Maharashtra State Board of Technical Education, Mumbai

Teaching and Examination Scheme for Post S.S.C. Diploma Courses

Program Name : Diploma in Automobile Engineering

Program Code : AE — **With Effect From Academic Year: 2017 – 18**

Duration of Program : 6 Semesters — **Duration : 16 Weeks**

Semester : Third — **Scheme - I**

S. N.	Course Title	Course Abbreviation	Course Code	Teaching Scheme			Credit (L+T+P)	Examination Scheme												Grand Total
								Theory								Practical				
								Exam Duration in Hrs.	ESE		PA		Total			ESE		PA		Total		
				L	T	P			Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks		Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
1	Strength of Materials	SOM	22306	3	2	2	7	3	70	28	30*	00	100	40		25@	10	25	10	50	20	150
2	Materials and Manufacturing Processes	MMP	22307	3	-	2	5	3	70	28	30*	00	100	40		25@	10	25	10	50	20	150
3	Automobile Engines	AEN	22308	3	-	4	7	3	70	28	30*	00	100	40		50#	20	50	20	100	40	200
4	Automobile Transmission System	ATS	22309	3	-	2	5	3	70	28	30*	00	100	40		25#	10	25	10	50	20	150
5	Basic Electrical and Electronics Engineering	BEE	22310	4	-	2	6	3	70	28	30*	00	100	40		25@	10	25	10	50	20	150
6	Automobile Engineering Drawing	AED	22023	1	-	4	5	--	--	--	--	--	--	--		50@	20	50~	20	100	40	100
			Total	**17**	**2**	**16**	**35**	--	**350**	--	**150**	--	**500**	--		**200**	--	**200**	--	**400**	--	**900**

Student Contact Hours Per Week: **35 Hrs.** Medium of Instruction: **English**

Theory and practical periods of 60 minutes each. Total Marks : **900**

Abbreviations: ESE- End Semester Exam, PA- Progressive Assessment, L - Lectures, T - Tutorial, P - Practical

@ Internal Assessment, # External Assessment, *# On Line Examination , ^ Computer Based Assessment

* 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 LOs required for the attainment of the COs.

~ For the courses having ONLY Practical Examination, the PA marks Practical Part - with 60% weightage and Micro-Project Part with 40% weightage

- **If Candidate not securing minimum marks for passing in the "PA" part of practical of any course of any semester then the candidate shall be declared as "Detained" for that semester.**

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

Program Name : **Mechanical Engineering Program Group**

Program Code : **AE/ME/PG/PT/FG**

Semester : **Third**

Course Title : **Strength of Materials**

Course Code : **22306**

1. RATIONALE

Strength of Material is a core technology subject which aims at enabling the student to understand and analyze various types of loads, stresses and strains along with main causes of change in physical properties and failure of machine parts. All Mechanical Engineering components are subjected to different loadings and behave in a specific way. The subject is pre-requisite for understanding principles of machine design and strengths of various materials used in industries. Understanding mechanical properties of materials will help in selecting the suitable materials for various engineering applications.

2. COMPETENCY

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

- **Estimate stresses in structural members and mechanical properties of materials.**

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. Compute Moment of Inertia of symmetric and asymmetric structural sections.
b. Estimate simple stresses in machine components.
c. Perform test to evaluate mechanical properties according to India Standards.
d. Compute shear force and bending moment and corresponding shear and bending stresses in beams subjected to point and uniformly distributed load.
e. Estimate stresses in shafts under twisting moments.
f. Estimate stresses in short member subjected to eccentric loading.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory							Practical					
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
L	T	P			Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	2	2	7	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.

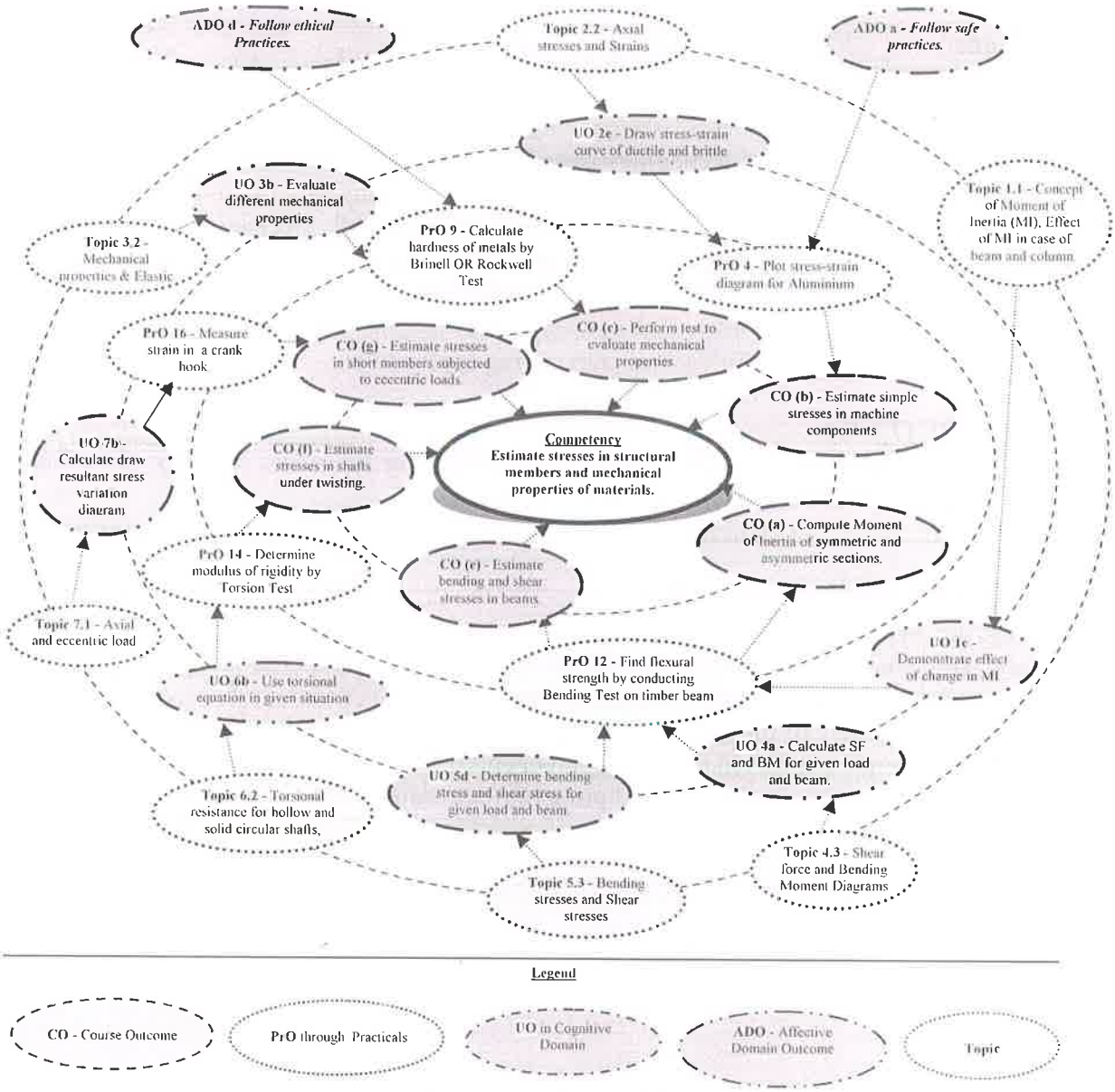

Figure 1 - Course Map

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	Determine yield stress, ultimate stress and breaking stress of Mild Steel by conducting Tension test (Part I) as per IS 432 (I)	II	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
2	Determine yield stress, ultimate stress and breaking stress of Mild Steel by conducting Tension test (Part II) as per IS432 (I)	II	02
3	Plot stress-strain diagram for Aluminium by conducting Tension test (Part I) as per IS 1608	II	02
4	Plot stress-strain diagram for Aluminium by conducting Tension test (Part II) as per IS 1608	II	02
5	Calculate compressive strength of Ductile such as Mild Steel (MS), Aluminium (Al), Brass (Br), Copper (Cu), using Compression testing machine as per IS 14858	II	02*
6	Calculate compressive strength of Brittle materials such as Cast Iron (CI), High Carbon steel using Compression testing machine as per IS 14858	II	02
7	Determine shear strength of various metals such as MS, Al, Br and Cu, (Any two metals) by Single Shear test as per IS 5242	II	02*
8	Determine shear strength of various metals such as MS, Al, Br and Cu, (Any two metals) by Double Shear test as per IS 5242	II	02
9	Evaluate toughness of Ductile and Brittle materials such as MS, Al, Br and Cu, by conducting Izod Impact test as per IS 1757	III	02*
10	Determine energy absorption capacity of Ductile and Brittle materials such as MS, Al, Br and Cu, by conducting Charpy Impact test as per IS 1598	III	02*
11	Draw Shear force and Bending moment diagrams of given loading using open source SF/BM simulation software.	IV	02*
12	Find flexural strength by conducting Bending Test on timber beam of Rectangular cross section with shorter side horizontally oriented as per IS 1708, IS 2408	IV	02
13	Find flexural strength by conducting Bending Test on timber beam of Rectangular cross section with shorter side vertically oriented as per IS 1708, IS 2408	IV	02
14	Determine modulus of rigidity by conducting Torsion Test on MS (Part I) as per IS 1717	V	02*
15	Determine modulus of rigidity by conducting Torsion Test on MS (Part II) as per IS 1717	V	02
16	Determination of Direct stress, Bending stress and Resultant stresses for a given practical approach	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 CO's 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 %
a.	Awareness about significance of particular test	15
b.	Understanding working principle of machine	15
c.	Preparation of experimental set up	20
d.	Setting and operation	20
e.	Observations and recording	10
f.	Interpretation of result and conclusion	10
g.	Answer to sample questions	5
h.	Submission of report in time	5
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.

