component design.
Unit– II Stresses in Automobile Components	2a. Identify stress(s) induced in the given component for the given load condition with justification. 2b. Describe mechanical properties / theories of failure of the given component material. 2c. Use safety factor in calculating dimensions of the given component under given load conditions. 2d. Suggest suitable remedies to reduce stress concentration for the given component/s with justification.	2.1 Normal and shear stresses, Crushing stress, Bearing pressure, Torsional and bending stresses, principal stresses, variable stresses, impact stresses, resilience. 2.2 Stress-strain diagram and its uses. 2.3 Working stress, factor of safety, selection of FOS. 2.4 Theories of failure under static loading- maximum principal or normal stress theory, Maximum shear stress theory, Maximum distortion energy theory. 2.5 Fatigue, Endurance limit, FOS for fatigue loading, S-N Curve. 2.6 Stress concentration, causes and remedies. 2.7 Load factor, Service factor and their applications.
Unit - III Design of Chassis Components	3a. Choose suitable materials for the given chassis component with justification. 3b. Explain stepwise design procedure for the given chassis component. 3c. Calculate dimensions of the given chassis component from the given data. 3d. Draw proportionate diagram of the given chassis component.	3.1 Function of tie rod, Materials for tie rod with justification and design of tie rod. 3.2 Function of clutch, Material for friction lining with justification, Design of disc clutch and multi plate clutch considering uniform wear condition. 3.3 Function of propeller shaft, Design of propeller shaft including universal coupling. 3.4 Function of semi elliptical leaf spring, Materials of leaf spring with justifications and design of semi elliptical leaf spring.
Unit - IV Design of Engine Components	4a. Select the relevant material with justification for the given engine component. 4b. Explain stepwise design procedure for the given engine component. 4c. Calculate dimensions of the	4.1 Function of cylinder block, Materials for cylinder block with justifications. Design of bore diameter; bore length and thickness of cylinder wall. 4.2 Function of piston, Materials with justification and Design of piston

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	given engine component from the given data. 4d. Draw proportionate diagram of the given engine component.	and piston pin. 4.3 Function of connecting rod, Materials with justification and Design of connecting rod. 4.4 Function of rocker arm, Materials with justification and Design of rocker arm (for rectangular cross section only) 4.5 Function of valve spring, Materials with justification and Design of valve spring. 4.6 Function of push rod, Material with justification and Design of push rod.
Unit - V Design of Axles	5a. Justify the selection of material for the given axle. 5b. Explain stepwise design procedure for the given axle. 5c. Calculate dimensions of the cross section of the given axle from the given data. 5d. Draw proportionate diagram of the given axle.	5.1 Function of front axle. Material with justification and Design of front axle. 5.2 Function of rear axle, Material for rear axle with justification and Design of full floating rear axle.

***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 DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fundamentals of Automobile Component Design	10	04	04	04	**12**
II	Stresses in Automobile Components	12	04	04	04	**12**
III	Design of Chassis Components	16	04	04	08	**16**
IV	Design of engine Components	18	04	04	08	**16**
V	Design of Axles	08	04	04	06	**14**
Total		**64**	**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. Prepare journals based on practical performed in laboratory.
b. Give seminar on relevant topic.
c. Develop display boards of scrap engine/chassis components mentioned under sub section 8 above.
d. Prepare charts of materials currently used for automotive components.
e. Compare pistons of any two commercially available engines of same class.

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:

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 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.

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. The concerned faculty could add similar micro-projects:

a. Perform Case study of design of simple automobile component(s), except those mentioned in curriculum.eg. Flywheel, cylinder head design, design of bolts, coil springs, crankshaft, and bearing selection.
b. Design of joints/couplings used in automobiles.
c. Prepare a report on sizes/standardization in automobile components.
d. Prepare a report on manufacturing, ergonomic and aesthetic considerations in designing different automobile components.
e. Prepare a report on Trends in component design.

13. SUGGESTED LEARNING RESOURCES :

S. No.	Title of Book	Author	Publication
1	Design of machine elements.	Bhandari,V. B.	McGraw Hill Education, New Delhi, 3RD Edition, 2012 ISBN-13:9780070681798
2	A Textbook of Machine Design.	Khurmi, R. S. Gupta, J. K.	S. Chand Publishing, NewDelhi,2010, **ISBN**-13: 978-8121925372
3	Machine Design	Jindal, U. C.	Pearson Education, New Delhi, 2016, ISBN 13: 9788131716595
4	Design Data Book	---	PSG College of Technology Coimbatore, 2014, ISBN-13:9788192735504
5	IS Codes:	---	Indian Standard Bureau, New Delhi
6	Design of machine elements.	K, Ganesh Babu. K, Srithar.	McGraw Hill Education, New Delhi,110008. 2ND Edition, 2010,ISBN-13:9780070672840
7	Auto Design Problems.	Aggarwal, K .M.	Satya Prakashan, New Delhi 2012 ISBN:81-7684207-9
8	Automobile Technology	Giri, N. K.	Khanna Publishers- Delhi 110006, 2012, ISBN: -13: 978-8174091789

14. SOFTWARE/LEARNING WEBSITES

a) https://www.youtube.com/watch?v=Wcqwi-2TKr4
b) https://www.youtube.com/watch?v=STT0D3E4REE
c) http://freevideolectures.com/Course/2363/Design-of-Machine-Elements-I/28
d) http://freevideolectures.com/Course/2363/Design-of-Machine-Elements-I/15
e) https://www.youtube.com/watch?v=9uJh1WLcL4E
f) https://www.youtube.com/watch?v=rBaJ_4i7Xa0


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