

Program Name : Diploma in Automobile Engineering
Program Code : AE
Semester : Third
Course Title : Materials and Manufacturing Processes
Course Code : 22307

1. RATIONALE

Due to globalization Automobile sector experiencing a vital change over, where the emphasis is on reducing weight of vehicles, fuel economy, ergonomically design and cost. It is essential to understand various materials, their composition, properties and applications. Manufacturing process is a core technological subject in Automobile engineering course. A diploma holder of Automobile engineering should be proficient in the selection and use of manufacturing processes for the variety of materials available now days. The knowledge of this subject is essential as prerequisite knowledge for subjects like Automobile component design and Automobile manufacturing processes.

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 material and manufacturing process to produce 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:

- Select the appropriate material for manufacturing of automobile components.
- Select appropriate heat treatment process for automobile components.
- Prepare a pattern and mould for casting automobile components.
- Select machining parameters, cutting tools and cutting fluids for machining automobile components.
- Perform various operations on lathe, drilling and milling machines to required for manufacturing of automobile components.

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.

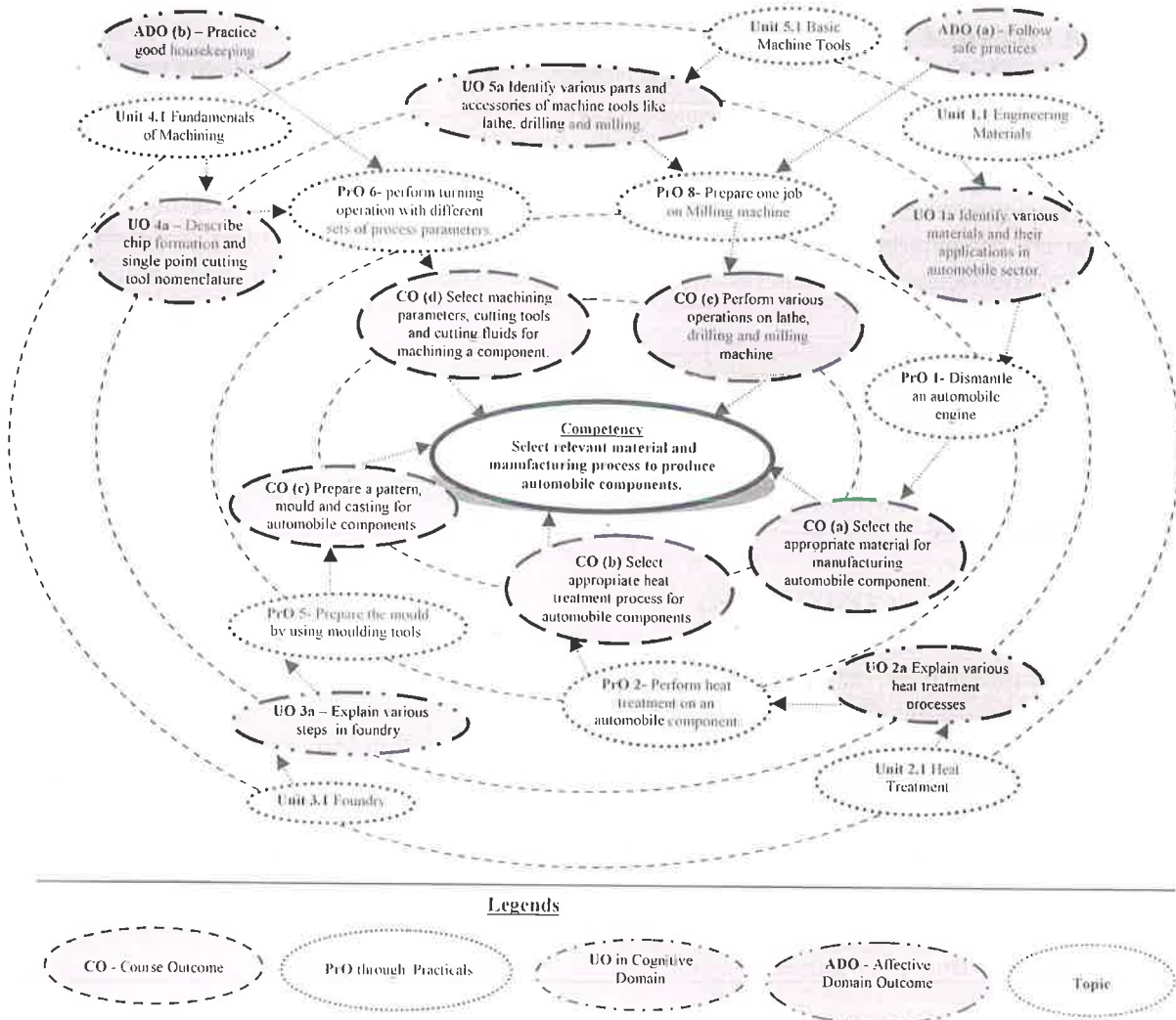


Figure 1 - Course Map

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 a)	Dismantle an automobile engine/steering assembly/suspension assembly/clutch assembly/gearbox and	I	02*
b)	Identify the properties, grades/designation of the materials		02
c)	Identify ferrous and non-ferrous materials for a given automobile		02