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	**Universal Testing Machine:** Capacity - 100 tonnes. Type: Mechanical type digital, electrically Operated. Accessories: (1) Tensile test attachment for flat and round specimen up to32 mm. (2) Compression test attachment (3) Shear test attachment with sizes of bushes 5,6,8,10,12.16,20,24 mm, (4) Transverse test attachment with bending Punch,(5)Service tools.(6) Operation and maintenance manuals - 2 nos. (7)Hardness attachment	1 to 8 and 12,13
2	**Digital Extensometer:** Least count - 0.001 mm. Max. Extension = 5 mm. Single dial gauge for 30,40 mm. 60 mm, 80 mm, 100 mm, 125 mm gauge length.	1 to 2
3	**Impact Testing Machine:** CHARPY Test Apparatus: Pendulum drop angle 140°; Pendulum effective Wt 20-25 kg; Striking velocity of pendulum 5-6 m/sec; Pendulum impact energy 300 j; Min scale graduation 2 [illegible] axis of pendulum rotation	9, 10

S. No.	Equipment Name with Broad Specifications	PrO. S. No.
	from center of specimen to specimen hit by pendulum 815 mm. IZOD Impact Test Apparatus: Pendulum drop angle: 90°-120; Pendulum effective Wt: 20-25 kg; Striking velocity of pendulum: 3-4 m/sec; Pendulum impact energy: 168 j; Min scale graduation: 2 J; Distance of axis of pendulum rotation from center of specimen to specimen hit by pendulum : 815 mm	
4	**Torsion Testing Machine:** Fixed with auto torque selector to regulate torque ranges Contains geared motor to apply torque to specimen through gearbox Attached with autographic recorder for relation between torque and angle of twist Accuracy + 1 % of the true torque Suitable For: Torsion and Twist test on diverse metal rods and flats Torque Measurement by pendulum dynamometer system	14, 15
7	**Compression Testing Machine:** Digital display manual control compression testing; machine; Max. Capacity (KN): 2000 ; Measuring range: 4%-100% of FS; Relative error of reading: $\leq \pm 1\%$; Max. distance between two platen (mm): 330; Compression platen size (mm): 220×220; Max. piston stroke (mm): 0-20; Max. piston speed (mm/min): Approx. 30; Column clearance (mm): 300×200; Oil pump motor power (KW): 1.5; Whole dimensions (mm): 855*380*1435	12, 13
8	Strain Gages set: CEA-13-125UR-350 Strain Gages; CEA-00-125UR-350 Strain Gages; CEA-00-125UT-350 Strain Gages. With strain gauge data logger and connecting cables.	16
9	Freeware/open source software for drawing SF and BM diagrams.	11

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 Moment of Inertia	1a. Calculate MI of the given standard shape. 1b. Calculate MI of the given simple composite shape. 1c. Explain with sketches effect of change in MI in case of the given beam and column. 1d. Calculate Polar MI and radius of gyration for the given body.	1.1 Concept of Moment of Inertia (MI), Effect of MI in case of beam and column. 1.2 MI about axes passing through centroid, Parallel and Perpendicular axes theorem, Polar MI, radius of gyration. 1.3 MI of standard basic shapes. 1.4 MI of Composite plane figures.
Unit– II Simple Stress and Strains	2a. Calculate axial deformation and axial stress for the given stress condition. 2b. Use Hooke's law for the	2.1 Equilibrium, Rigid body, Deformable body. 2.2 Axial Stress- meaning, Resistance, Types of stresses; Axial (linear) Strain – concept.

	given stress condition. 2c. Calculate Modulus of Elasticity and Rigidity for the given situation. 2d. Determine nature and magnitude of thermal stress in the given situation. 2e. Draw stress-strain curve of the given ductile and brittle material(s) in tension. 2f. Calculate shear stresses for the given single/double shear condition.	types. 2.3 Hooke's Law, Young's Modulus, Axial deformation in a body and bodies in series. 2.4 Behavior of ductile and brittle materials subjected to axial tension, stress-strain or Load-deformation curve, Limit of proportionality, yielding, permanent set, yield stress, ultimate stress. 2.5 Shear stress and shear strain, Modulus of rigidity, punching shear, shear connectors, single and double shear. 2.6 Temperature stress and strain in case of bodies having uniform cross-section, deformation fully prevented, field examples.
Unit – III Mechanical Properties and Elastic Constants of Metals	3a. Identify type of deformation for the given type of load with justification. 3b. Evaluate different mechanical properties of the given material. 3c. Identify types of load acting in the given situation with justification. 3d. Identify type of material from the given data with justification. 3e. Calculate strain and axial deformation in each direction under the given bi- and tri-axial stresses. 3f. Estimate Resilience, Modulus of resilience, Proof Resilience for the given case.	3.1 Types of loads (actions) and related deformations. Flexure, torsion, shear. 3.2 Mechanical properties: Elasticity, Plasticity, Ductility, Brittleness, Malleability, Fatigue, Creep, Toughness, Hardness. 3.3 Strength, Factor of Safety, Stiffness and flexibility. 3.4 Linear and lateral strain, Poisson's ratio, changes in lateral dimension. 3.5 Uni- Bi –Tri-axial stress systems, strain in each direction, Bulk modulus, volumetric strain. 3.6 Relation between three moduli. 3.7 Stress due to Gradual, Sudden and Impact load, corresponding deformation. Strain Energy, Resilience, Proof Resilience and Modulus of resilience.
Unit-IV Shear Force - Bending Moment and Shear Stresses- Bending Stresses	4a. Calculate SF and BM for the given load and beam. 4b. Draw SFD and BMD for the given loaded beam. 4c. Locate point of maximum BM and point of contra-flexure in the given case. 4d. Draw deflected shape of beam from the given BMD. 4e. Use flexural formula for the given bending situation. 4f. Draw NA and extreme	4.1 Types of Beams (Simply supported with or without overhang, Cantilever) , Types of loads (Point load, Uniformly Distributed load), Bending of beam, deflected shape. 4.2 Meaning of SF and BM, Relation between them, Sign convention. 4.3 SFD and BMD. Location of point of maximum BM. Deflected shape from BMD. Location of Point of Contra-flexure. 4.4 Theory of simple bending, Assumptions in

	fibers in bending for the given beam. 4g. Determine Section modulus and Moment of resistance for the given beam. 4h. Determine bending stress and shear stress for the given load and beam. 4i. Draw bending stress and shear stress variation diagram for the given beam.	theory of bending, Flexural formula, Neutral axis. 4.5 Moment of resistance, Section modulus. 4.6 Bending stress variation diagram across depth for cantilever and simply supported beam for symmetrical and unsymmetrical sections. 4.7 Transverse shear stress, average and maximum shear stress, Shear stress variation diagram.
Unit-V Torsion	5a. Use torsional equation in the given situation 5b. Calculate torque and power transmitted by a shaft in the given situation. 5c. Determine shear stress and angle of twist in a shaft for the given power to be transmitted/torque. 5d. Determine diameter of shaft for the given shear stress/ angle of twist.	5.1 Torsion: Concept, field applications (Shaft, flange couplings, shear bolts), torsional rigidity, torsional equation and assumptions. 5.2 Torsional resistance for hollow and solid circular shafts, Power transmitted by shaft, replacement of section.
Unit-VI Direct and Bending Stresses	6a. Identify machine components subjected to eccentricity with justification. 6b. Calculate resultant stress and draw resultant stress variation diagram for the given situation. 6c. Mark core (kernel) of the given standard section. 6d. Determine size of component for the given stress condition.	6.1 Axial and eccentric load, effects of eccentricity, Field cases (Hook, clamp, Bench Vice, Frame etc). 6.2 Axial stress and bending stress, resultant stress intensities, resultant stress variation (Eccentricity about one axis only). 6.3 Limiting eccentricity, Core of section. 6.4 No tension condition.

***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	Moment of Inertia	04	02	00	04	06
II	Simple stresses and Strains	08	02	02	06	10
III	Mechanical properties and Elastic Constants	08	02	02	04	08
IV	Shear force- Bending Moment and Shear stresses- Bending stresses	16	02	06	20	28*
V	Torsion	06	00	02	06	08
VI	Direct and Bending stresses	06	02	02	06	10
Total		**48**	**10**	**14**	**46**	**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.*
* These 28 marks should be equally divided between 'Shear force- Bending Moment' and 'Shear stresses- Bending stresses', hence questions of 14 marks should be asked from each of these topics.

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. Undertake micro-projects.
b. Prepare journals based on practical performed in laboratory.
c. Poster presentation on any one topic.
d. Market survey specific to properties of various type of materials used in Mechanical Engineering

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 deeper understanding of the subject.
h. Observe continuously and monitor the performance of students in Lab.
i. Show video/animation film to demonstrate the testing of different materials.
j. Arrange a visit to nearby material testing lab.
k. Use flash/animations to explain the failure of different machine components under various load situations.

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 information and present in tabular form, values of different engineering properties of five standard mechanical engineering materials.
b. Present a seminar on different testing methods used in industry.
c. Prepare models of single and double shear conditions.
d. Prepare a model of a shaft to demonstrate relation between length and angle of twist.
e. Prepare an excel sheet to calculate SF and BM in a simply supported beam and cantilever beam.
f. Collect information comprising of different machine components subjected to direct and bending stresses.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Strength of Materials	Punmia B.C.	Laxmi Publications (p) Ltd. New Delhi, 10/e, 2015.ISBN: 9788131809259
2	Strength of Materials	Ramamurtham S.	Dhanpat Rai Publishing . New Delhi; 2014. ISBN: 9789384378264
3	Strength of Materials	Timoshenko Gere	CBS,2 edition, 2006, New Delhi, ISBN: 9788123908946
4	Strength of Materials	Khurmi R.S.	S. Chand Publishing, New Delhi, 2006 , ISBN: 9788121928229
5	Strength of Materials	Rattan S.S.	McGraw Hill Education;, New Delhi, 2016. ISBN: 9789385965517

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. nptel.iitm.ac.in/courses/.../IIT.../lecture%2023%20and%2024.htm
b. en.wikipedia.org/wiki/Shear_and_moment_diagram
c. www.freestudy.co.uk/mech%20prin%20h2/stress.pdf
d. www.engineerstudent.co.uk/stress_and_strain.html
e. https://www.iit.edu/arc/workshops/pdfs/Moment_Inertia.pdf

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:

a. Select the appropriate material for manufacturing of automobile components.
b. Select appropriate heat treatment process for automobile components.
c. Prepare a pattern and mould for casting automobile components.
d. Select machining parameters, cutting tools and cutting fluids for machining automobile components.
e. 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												
				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 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.

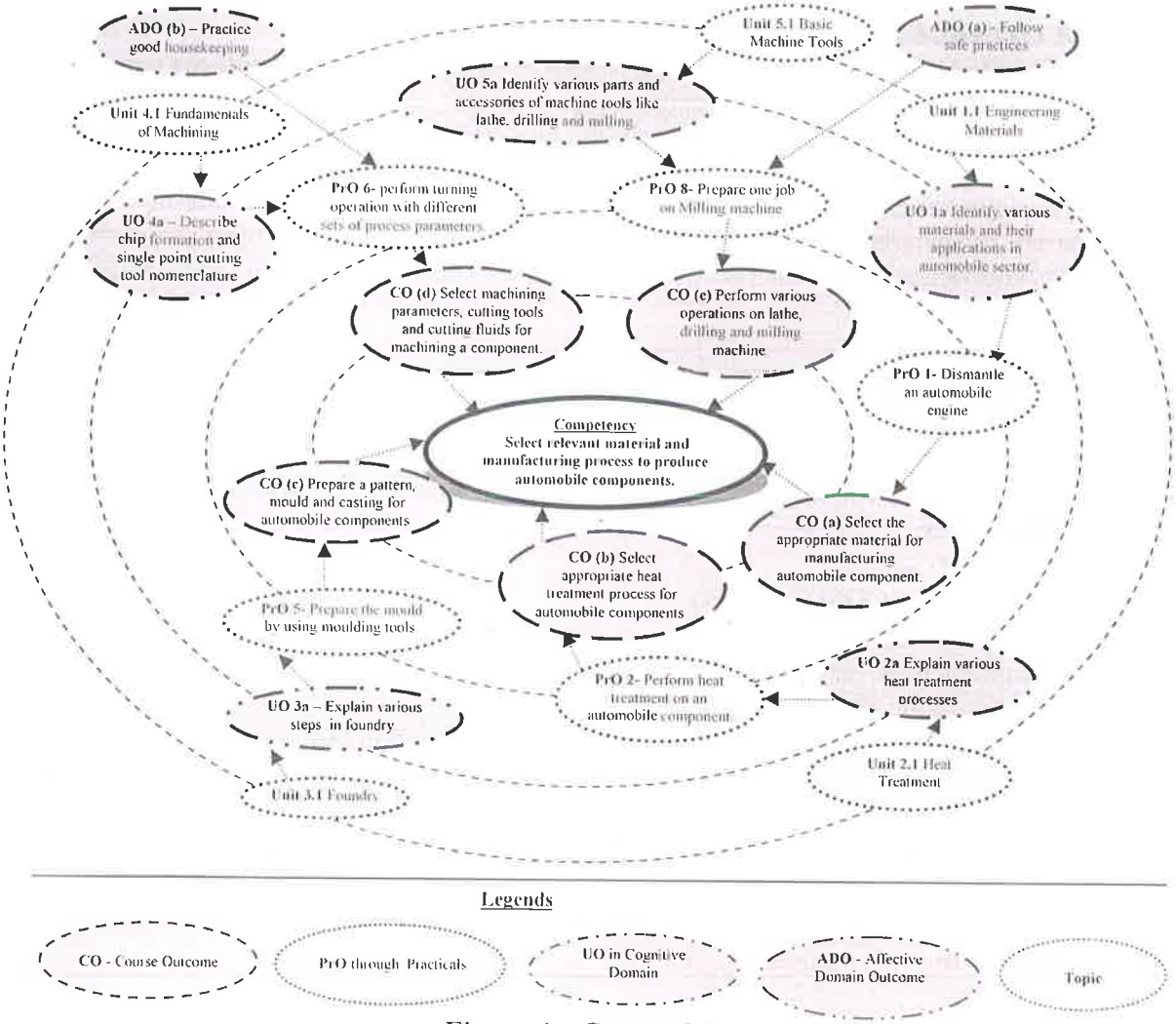

Figure 1 - Course Map

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 metals 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
	justification. 1b. Identify ferrous metal for the given automobile component with justification. 1c. Identify non-ferrous metal for the given automobile component with justification. 1d. Describe applications of the given materials in the given types of automobiles.	1.2 **Ferrous metals and their alloys:** Cast iron: types, composition and applications. Plain carbon steel: types, composition and applications. 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. 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 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)
Unit– II Heat Treatment	2a. Interpret the given Iron-Iron carbide (Fe-Fe3C) equilibrium diagram. 2b. Explain with sketches the given type of heat treatment process and its application. 2c. Differentiate the features of the two given heat treatment process 2d. Select the relevant heat treatment process for the given automobile component with justification.	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. 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.

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 tpe 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, Facing, 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 taping. 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:

a. Prepare specification of machine tools.
b. Prepare list of various cutting tools available in the market.
c. List of various Material codes as per IS designation.
d. Prepare a sequence of operation for any one automobile component.
e. 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, 8186314008

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 Promotors, 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

Program Name : **Diploma in Automobile Engineering**

Program Code : **AE**

Semester : **Third**

Course Title : **Automobile Engines**

Course Code : **22308**

1. RATIONALE

This is a core technology course. All automotive vehicles are powered by engines. Hence the fundamental knowledge of automobile engine is most essential for an auto technologist. This course will help in understanding the procedure of inspection, diagnosis and testing of various types of engines and other systems. This course also forms the basis for the Advanced Automobile Engine and vehicle 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:

- **Check the functioning of the 2-wheeler and passenger car engine 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. Interpret the IC engine specifications.
b. Identify various petrol and diesel engine components.
c. Troubleshoot petrol and diesel fuel supply system.
d. Check ignition systems.
e. Use service manual for routine maintenance of cooling and lubrication systems.
f. Estimate I.C. engine performance.

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	--	4	7	3	70	28	30*	00	100	40	50#	20	50	20	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 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.

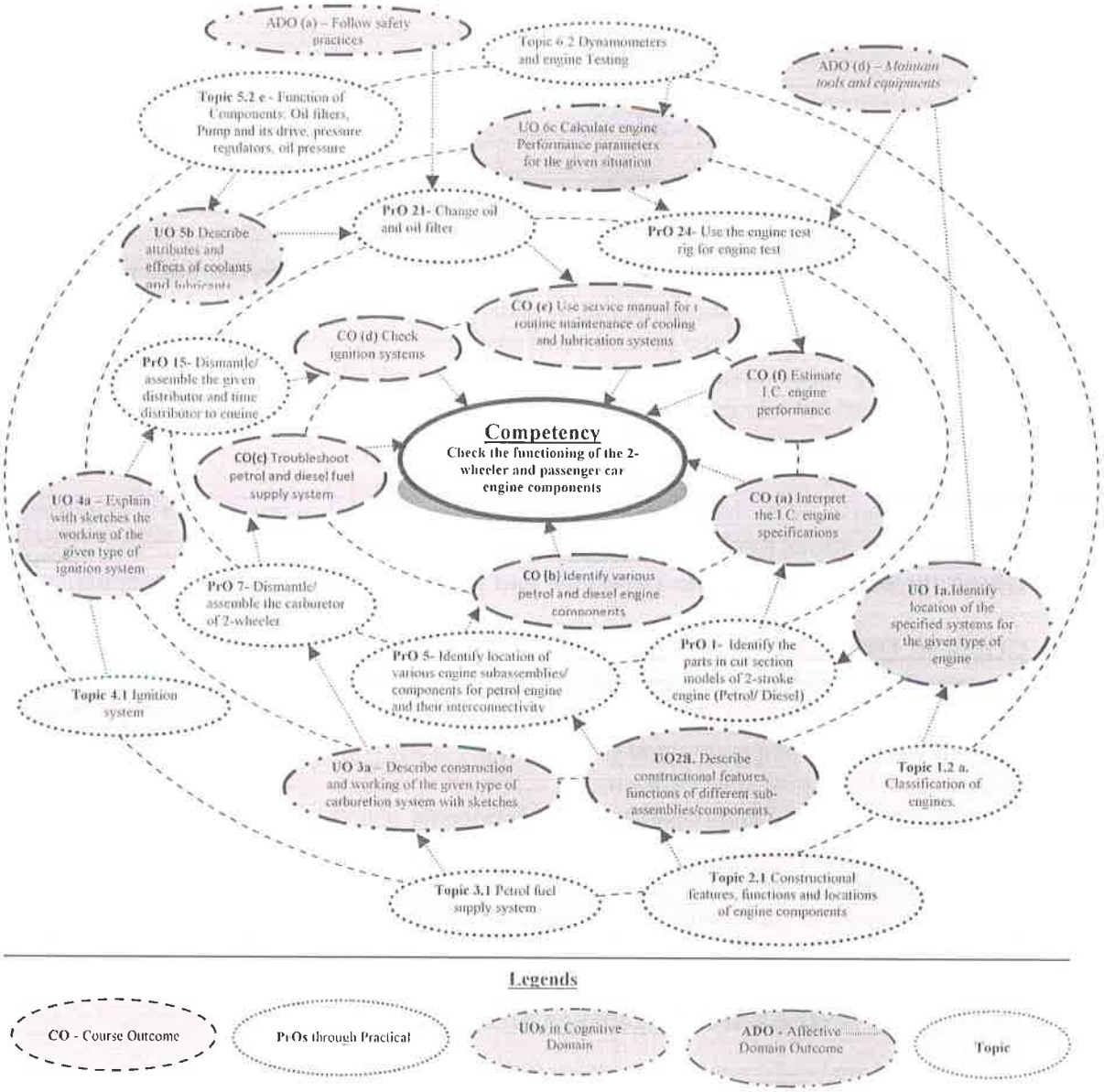

Figure 1 - Course Map

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 in cut section models of 2-stroke engine (petrol/ diesel).	I	02*
2.	Identify the parts in cut section models of 4-stroke engine (petrol/ diesel).	I	02
3.	Use special tools in dismantling 2-stroke engine.	I	02
4.	Use special tools in assembling 4-stroke engine.	I	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
5.	Identify location of various engine subassemblies/ components for petrol engine and their interconnectivity. Part - I	II	02
6.	Identify location of various engine subassemblies/ components for diesel engine and their interconnectivity. Part - II	II	02*
7.	Dismantle/ assemble the carburetor of 2-wheeler. Part - I	III	02*
8.	Dismantle/ assemble the carburetor of 2-wheeler. Part - II	III	02
9.	Trace induction and fuel supply system of a diesel engine	III	02*
10.	Dismantle/assemble fuel injector of a diesel engine	III	02*
11.	Dismantle/ assemble Single element Fuel injection pump of a diesel engine.	III	02*
12.	Trace ignition system of a 2-wheeler engine.	IV	02*
13.	Trace ignition system of a 4-wheeler engine.	IV	02
14.	Carry out maintenance of Spark Plug, ignition coil and HT cords.	IV	02
15.	Dismantle/ assemble the given distributor and time distributor to engine. Part - I	IV	02
16.	Dismantle/ assemble the given distributor and time distributor to engine. Part - II	IV	02
17.	Check 4-wheeler engine cooling system.	V	02
18.	Test Thermostat Valve and Electric Cooling Fan Thermo-switch.	V	02
19.	Replace/replenish coolant of an engine after checking.	V	02
20.	Check lubrication system of a passenger car engine.	V	02
21.	Change oil and oil filter.	V	02*
22.	Service oil pump of passenger car engine.	V	02
23.	Perform the servicing of Oil Pressure Relief Valve	V	02
24.	Use the engine test rig for engine test. Part I	VI	02*
25.	Use the engine test rig for engine test. Part II	VI	02
26.	Use the engine test rig for engine test. Part II	VI	02
27.	Conduct Morse Test on multi-cylinder petrol engine. Part I	VI	02*
28.	Conduct Morse Test on multi-cylinder petrol engine. Part II	VI	02
29.	Dismantle/ Assemble a multi-cylinder diesel engine. Part - I	VI	02*
30.	Dismantle/ Assemble a multi-cylinder diesel engine. Part - II	VI	02
31.	Dismantle/ Assemble a multi-cylinder petrol engine. Part - I	VI	02*
32.	Dismantle/ Assemble a multi-cylinder petrol engine. Part - II	VI	02
	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 judicial 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	20

S. No.	Performance Indicators	Weightage in %
	tools	
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. Demonstrate working as a leader/a team member.
d. Maintain tools and equipments.
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. 'Organizing Level' in 2nd year
c. '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	General purpose tools (Spanners, ring spanner and socket)- 6mm to 32 mm	All
2	Special purpose tools (Piston ring expander, Piston ring compressor, Valve lifter, Torque wrench)- Torque wrench range- 10 Nm to 200Nm.	
3	Two stroke engine cut-section model- single cylinder (motorized/ manual)	
4	Four stroke engine cut-section model- single cylinder (motorized/ manual)	
5	Two stroke engine (Single cylinder) Petrol / Diesel	
6	Four stroke engine (Single / Multi-cylinder)	
7	Fuel Supply system (Petrol)- including carburettor, fuel pump and fuel filter of two wheeler/ four wheeler	
8	Fuel Supply system (Diesel) - Fuel Injection pump, primary filter, secondary filter, Injectors.- Single cylinder/ multi-cylinder engine FIP unit .	
9	Magneto coil ignition system- including Magneto, Ignition coil, Spark plug and battery.	
10	Distributor	
11	Four stroke multi-cylinder diesel/ petrol engine with water cooling system	
12	Four stroke diesel / petrol engine with lubrication system.	