S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	component.		
2	Perform heat treatment on an automobile component. (Part-I)	II	02*
3	Perform heat treatment on a automobile component. (Part-II)		02
4	Develop one pattern for a given job considering all aspects of pattern making for group of 4 to 6 student. Job shall involve split pattern with core and core print.	III	
a)	Calculate of all dimensions based on final product.		02
b)	Planning the rough block to required dimensions.		02
c)	Prepare the pattern.		02*
d)	Polish the pattern.		02
5	Prepare a sand mould for the above pattern.	III	
a)	Prepare the green sand and selecting suitable foundry tools.		02*
b)	Prepare cope and drag portions of green sand mould.		02*
6	Prepare similar MS jobs on lathe machine and perform turning operation with different sets of speed, feed and depth of cut.	IV	
7	Prepare one job on lathe machine for following operations: Facing, step turning, taper turning, chamfering, threading, knurling.	V	
a)	Select suitable work holding tool, cutting tool, raw material, Loading the job, centering.		02*
b)	Facing, step turning.		02
c)	Taper turning.		02
d)	Chamfering and threading		02
e)	Knurling		02
8	One job in a group of 4 to 6 students on milling machine involving face/end milling, keyway/slot milling.	V	
a)	Selecting the work holding device, cutter, machining parameters.		02
b)	Face milling		02
c)	End milling		02
d)	Key way		02
e)	Slot milling		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 judicial 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.	Dimensional accuracy	40
2.	Surface finish achieved	20
3.	Use of protective equipment	10
4.	Following safety rules	20



S. No.	Performance Indicators	Weightage in %
5.	Submitting workshop diary 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. Demonstrate working as a leader/a team member.
- d. Maintain tools and equipment.
- 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
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year.

6. 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	Wood working lathe	01
2	Center Lathe Machine (Length between centers : 2000 mm)	03
3	Radial drilling machine (Drill diameter : upto 40 mm)	03
4	Pattern making, moulding and casting shop with necessary equipments.	02
5	Plastic Hand Moulding Machine	02
6	Feed system	02
7	Metallurgical Microscope ideal for examining Large and Single Side polished Metal samples	
8	Reheating furnace	
9	Power hacksaw	03.04
10	Milling machine	04

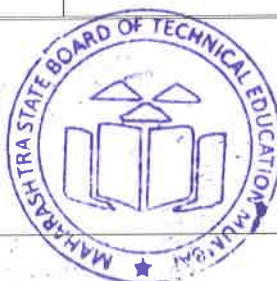
7. UNDERPINNING THEORY COMPONENTS

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 Engineering Materials	1a. Identify the properties, grades/designation of the given material with	1.1 Introduction: Need of advanced materials in automobile sector, Classification of engineering materials.



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	<p>justification.</p> <p>1b. Identify ferrous metal for the given automobile component with justification.</p> <p>1c. Identify non-ferrous metal for the given automobile component with justification.</p> <p>1d. Describe applications of the given materials in the given types of automobiles.</p>	<p>1.2 Ferrous metals and their alloys: Cast iron: types, composition and applications. Plain carbon steel: types, composition and applications.</p> <p>1.3 Alloy Steels: Alloy steels like stainless steel, Tool steels, their composition and Application. Effects of alloying elements like- Nickel, chromium, silicon, molybdenum and tungsten on the properties of steel.</p> <p>1.4 Non-ferrous metals and their alloys: Aluminium and its alloys: duralumin, 'Y' alloy, their composition, properties and applications. Copper and its alloys: brass, bronze, gun metal, Babbitt metal their composition, properties and applications. Magnesium alloys: Properties and applications of AZ31 Titanium alloys: Properties and applications of Ti-6Al-4V</p> <p>1.5 Other materials: Polymeric materials- properties and applications; Thermoplastics- Nylons and Polypropylene; Thermosetting Plastics- Epoxy resins and Polyesters Rubber – Natural and synthetic Ceramic materials: Properties and application in automotive industry; Composites: Properties and applications of Glass fiber (GRP/GFRP), Carbon fiber (CRP/CFRP)</p>
Unit– II Heat Treatment	<p>2a. Interpret the given Iron-Iron carbide (Fe-Fe₃C) equilibrium diagram.</p> <p>2b. Explain with sketches the given type of heat treatment process and its application.</p> <p>2c. Differentiate the features of the two given heat treatment process</p> <p>2d. Select the relevant heat treatment process for the given automobile component with justification.</p>	<p>2.1 Introduction: Need of Heat treatment. Concept of phase and phase transformations. Cooling curve for pure iron, Iron-Iron carbide (Fe-Fe₃C) equilibrium diagram.</p> <p>2.2 Common heat treatment processes and their applications in Automobile sector: Annealing, Normalizing, Hardening, Tempering, Surface hardening processes: Case carburizing, Nitriding, Cyaniding, Induction and Flame hardening.</p>