S. No.	Equipment Name with Broad Specifications	PrO. No.
13	Single cylinder/ multi-cylinder Engine test rig with dynamometer.	
14	Four stroke CI and SI engines	
15	Engine dismantling and assembly tools	
16	Consumables (cotton waste, fuel and lubricants), Water supply provision, Electrical supply provision, Exhaust gas outlet, Wooden blocks, safety equipment, fire extinguisher	

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 I.C. Engine.	1a. Identify location of the specified systems for the given type of engine. 1b. Explain with sketches the working principle of the given type of engine. 1c. Identify the engines from the given specifications with justification. 1d. Interpret the specifications of the given type of engine.	1.1 Definition of I C engine, Engine nomenclature. 1.2 **Classification** a. Classification of engine on the basis of: Cycle of operation, Fuel, Method of Charging, Ignition, Cooling, Cylinder arrangement, Camshaft, layout, b. Vertical and horizontal engines and its Merits and Demerits 1.3 **Types of Engines** a. Four-Stroke Spark Ignition and Four-Stroke Compression Ignition Engine. b. Two-Stroke and Four-Stroke engine scavenging 1.4 **Engine Specifications and applications** a. Engine Specifications - Two Wheelers, Light Motor Vehicle, Medium Motor Vehicle and Heavy Motor Vehicle. b. Applications of IC Engines.
Unit – II Constructional Features of Engine Components.	2a. Describe constructional features, functions and materials of the given systems/sub-assemblies/ components of the given I.C. engines with sketches. 2b. Differentiate the working/materials between the given types of engine component. 2c. Compare the salient features of the given types of valves and cams arrangement.	2.1 **Constructional features, functions, locations and materials of engine components.** a. Cylinder block, Cylinder liners – Dry and Wet, Cylinder head, Inlet and Exhaust manifold, Tappet cover, Timing cover, Crank case. Oil Sump. b. Crank Mechanism: Piston and piston rings, Piston pin, Connecting rod, Crank Shaft, Cam shaft, Flywheel, Bearings, Oil seals, Gaskets. c. Valve and Valve Operating Mechanisms: Overhead Valve and Overhead Cam arrangements; Valve Cooling. 2.2 **Camshaft Drives and Valve Timing** a. Camshaft drives: Timing Gears, Chain and

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	2d. Identify relative position of crankshaft and camshaft in the given situation with justification.	Belt drive. b. Relation between speed of camshaft and crank Shaft. Valve timing Diagram.
Unit– III Fuel and Air feed System	3a. Describe construction and working of the given type of carburetion system with sketches. 3b. Explain with sketches the construction and working of the given type of fuel injection systems. 3c. Describe with sketches the working of the given type of governor in the given type of engine. 3d. Select relevant lubrication system for the given situation with justification. 3e. Choose the relevant fuel supply system components for the given situation with justification.	3.1 **Petrol fuel supply system.** a. Pump feed :Layout, Function of Components and location; Construction and working of components: Fuel Tank. Fuel Filter, S. U. Electrical Fuel Pump b. Air cleaners – dry type and oil wetted types. c. Working Principle of Simple Carburettor, Air Fuel ratio requirements, Circuits in Two-wheeler carburettor. **3.2 Diesel fuel supply system** a. Diesel Engine: Need and requirements of Fuel Injection Systems; Layout of Fuel Injection systems Individual pump, Unit injector system, Distributor system and Common rail system. b. Fuel Injector and types of nozzles. c. Fuel metering in Fuel Injection Pump (Inline pump and Distributor pump) 3.3 Working of Mechanical Governor in Fuel Injection Pump.
Unit– IV Ignition and Exhaust System	4a. Explain with sketches the working of the given type of ignition system. 4b. Explain with sketches the firing order for the given type of engine. 4c. Explain with sketches the construction and working of the given type of exhaust system 4d. Select the relevant type of silencer/Mufflers for the given engine with justification.	4.1 **Ignition System** a. Requirements of ignition system. b. Magneto and Battery Ignition systems c. Firing order used in 3,4 and 6 cylinder engines 4.2 **Exhaust system** a. Function of Exhaust manifold. b. Types of silencer / Mufflers (Construction and Working).
Unit– V Cooling and Lubricatio n system	5a. Describe layout, construction and working of the given cooling System with sketches. 5b. Describe attributes and effects of the given type	5.1 **Engine cooling system**: a. Need of cooling system and limitations of cooling system. b. Types: Air, Water/ Liquid cooling system (Layout and Function of Components) c. Properties of coolants and coolant additives

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	of coolant and lubricant. 5c. Describe with sketches properties of the given type of engine oil and their effects. 5d. Select the relevant coolant, lubricant and engine oil for the given situation with justification.	5.2 **Cooling system components**: a. Construction and working of: Thermostat valve, Water expansion tank, Temperature Indicators, Pressure cap, Water pump, Fan and fan belt, Electrically driven Fan circuit. b. Radiator: Construction and type of radiator cores. c. Types and Characteristics of a Coolant , and their effect on performance of engine cooling; Lubrication system: Need, Properties and additives of lubricating oil, Parts to be lubricated d. Classification of Lubricating Oils on the basis of Viscosity (SAE) and Load (API) Severity rating; Types of lubrication system: Splash, Pressure – wet sump and dry sump e. Function of Components: Oil filters, Pump and its drive, pressure regulators, oil pressure gauge.
Unit– VI I.C. Engine Performance.	6a. Interpret the given engine performance parameters and their implications. 6b. Explain with sketches the working principle of the given type of dynamometer. 6c. Calculate engine Performance parameters for the given situation. 6d. Prepare heat balance sheet for the given situation.	6.1 **Performance parameters.** a. Definitions: Indicated Power, Brake Power and Frictional Power. b. Efficiencies - Air standard, Mechanical, Brake Thermal, Indicated Thermal, Volumetric and Relative. 6.2 **Dynamometers and engine testing:** a. Working Principle and types of Dynamometers: Hydraulic and Eddy current. b. Engine Testing: Morse Test, Willian's line Method for finding Frictional Power. c. Heat balance sheet and Method of calculating Volumetric Efficiency and Fuel Consumption.

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 I.C. engines	08	04	02	04	10
II	Constructional features of engine components.	08	04	04	04	12

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
III	Fuel and air feed system	10	04	04	06	14
IV	Ignition and exhaust system	04	02	02	04	8
V	Cooling and lubrication system	10	02	04	06	12
VI	I.C. Engine performance	08	02	06	06	14
Total		**48**	**18**	**22**	**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 journal of practicals.
b. Undertake micro-projects.
c. List down the specifications of a bike engine.
d. Compare engine specifications of two bikes of different manufacturers.
e. Record the specifications of diesel engine of a electric generator.
f. Visit an auto parts shop and list down the salient features of three lubricating oils and three coolants.
g. Compare engines of petrol and diesel version of same car of a manufacturer on the basis of Power, Tourqe, RPM, noise, pollution, maintenance etc.

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 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. Choose a modern engine. Search information on any one system from website. Prepare a report for the same.
b. Make a few engine components/ their models using suitable material like thermocol/ wood/ plastic.
c. Prepare a CAD production drawing of the same. Suitable technique like 3D printing may be used.
d. Investigate valve timing diagram of a four stroke engine. Verify result with manufacturer's specification.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Automobile Engg. Vol.-2	Singh, Kirpal	Standard Publishers, New Delhi, 2015: ISBN: 9788180142062
2	Automobile Engineering	Jain K. K. and Asthana	Tata McGraw Hill Publishers, 2010, New Delhi ISBN : 007044529X
3	Automobile EngineeringVol.1	Chhikara, Anil	Satya Prakashan, New Delhi, 2009, ISBN: 9788176843515
4	Automobile Engineering	Gupta, R.B.	Satya Prakashan, New Delhi, 2011, ISBN: 9788176843799
5	Automobile Engineering	Ramlingam, K.K.	Scitech Publications, New Delhi, 2008, ISBN-9788183715744
6	Internal Combustion Engine Fundamentals	Heywood, John B.	McGraw-Hill International Edition New Delhi, 2010, ISBN: 9781259002076
7	Internal Combustion Engine	Newton and Steeds	Butterworth Publishers, NY, 2000 ISBN: 9780750644495

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. http://nptel.ac.in
b. https://www.youtube.com/watch?v=bLXDPs7UrXs for I.C. engine working principle
c. www.Learnengineering.org
d. https://www.youtube.com/watch?v=Rlw7Z4ksFgg for time an engine without timing marks
e. https://www.youtube.com/watch?v=OrfjuiQHkMs0 for engine lubrication system

f. https://www.youtube.com/watch?v=vErfnY5bPrY and https://www.youtube.com/watch?v=9BYm0HnLGRU for carburettor working animation
g. https://www.youtube.com/watch?v=EhwK2KWDH1Y for fuel filter animation
h. https://www.youtube.com/watch?v=JSymXTP8HTg for Distributor type FIP animation
i. https://www.youtube.com/watch?v=IjXnbFVJKRY for Jerk type FIP animation

Program Name : **Diploma in Automobile Engineering**

Program Code : **AE**

Semester : **Third**

Course Title : **Automobile Transmission System**

Course Code : **22309**

1. RATIONALE

This course provides knowledge about the various components of vehicle layout and the power transmission train used. This course will also help the students during inspection, installation, operation and maintenance of transmission system of automobile. This course is therefore a core course for automobile engineers and they should develop desired knowledge and skills over it.

2. COMPETENCY

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

- **Check the functioning of the automobile power transmission system 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. Select proper tools and equipment to check automobile transmission system components.
b. Select relevant vehicle layout and chassis for specific purpose.
c. Check automobile transmission system components.
d. Dismantle/assemble automobile transmission system components.
e. Diagnose simple problems pertaining to wheels and tyres of automobiles.

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 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.