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit- III Foundry	3a. Describe with sketches the given manufacturing process applicable to Automobile engineering. 3b. Describe with sketches the steps in foundry process of the given component. 3c. Describe with sketches the process of pattern making based on the given aspects. 3d. Describe with sketches the process of preparing the given type of mould by using the given moulding tools. 3e. Identify defects in the given casting with their probable remedies.	3.1 Introduction: Introduction to various manufacturing processes, Importance of foundry processes, Steps in foundry process, Types of Foundries, Advantages and disadvantages of foundry process. 3.2 Pattern Making: Pattern materials and their selection, Types of pattern and their selection, Pattern Allowances. Pattern colour coding. 3.3 Moulding: Moulding tools and flasks. Moulding sand: Composition, Types and properties, Classification of moulding processes. Use of Core, core print and core boxes. 3.4 Casting: Gating system in casting- Function and Block diagram, Process and applications: Pressure Die casting, Shell moulding and True Centrifugal casting, Defects in casting: causes and remedies.
Unit-IV Fundamentals of Machining	4a. Select the machining parameters for the given job with justification. 4b. Identify the type of chip formed based on the given type of material and machining parameters with justification. 4c. Select the relevant cutting tool material and cutting fluid for the given situation with justification. 4d. Describe with sketches the features of the different types of cutting. 4e. Describe the given cutting tool with sketches.	4.1 Chip formation: Mechanism of chip formation, Types of chips Orthogonal and Oblique cutting Machining parameters like Cutting Speed, Feed and Depth of cut, Tool life. 4.2 Cutting tools and fluids: Types of cutting tools: single and multi-point, Cutting tool materials: Selection, Properties and types Single point cutting Tool nomenclature and tool signature, Cutting fluids: Properties, types
Unit –V Basic Machine Tools	5a. Identify various parts and accessories of the given type of machine tool sketch. 5b. Explain with sketches the procedures of given operations on the given type of machine. 5c. Prepare the specification of the given type of	5.1 Introduction: Definition of machine tool, Types of machine tools. 5.2 Lathe: Classification of lathes. Major parts of Centre lathe machine with block diagram, Lathe specifications. Accessories used on lathe, Operations performed on lathe – Turning, Taper turning by swiveling compound rest, Knurling and Threading.



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	machine tool. 5d. Describe the safety precautions to be taken during operation of the given type of machine.	5.3 Drilling: Classification of drilling machines. Major parts of bench drilling machine with block diagram, Operations performed on drilling machines – drilling, boring, reaming and tapping. 5.4 Milling: Classification of milling machines, major parts of column and knee type universal milling machine, standard milling cutters, Milling operations like Face milling, Gang milling, Key-way milling and End milling.

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	Engineering Materials	10	04	06	06	16
II	Heat Treatment	06	02	02	04	08
III	Foundry	13	04	08	08	20
IV	Fundamentals of Machining	06	02	02	04	08
V	Basic Machine Tools	13	04	06	08	18
Total		48	16	24	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 specification of machine tools.
- Prepare list of various cutting tools available in the market.
- List of various Material codes as per IS designation.
- Prepare a sequence of operation for any one automobile component.
- List the automobile components which require heat treatment.

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. Visit to foundry shop where automobile components are manufactured and demonstrate various foundry activities.
- g. Visit to machine shop where automobile components are manufactured and demonstrate various machine tools, cutting tools and cutting fluids.
- h. Visit to heat treatment shop where automobile components are processed and demonstrate various heat treatments.

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. Select any one component of automobile for each group.
- b. List the material used for the manufacturing of the selected component.
- c. Write the names of manufacturing processes used.
- d. Prepare the process sheet (Process sheet shall include operation number, work description, name of machine tool, cutting tool used, measuring instruments and machining time etc.)

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Engineering Materials and Metallurgy	Rajput R. K.	S. Chand Limited, New Delhi. 2013, ISBN 13: 9788121927093
2	Material Science and Metallurgy	Kodgire V. D.	Everest Publishing House, Pune. 1020, ISBN: 9788186314005, 186314008



S. No.	Title of Book	Author	Publication
3	A Course in Workshop Technology, Vol. I and Vol. II	Raghuvanshi B. S.	Dhanpat Rai and Company Pvt. Ltd. 2011, ISBN-13: 1234567144375
4	Elements of Workshop Technology Vol. I and Vol. II	Hajra Choudhury S.K.; Hajra Choudhury A.K	Media Promoters, Kolkatta, 2009, ISBN: 978-8185099156

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

- a. <https://en.wikipedia.org/wiki/Foundry>
- b. <http://www.iifncts.org/wp-content/site/index.php>
- c. <http://www.imtma.in/>
- d. <http://cmti-india.net/>
- e. <http://www.mechengg.net>