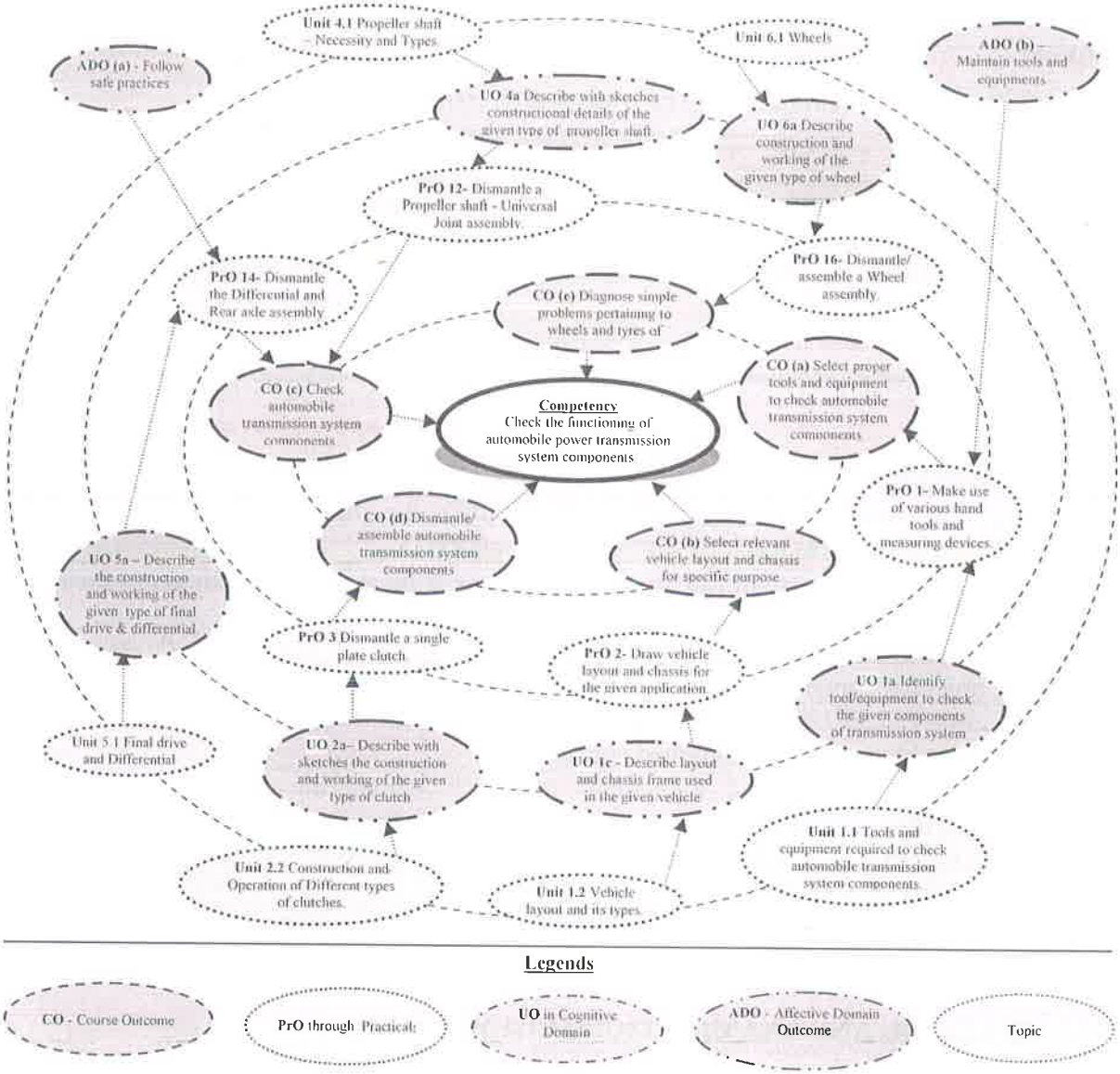

Figure 1 - Course Map

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	Make use of various hand tools and measuring devices.	I	02*
2	Trace vehicle layout and chassis of the given vehicle.	I	02*
3	Dismantle a single plate dry type clutch assembly.	II	02*
4	Assemble a single plate dry type clutch assembly.	II	02
5	Dismantle a Multi-plate clutch assembly used in two wheelers.	II	02*
6	Assemble a Multi-plate clutch assembly used in two wheelers.	II	02
7	Dismantle a Synchromesh gear box.	III	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
8	Assemble a Synchromesh gear box	III	02
9	Dismantle a Vario-drive used in mopeds.	III	02*
10	Assemble a Vario-drive used in mopeds.	III	02
11	Identify the components of the sequential automatic transmission.	III	02*
12	Dismantle a Propeller shaft - Universal Joint assembly.	IV	02*
13	Assemble a Propeller shaft - Universal Joint assembly.	IV	02
14	Dismantle the Differential and Rear axle assembly.	V	02*
15	Assemble the Differential and Rear axle assembly.	V	02
16	Dismantle/ Assemble a Wheel assembly.	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 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 %
a.	Follow safety rules and adopt standard practices for handling tools and equipments.	20
b.	Refer workshop manual and include relevant data in the journal.	10
c.	Sketching, Drawing layouts and conclusion.	40
d.	Answer to sample questions/Demonstration ability	20
e.	Timely submission of journal.	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
- 'Organising Level' in 2nd year
- '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	Vehicles – a) Two Wheeler – Minimum 100 cc motorcycle of make Bajaj/Hero/ Honda/Yamah/ TVS or alike. b) Three wheeler – RERWD Auto Rickshaw of Make Bajaj/ Piaggio or alike in good working condtion. c) Four wheeler vehicle – Car (FEFWD)/LMV (FERWD) of make Maruti/ TATA/Mahindra or alike in good running condtion.	All
2	Cut – section working model of Single Plate dry clutch: Coil spring/Diaphragm type single plate clutch assembly used in car/LMV/HMV suitably mounted on M.S. stand and in good operating condition.	3
3	Cut – section working model of Multi-Plate Wet type clutch: Multi-Plate Wet type clutch used in motorcycle suitably mounted on M.S. stand and in good operating condition.	3
4	Cut – section working model of simple Pulley based vario-drive used in mopeds.	3
5	Cut – section working model of four wheeler transmission system: Synchromesh gear box used in LMV/HMV suitably mounted on M.S. stand and in good operating condition.	5
6	Cut – section working model of Sequential automatic transmission system.	7
7	Cut – section working model of Final drive and differential used in Car/LMV/HMV and suitably mounted on M.S. stand and in good operating condition.	9
8	Four wheeler chassis – Cut section working model of chassis of Front Engine Rear wheel drive/Four wheel drive vehicle with Engine, transmission, steering, brakes, suspension and electrical systems.	All
9	Four wheeler chassis – Cut section working model of chassis of Front Engine Front wheel drive car of any make with MPFI engine, transmission, steering, brakes, suspension and electrical systems.	

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 Automotive Transmission System	1a. Identify tool/equipment to check the given component of automotive transmission system. 1b. Interpret the given vehicle layout for functional relationship of the given components of	1.1 Tools and equipment required to check automotive transmission system components. 1.2 Vehicle layout and its types: (a) Introduction of related terms- an automobile, Chassis, Body, Types of vehicles and Vehicle layout. (b) Classification of vehicle layout with respect to- i) Location of engine, ii) No of live axles, iii)

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	transmission system. 1c. Describe layout and chassis frame used in the given vehicle. 1d. Select the relevant frame for the given capacity of vehicle with justification. 1e. Identify the materials of the given types of frames.	Arrangement of Engine, Passenger and Luggage section, iv) Application (c) Layout of the front engine rear wheel drive vehicle- Location and functions of major components of transmission system. 1.3 Chassis Frames: Necessity of frame. (a) Loads acting on frame. (b) Types of frames- conventional (ladder and x-member type), semi integral and integral types. Sub frames. (c) Frame sections-channel, box and tubular sections. (d) Materials for frames.
Unit– II Automotive Clutches	2a. Describe with sketches the construction and working of the given type of clutch. 2b. Describe with sketches the operation of the given clutch actuating mechanism. 2c. Compare with sketches the types of clutches on the basis of construction, torque transmission, size.	2.1 Clutch: Necessity of clutch, Requirements of automotive clutches, Classification - Friction and Non friction type clutches 2.2 Construction and Operation of Different type of clutches a. Construction and Operation of a Single plate (coil and Diaphragm) dry clutch, Multi-plate – Dry and wet clutch, Centrifugal clutch. b. Construction details of Clutch plate. Clutch lining materials. c. Clutch operating mechanisms-mechanical, hydraulic, vacuum. d. Fluid Coupling – Principle, Construction and Working
Unit– III Automotive Gear boxes	3a. Describe with sketches the construction and working of the given type of gear box. 3b. Determine the gear ratio for the given type of gear arrangement. 3c. Describe the power flow diagrams for the given type of gear box when forward and reverse gears are in engaged positions. 3d. Describe with sketches the method of lubrication for the given type of gearbox.	3.1 Necessity of Gear Box 3.2 Types of automotive Gear Boxes -Construction and operation of - Sliding Mesh, Constant Mesh, Synchromesh gear box, Power flow diagrams for forward and reverse gears in engaged position. 3.3 Torque Converter- Construction and working and application. 3.4 Concept of Semiautomatic and automatic transmission. 3.5 Variator Drive, Continuously variable transmission 3.6 Gear selector mechanism with gear lever mounted on top of gear box. 3.7 Transfer case – Purpose, construction and working. 3.8 Lubrication of gear box.
Unit-IV Propeller shaft and	4a. Describe with sketches the constructional details of the given type of	4.1 Propeller shaft - Necessity and Types. Constructional details of Hollow and solid propeller shaft.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Universal joints	propeller shaft. 4b. Compare with sketches the given type of axle drives based on construction, working, loads acting on it and applications. 4c. Describe with sketches the construction, working and applications of the given type of universal joint.	4.2 Types of rear axle drives – construction, working and applications of Torque tube drive and Hotchkiss drive. 4.3 Universal Joint – Functions, Types, Construction and Operation of simple Hooke's joint, Constant velocity joints – Inboard Tripod Joint and outboard Rezappa joint. 4.4 Functions and construction of slip joint.
Unit –V Final drive, Differential and Rear axle	5a. Explain with sketches the construction and working of the given of type of final drive and differential. 5b. Compare with sketches the given types of rear axles used in the given four wheeler based on construction, working and application. 5c. Describe with sketches the method of lubrication for the given type of rear axle assembly.	5.1 Final drive and Differential a. Necessity and types of final drive. b. Necessity and types of differential. c. Construction and working of final drive and differential. 5.2 Rear Axle a. Necessity of Rear Axle. b. Loads acting on the rear axle c. Types of rear axles- semi floating, Three quarter floating and full floating type. d. Rear axle casing- split and banjo type. e. Double reduction axle. f. Method of lubrication for rear axle assembly.
Unit-VI Wheels and Tyres	6a. Describe construction and working of the given type of wheel with sketches. 6b. Compare with sketches the the given types of tyres based on specifications, construction and performance. 6c. Select the suitable tyre and its inflation for the given application. 6d. Interpret the specifications for the given type of tyre.	**6.1** Wheels: Functions, Types of wheels - construction and applications of Wired spoke wheel, Disc wheel and Alloy wheels. 6.2 Tyres a. Functions of tyre, Types of Tyres - Construction and working of tubed tyre and Tubeless tyres. Radial ply, Cross ply, Belted bias types of tyres, Tyre Specifications. b. Concept of Aspect ratio. c. Types of tread patterns. d. Tyre inflation –Types and effects of incorrect tyre inflation. e. Tyre rotation – Necessity.

***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 Automotive Transmission System	08	04	04	04	12
II	Automotive Clutches	10	02	08	06	16
III	Automotive Gearboxes	10	02	08	06	16
IV	Propeller shaft and Universal joints	06	02	04	02	08
V	Final drive, Differential and Rear axle	08	02	04	04	10
VI	Wheels and tyres	06	02	04	02	08
Total		**48**	**14**	**32**	**24**	**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 journal of practicals.
b. Undertake micro-projects.
c. Compare clutches used in a two wheeler, four wheeler and moped.
d. Write down the parts of transmission system of your bike with detailed specification and manufacturer's name.
e. List examples/situations where universal joints are used.
f. Write down the specification of tube less tyres for three leading tyre manufacturers.
g. Compare broad base and narrow base tyres.
h. Visit a nearby vehicle repair shop and observe the construction and working of two and four wheeler gear boxes.

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 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. Observe the number of vehicles running on road and classify them according to different bases.
b. Collect the data of any three vehicles of same category and compare them.
c. Collect the data of Indian Motor vehicle manufacturers and their products and write a report on it.
d. Collect the data of different types of clutches commonly used in vehicles and compare it.
e. Collect the different types of universal joints from scrap/garage and write report with their comparison.
f. Identify the advance systems used in modern vehicle and prepare report on it.
g. Prepare cut-section models of any one used transmission system component/assembly.
h. Collect the data of different types of tyres from market and compare it.
i. Collect the different types of tyre tread sections and demonstrate their applications.
j. Prepare display boards or charts for clutch, gear box, propeller shaft and universal joints, differential and types of rear axle, wheels and tyres etc.

13. SUGGESTED LEARNING RESOURCES:

S. No.	Title of Book	Author	Publication
1	Automobile Engineering	Gupta, R. B.	Satya Pralkashan, New Delhi, 2010 ISBN-13: 9788176843799
2	Automobile Engineering	Gupta K. M.	Umesh Publication, New Delhi, 2011, ISBN-13: 5551234002614
3	Automobile Engineering	Jain, K.K.; Asthana, R.B.	TATA McGraw Hill Publications, New Delhi, 2015, ISBN-007044529X, 97800705291.
4	Automobile Engineering	Narang, G.B.S	Khanna Publishers, New Delhi, 2012, ISBN-13: 1234567144518
5	Automobile	Singh, Kirpal	Standard Publishers distributors, New

S. No.	Title of Book	Author	Publication
	Engineering Vol. II		Delhi, 2009, ISBN-13: 978-8180142062
6	Automotive Mechanics	Srinivasan, S.	Tata McGraw-Hill Education – 2nd Edition, 2003, ISBN 13: 9780070494916
7	Motor Automotive Technology	Schwaller, Anthony E.	Delmar Publishers Inc. New Delhi, 2009, ISBN-13: 978-0827351004
8	Automotive Mechanics	Crouse, William H; Anglin Donald L	McGraw Hill Education (India) Pvt. Ltd. 2006 ISBN 13: 9780070148604
9	Automobile Mechanics	Giri, N. K.	Khanna Publishers, New Delhi, 8th Edition, 2008, ISBN: 9788174092168
10	Basic Automobile Engineering	Nakra, C. P.	Dhanpat Rai Publication Co. (P) Ltd., New Delhi, 2009, ISBN-13: 9788187433224

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=H7Iay0Ke_t4-For Clutch
b. https://www.youtube.com/watch?v=OQ9eI7mEmxw-For Clutch
c. https://www.youtube.com/watch?v=F8W5hp1Y2XE-For Synchromesh Gear box
d. https://www.youtube.com/results?search_query=Differential+
e. https://www.youtube.com/results?search_query=Rear+axle

Program Name : **Mechanical Engineering & Automobile Engineering Program**

Program Code : **AE/ME**

Semester : **Third**

Course Title : **Basic Electrical & Electronics Engineering**

Course Code : **22310**

1. RATIONALE

Diploma engineers (also called technologists) passouts have to deal with electrical and electronics engineering principles and applications in industrial processes of different fields. It is therefore necessary for them to apply the principles of electrical and electronics engineering. This course will make them conversant with electrical / electronic engineering aspects of manufacturing, production, fabrication, automobile and mechanical engineering based processes in industries.

2. COMPETENCY

This course is to be taught and implemented with the aim to develop in the student, the course outcomes (COs) leading to the attainment of following industry identified competency expected from this course:

- **Use electrical and electronic equipment safely in mechanical engineering applications.**

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. Use principles of electric and magnetic circuits to solve engineering problems.
b. Determine voltage and current in A.C. circuits.
c. Connect transformers and electric motors for specific requirements.
d. Identify electronic components in electric circuits.
e. Use relevant electronic components safely.
f. Use relevant electric/electronic protective devices safely.

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
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.

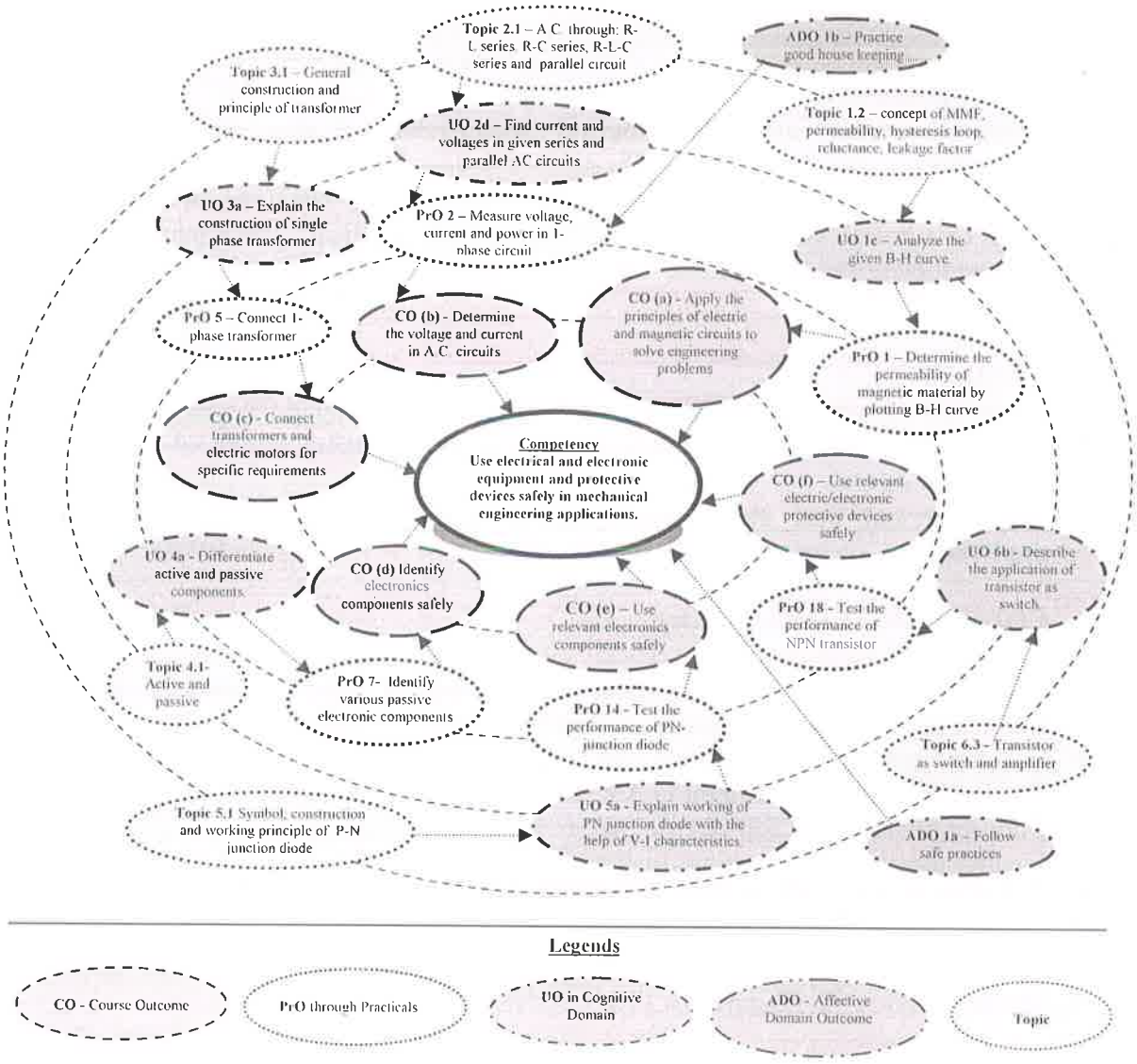

Figure 1 - Course Map

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	Determine the permeability of magnetic material by plotting its B-H curve.	I	02*
2	Measure voltage, current and power in 1-phase circuit with resistive load.	II	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
3	Measure voltage, current and power in R-L series circuit.	II	02*
4	Determine the transformation ratio (K) of 1-phase transformer.	III	02
5	Connect single phase transformer and measure input and output quantities.	III	02
6	Make Star and Delta connection in induction motor starters and measure the line and phase values.	III	02
7	Identify various passive electronic components in the given circuit	IV	02
8	Connect resistors in series and parallel combination on bread board and measure its value using digital multimeter.	IV	02
9	Connect capacitors in series and parallel combination on bread board and measure its value using multimeter.	IV	02*
10	Identify various active electronic components in the given circuit.	IV	02
11	Use multimeter to measure the value of given resistor.	IV	02
12	Use LCR-Q tester to measure the value of given capacitor and inductor.	IV	02
13	Determine the value of given resistor using digital multimeter to confirm with colour code.	IV	02*
14	Test the PN-junction diodes using digital multimeter.	V	02*
15	Test the performance of PN-junction diode.	V	02
16	Test the performance of Zener diode.	V	02
17	Test the performance of LED.	V	02
18	Identify three terminals of a transistor using digital multimeter.	VI	02
19	Test the performance of NPN transistor.	VI	02*
20	Determine the current gain of CE transistor configuration.	VI	02
21	Test the performance of transistor switch circuit.	VI	02
22	Test the performance of transistor amplifier circuit.	VI	02
	Total		**44**

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	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. 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
- 'Organising Level' in 2nd year
- '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	Single Phase Transformer: 1kVA, single-phase, 230/115 V, air cooled, enclosed type.	1,5
2	Single phase auto transformer (Dimmerstat) - Single-Phase, Air cooled, enclosed model, Input: 0 ~ 230, 10A, Output: 0 ~ 270Volts	2,3,4
3	Lamp Bank - 230 V 0-20 A	17
4	Single phase Induction motor – ½ HP,230 V,50 Hz, AC supply	5
5	Different types of starters	6
6	Digital multimeter , 3and ½ digit, seprate range for resistancs and capacitance,component tester, AC and DC measurement.	7,8,11,13, 14,15,16
7	Dual trace CRO/DSO, 50MHz.	4,5,19, 20
8	Function generator,:0-2MHz. for generation of Sin ,square, pulse and triangular wave shapes	17,21,22
9	LCR-Q Meter/Tester	12

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
	Electrical Engineering	
Unit – I Electric	1a. Explain the given technical terms related to electric and	1.1 EMF, Current, Potential Difference, Power and Energy.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
and Magnetic Circuits	magnetic circuits. 1b. Intrepret the given B-H curve. 1c. Intrepret hysteresis loop of the given material. 1d. Apply Fleming's right hand rule and Lenz's law for determination of direction of induced emf in the given situation.	1.2 M.M.F, magnetic force, permeability, hysteresis loop, reluctance, leakage factor and B-H curve. 1.3 Analogy between electric and magnetic circuits. 1.4 Electromagnetic induction, Faraday's laws of electromagnetic induction, Lenz's law, Dynamically induced emf. 1.5 Statically induced emf.-(a) Self induced emf (b) Mutually induced emf; Equations of self and mutual inductance.
Unit– II A.C. Circuits	2a. Explain attributes of the given AC quantities. 2b. Find currents and voltages in the given series and parallel AC circuits. 2c. Derive the current and voltage relationship in the given star and delta connected circuits 2d. Determine the current and voltage in the given star and delta connection. 2e. Solve simple numerical problems related to the given AC circuits.	2.1 Cycle, Frequency, Periodic time, Amplitude, Angular velocity, RMS value, Average value, Form Factor , Peak Factor, impedance, phase angle, and power factor. 2.2 Mathematical and phasor representation of alternating emf and current; Voltage and Current relationship in Star and Delta connections. 2.3 A.C. in resistors, inductors and capacitors; A.C. in R-L series, R-C series, R-L-C series and parallel circuits; Power in A. C. Circuits, power triangle.
Unit– III Transformer and single phase induction motors	3a Explain with sketches the construction and working principle of the given type of single phase transformer. 3b Explain with sketches the working principle of the given Autotransformer. 3c Describe with sketches the the construction of the given single phase motor. 3d Explain with sketches the working principle of the given single phase induction motors.	3.1 General construction and principle of different type of transformers, Emf equation and transformation ratio of transformers. 3.2 Auto transformers. 3.3 Construction and Working principle of single phase A.C. motor. 3.4 Types of single phase motors, applications of single phase motors.
	Electronics Engineering	
Unit – IV Electronic Components	4a. Differentiate between the given active and passive electronic components. 4b. Calculate value of the given	4.1 Active and passive components; Resistor, capacitor, inductor symbols, colour codes, specifications.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
and Signals	resistor and capacitor using colour code. 4c. Explain the given signal parameters with sketches. 4d. Identify the given type of ICs based on the IC number.	4.2 Voltage and Current Sources. 4.3 Signals: waveform (sinusoidal, triangular and square), time and frequency domain representation, amplitude, frequency, phase, wavelength. 4.4 Integrated Circuits – analog and digital.
Unit– V Diodes and Applications	5a. Explain with sketches the working of the given type of diode usiing V-I characteristics. 5b. Locate the zener voltage on the given V-I characteristic with justification. 5c. Explain with sketches the working of the given type of rectifier using circuit diagrams. 5d. Justify selection of power supply and LEDs for the given circuit.	5.1 P-N junction diode: symbol. construction , working and applications. 5.2 Zener diode: working, symbol, voltage regulator. 5.3 Rectifiers: Half wave, Full wave and Bridge Rectifier, Performance parameters: PIV, ripple factor, efficiency. 5.4 Filters: circuit diagram and working of 'L', 'C' and 'π'' filter 5.5 Light Emitting Diodes: symbol, construction, working principle and applications.
Unit– VI Bipolar Junction Transistor	6a. Explain with sketches the the application of the given type of transistor as a switch. 6b. Determine the current gain of the given type of transistor configurations using transfer characteristic curve. 6c. Compare the performance of the given transistor configurations. 6d. Select the type of transistors and their configurations for the given application.	6.1 BJT: symbol, construction and working principle. 6.2 Transistor as switch and amplifier. 6.3 Input and Output characteristics: CE, CB and CC configurations. 6.4 Operating regions: Cut-off, saturation and Active. 6.5 Transistor parameters: CB gain α, CE gain β, input resistance, output resistance, relation between (α) and (β).

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
	Electrical Engineering					
I	Electric and Magnetic Circuits	08	02	02	04	08
II	A.C. Circuits	10	02	04	06	12
III	Transformer and single phase		04	06	06	16

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
	induction motors					
	Electronics Engineering					
IV	Electronic components and Signals	10	02	04	06	12
V	Diodes and applications	10	02	04	06	12
VI	Bipolar Junction Transistor	12	02	04	04	10
Total		**64**	**14**	**24**	**32**	**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. Make star delta connections of transformer.
b. Connect the various meters to measure the current and voltage of induction motor.
c. Visit site and interpret the name plate ratings and identify the parts of a transformer.
d. Present seminar on any of the above or relevant topic.
e. Conduct market survey and interpret the name plate ratings and identify the parts of an induction motor.

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. Use Animations to explain the construction and working of electrical machines.

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. **Electric and magnetic circuit**: Each batch will prepare a coil without core. Students will note the deflection of galvanometer connected across the coil for: movement of the North Pole of permanent magnet towards and away from the coil (slow and fast movement), movement of the South Pole of permanent magnet towards and away from the coil (slow and fast movement). Students will demonstrate and prepare a report based on their observations. (**Duration: 8 hours**)

b. **Transformer**: Each batch will visit nearby pole mounted sub-station and prepare a report based on the following points:
   i. Rating: kVA rating, primary and secondary voltage, connections
   ii. Different parts and their functions
   iii. Earthing arrangement

c. **Single phase induction motor:** Each batch will select a three phase squirrel cage type induction motor for a particular application (assume suitable rating). They will visit local electrical market (if the market is not nearby you may use the Internet) and prepare a report based on the following points:
   i. Manufactures
   ii. Technical specifications
   iii. Features offered by different manufacturers
   iv. Price range

d. **Transistor as a switch:** Each batch (3-4 students) will search and study datasheet of transistor and relevant component and will build / test transistor switch circuit on breadboard/General purpose PCB for various input signal.

e. **Prepare display boards consisting of electronic components**: Each batch (3-4 students) will prepare display boards/ models/ charts/ Posters to visualize the appearance of electronic active and passive components.

f. **Diode:** Build a circuit on general purpose PCB to clamp a waveform at 3.0V using diode and passive components.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Basic Electrical Engineering	Mittle and Mittal	McGraw Education, New Delhi, 2015, ISBN : 978-0-07-0088572-5
2	Fundamentals of Electrical Engineering	Saxena. S. B. Lal	Cambridge University Press, latest edition ISBN : 9781107464353
3	Electrical Technology Vol – I	Theraja, B. L.	S. Chand publications, New Delhi, 2015, ISBN: 9788121924405

S. No.	Title of Book	Author	Publication
4	Electrical Technology Vol – II	Theraja, B. L.	S. Chand publications, New Delhi, 2015, ISBN: 9788121924375
5	Basic Electrical and Electronics Engineering	Jegathesan, V.	Wiley India, New Delhi, 2015 ISBN : 97881236529513
6	A text book of Applied Electronics	Sedha, R.S.	S.Chand ,New Delhi, 2008 ISBN-13: 978-8121927833
7	Electronics Principles	Malvino, Albert Paul, David	McGraw Hill Eduction, New Delhi, 2015, ISBN-13: 978-0070634244
8	Principles of Electronics	Mehta, V.K. Mehta, Rohit	S. Chand and Company, New Delhi, 2014, ISBN-13-9788121924504
9	Fundamental of Electronic Devices and Circuits	Bell Devid	Oxford University Press, New Delhi 2015 ISBN : 9780195425239

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. en.wikipedia.org/wiki/Transformer
b. www.animations.physics.unsw.edu.au//jw/AC.html
c. www.alpharubicon.com/altenergy/understandingAC.htm
d. www.electronics-tutorials
e. learn.sparkfun.com/tutorials/transistors
f. www.pitt.edu/~qiw4/Academic/ME2082/Transistor%20Basics.pdf
g. www.technologystudent.com/elec1/transis1.htm
h. www.learningaboutelectronics.com/
i. www.electrical4u.com

Program Name : **Diploma in Automobile Engineering**

Program Code : **AE**

Semester : **Third**

Course Title : **Automobile Engineering Drawing**

Course Code : **22023**

1. RATIONALE

Automobile engineering technologists, irrespective of their field of operation in an automobile industry, is expected to possess a thorough understanding of drawing, which includes clear visualization of objects and automobile components with the proficiency in reading and interpreting variety of production drawings. Besides, they are also expected to possess drafting skills depending upon job function, to perform day to day activity i.e. communicating and discussing innovative ideas and concepts with supervisors and passing on instructions to subordinates unambiguously. This course is enhancing the knowledge and skills acquired in the earlier two courses viz. Engineering Graphics & Engineering Drawing.

2. COMPETENCY

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

- Prepare drawings of automobile components using conventional drawing instruments and standards.

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. Draw development of lateral surface of various solids.
b. Draw intersection curves of different solids used in the field of automobile engineering.
c. Draw production drawings used to produce products.
d. Draw assembly and detailed drawings of products.
e. Use various drawing codes, conventions and symbols as per IS SP-46.

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
1	-	4	5	--	--	--	--	--	--	--	50@	20	50~	20	100	40

(#):No theory Exam; (~[2]): For the courses having ONLY practical examination, the PA has two parts – marks for ~[2] (i) practical part - 30 marks (60%) (ii) micro-project part – 20 marks (40%).

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.

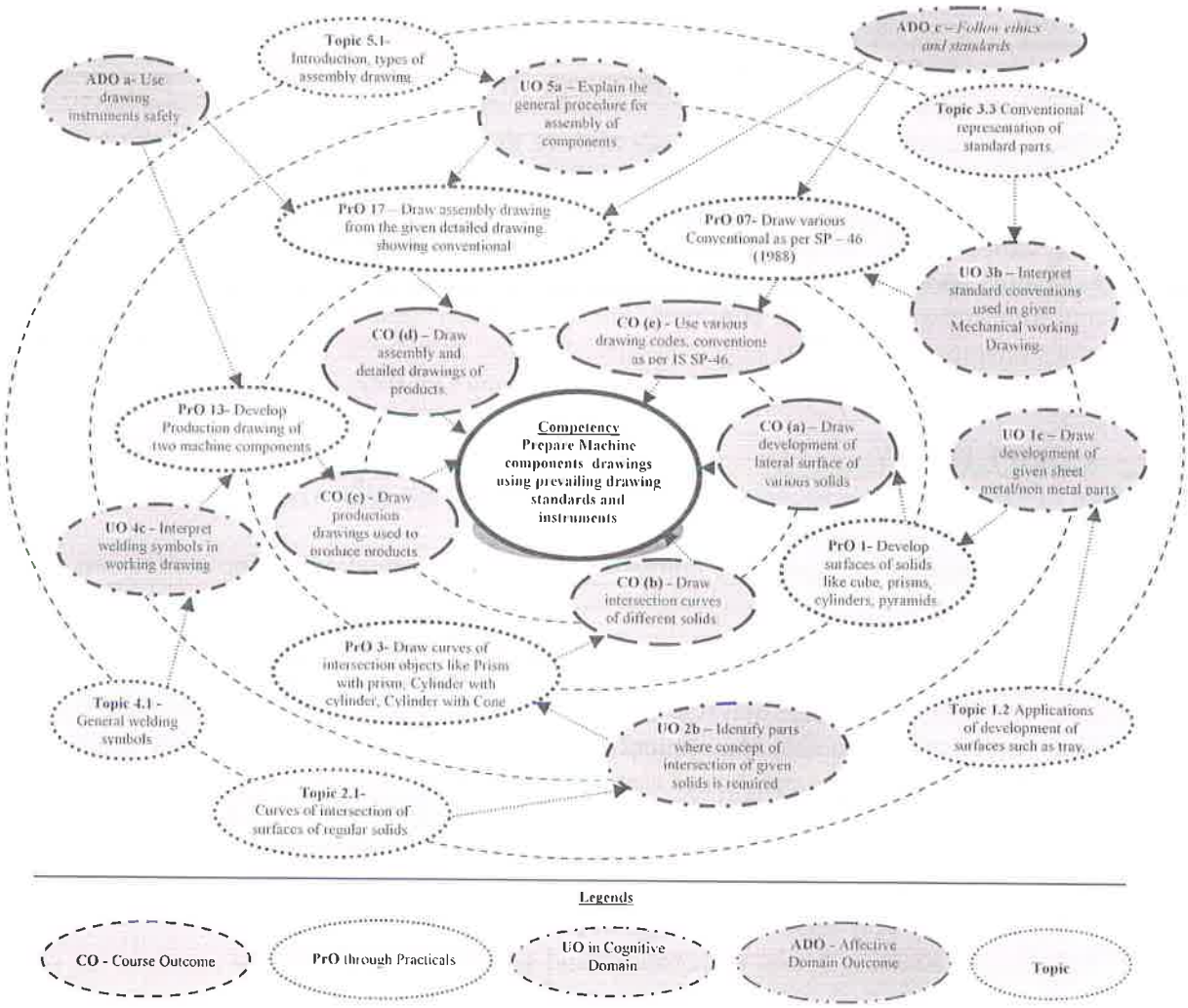

Figure 1 - Course Map

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
Sheet No.:1			
1	Develop surfaces of solids like cube, prisms, cylinders, pyramids. (Part I)	I	02*
2	Develop surfaces of solids like pyramids, cones. (Part II)		
Sheet No.:2			
3	Draw curves of intersection of any two objects like Prism with prism (Tri-angular and square), Cylinder with cylinder, Square	II	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
	Prism with Cylinder, Cylinder with Cone. (Part I)		
4	Draw curves of intersection of any two objects like Prism with prism (Tri-angular and square), Cylinder with cylinder, Square Prism with Cylinder, Cylinder with Cone. (Part II)	II	02
5	Draw curves of intersection of any two objects like Prism with prism(Tri-angular and square), Cylinder with cylinder, Square Prism with Cylinder, Cylinder with Cone. (Part III)	II	02
6	Draw curves of intersection of any two objects like Prism with prism(Tri-angular and square), Cylinder with cylinder, Square Prism with Cylinder, Cylinder with Cone. (Part IV)	II	02
Sheet No.:3			
7	Draw various Conventional Representations as per SP – 46 (1988) (Part I)	III	02*
8	Draw various Conventional Representations as per SP – 46 (1988) (Part II)	III	02
9	Draw various Conventional Representations as per SP – 46 (1988) (Part III)	III	02
Sheet No.:4			
10	Draw Dimensional and Geometrical Tolerances, welding symbols, surface roughness and Machining Symbols on given figures and tables. (Part I)	IV	02*
11	Draw Dimensional and Geometrical Tolerances, welding symbols, surface roughness and Machining Symbols on given figures and tables. (Part II)	IV	02
12	Draw Dimensional and Geometrical Tolerances, welding symbols, surface roughness and Machining Symbols on given figures and tables. (Part III)	IV	02
Sheet No.:5			
13	Develop Production drawing of at least two machine components showing dimensional and geometrical tolerance, surface finish etc. (Part I)	IV	02*
14	Develop Production drawing of at least two machine components showing dimensional and geometrical tolerance, surface finish etc. (Part II)	IV	02
15	Develop Production drawing of at least two machine components showing dimensional and geometrical tolerance, surface finish etc. (Part III)	IV	02
16	Develop Production drawing of at least two machine components showing dimensional and geometrical tolerance, surface finish etc. (Part IV)	IV	02
Sheet No.:6			
17	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (Part I)	V	02*
18	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (Part II)	V	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
19	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (Part III)	V	02
20	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (Part IV)	V	02
21	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (Part V)	V	02
22	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (Part VI)	V	02
23	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (Part VII)	V	02
24	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (Part VIII)	V	02
Sheet No.:7			
25	Draw detailed drawings from given assembly drawing of Rocker arm showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (Part I)	VI	02*
26	Draw detailed drawings from given assembly drawing of Rocker arm showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (Part II)	VI	02
27	Draw detailed drawings from given assembly drawing of Rocker arm showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (Part III)	VI	02
28	Draw detailed drawings from given assembly drawing of Rocker arm showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (Part IV)	VI	02
29	Draw detailed drawings from given assembly drawing of Rocker arm showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (Part V)	VI	02
30	Draw detailed drawings from given assembly drawing of Rocker arm showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (Part VI)	VI	02
31	Draw detailed drawings from given assembly drawing of Rocker arm showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (Part VII)	VI	02
32	Draw detailed drawings from given assembly drawing of Rocker arm showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (Part VIII)	VI	02
	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 judicial 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.	Interpretation of given problem	20
2.	Draw sheet using different drafting instrument	35
3.	Follow line work for neat and accurate drafting	10
4.	Dimensioning the given drawing and writing text	10
5.	Answers to sheet related questions	10
6.	Submit the assigned sheet on time	5
7.	Follow cleanliness and housekeeping in Drawing Hall	5
8.	Attendance and punctuality	5
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. Use drawing instruments safely.
b. Practice cleanliness and neatness.
c. Follow ethics and standards.

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
- '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 administrators.

S. No.	Equipment Name with Broad Specifications	PrO. Unit.No.
1.	Drawing Table with Drawing Board of Full Imperial/ A1 size	All
2.	Paper Models of objects for development of Lateral surfaces of solid	01, 02
3.	Models of solids showing intersection curves	03 to 06
4.	Models of machine components for conventional representation	07 to 09
5.	Actual assemblies mentioned in unit V	13 to 32
6.	Set of various production drawings being used by industries	All
7.	Specimen library of various machine components	All
8.	Set of drawings sheets mentioned in section 6.0 could be developed by experienced teachers and made available on the MSBTE portal to be used as reference/standards	All

S. No.	Equipment Name with Broad Specifications	PrO. Unit.No.
9.	Drawing equipment's and instruments for class room teaching-large size: a. T-square or drafter (Drafting Machine) b. Set squares (45^0 and 30^0- 60^0) c. Protractor Drawing instrument box (containing set of compasses and dividers)	All
10.	Interactive board with LCD overhead projector	All

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 Development of Surfaces	1a. Identify parts where concept of development of the given surfaces is required. 1b. Describe the procedure to draw development of lateral surfaces of the given solid. 1c. Describe the procedure to draw development of given sheet metal/non metal parts.	1.1 Developments of Lateral surfaces of cube, prisms, cylinder, pyramids, cone. (Parallel and Radial Line methods) 1.2 Applications of development of surfaces such as tray, funnel.
Unit-II Intersection of Solids	2a. Identify parts where concept of intersection of the given solids is required. 2b. Describe different methods of Intersection of surfaces of solids 2c. Describe the procedure to draw curves of intersection of the given solid combinations.	2.1 Method of Intersection of surfaces of two solids: Line Method, Cutting Plane Method. 2.2 Curves of intersection of surfaces of the regular solids in the following cases: Prism with prism(Tri-angular and square), Cylinder with cylinder, Square Prism with Cylinder when (i) the axes are at 90° and intersecting. (ii) The axes are at 90° and Offset. 2.3 Cylinder with Cone: when axis of cylinder is parallel to both the reference planes and cone resting on base on HP with axis intersecting and offset from axis of cylinder.
Unit– III Conventional Representation	3a. Use IS SP-46 (1988) codes. 3b. Interpret standard conventions used in the given mechanical working drawing. 3c. Select the standard	3.1 Conventional breaks in pipe, rod and shaft. 3.2 Conventional representation of common features like slotted head, radial rib, knurling, serrated shaft, splined shaft, ratchet and pinion, repeated parts, square on shafts, holes on circular pitch, internal

	conventions in practice for the given situation.	and external thread. 3.3 Conventional representation of standard parts like ball and roller bearing, keys, gears, springs. 3.4 Pipe joints and valves. 3.5 Counter sunk and Counter bored holes. 3.6 Tapers (As per standard conventions using IS SP – 46 (1988)
Unit– IV Conventional Representation and Production Drawings	4a. Calculate tolerances of the given machine components. 4b. Identify fit required between mating parts of the given machine components based on the given tolerance values. 4c. Interpret welding symbols in the given working drawing. 4d. Interpret surface roughness characteristics from the values the given on component drawing. 4e. Describe the procedure to draw above conventional representations for the given situation.	4.1 Limits, Fits and Tolerances: a) Definitions, introductions to ISO system of Tolerance. b) Dimensional tolerances:-Terminology, selection and representation of dimensional tolerance- number and grade method. Definitions concerning Tolerance and Limits system, unilateral and bilateral tolerance, Hole and shaft base systems, Types of fits- Clearance, transition and Interference, Selection of fit for engineering applications. Calculation of limit sizes and identification of type of fit from the given sizes like Ø50 H7/s6, Ø30 H7/d9 etc. 4.2 Geometrical Tolerances: Types of geometrical tolerances, terminology for deviation, Tolerances of form and position and its geometric representation. Tolerance frame, datum feature, magnitude of tolerance and symbol, representation and interpretation of geometrical tolerance on drawing. 4.3 General welding symbols, length and size of weld, surface contour and finish of weld, all round and site weld, symbolic representation in Engineering practices and its interpretation. 4.4 Machining symbol and surface texture: Indication of machining symbol showing direction of lay, sampling length, roughness grades, machining allowances, manufacturing methods. Representation of surface roughness on drawing.
Unit– V Details to Assembly	5a. Explain the general procedure for assembly of components. 5b. State details of components and the sequence of components	5.1 Introduction, types of assembly drawing, accepted norms to be observed for assembly drawings, sequence for preparing assembly drawing. Bill of Material. Assembly drawings of: a) Couplings - Universal couplings

	of the given assembly. 5c. Describe the procedure to draw assembly drawing from the given detailed drawing.	b) Bearing –Pedestal Bearing c) Tool Post – Lathe Square tool post. d) Screw Jack e) Drilling Jig
Unit– VI Assembly to Details	6a. Identify various components in the given assembly and the sequence of dismantling it. 6b. Describe the procedure for dismantling the assembly into components. 6c. Describe the procedure to draw detailed drawing from the given assembly drawing.	6.1 Basic principles of process of dismantling the assembly into components. 6.2 Details of following assemblies a) Non - Return Valve b) Piston & connecting rod assembly, c) Single plate clutch assembly d) Rotary Gear pump. e) Fuel injector.

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

-Not applicable-

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. Student should maintain a separate A3 size sketch book which will be the part of term work and submit it along with drawing sheets. Following assignment should be drawn in the sketch book
   i. Minimum 5 problems each on Unit No I and II.
   ii. Convention Representation of material, gear, spring, bearings, internal threads, external threads, welding joints, machining symbol, direction of lays.
b. Students should collect Production drawings from nearby workshops/industries and try to visualize the part from the given views.
c. Prepare paper models of development of lateral surfaces of solids
d. Visit any sheet metal workshop and prepare a report related to type of components, dimensions, material, area of application, raw material required, name of operations performed.
e. Prepare clay/ paper models of solids showing curves of intersection.
f. Each student should explain at least one problem for construction and method of drawing in sheet to all batch colleagues.
g. Each student will assess at least one sheet of other students (May be a group of 5-6 students identified by teacher can be taken) and will note down the mistakes committed by them. Student will also guide the students for correcting the mistakes, if any.
h. Student to make assembly and dismantling physically of at least one automobile assembly.

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 deeper understanding of the subject.
h. Observe continuously and monitor the performance of students during practice.
i. Arrange visit to nearby industries and workshops for understanding various production drawings.
j. Show video, animation films, solid modeling software to explain intersection of solid, Assembly and details
k. Prepare wall charts for Dimensional and Geometrical Tolerances.

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. Visit nearby fabrication workshop and prepare report on various types of welding symbols used for fabrication work.
b. Visit nearby process industries like sugar factory, chemical industries etc and prepare report representing conventional representation of various piping joints.
c. Visit Institute's Power engineering Lab and prepare detailed drawings of Various IC Engine components using proper measuring instruments.
d. Visit Institute's workshop and prepare assembly drawing and working drawing of machine vice/ lathe tailstock/ tool post etc.
e. Create models showing types of fits.
f. Any other micro-projects suggested by subject faculty on similar line.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Machine Drawing	Bhatt N.D., Panchal V.M.	Charotar Publishing house pvt ltd., Anand, Gujarat, 2013, ISBN 9789380358635
2	Engineering Drawing practice for schools and colleges IS:SP- 46	Bureau of Indian standard	BIS, New Delhi, Third reprint, Octomber 1998 ISBN 8170610912
3	Production Drawing	Narayanan L.K., Kannaich P., VenkatReddy K.	New Age International Publication, New Delhi, 2009, ISBN: 9788122435016
4	Engineering Drawing	Bhatt N.D.	Charotar Publishing house pvt ltd. Anand, Gujarat, ISBN:9789380358178
5	A text book of Machine Drawing	Gill P.S.	S.K.Kataria and Sons, New Delhi,2007, ISBN: 9789350144169
6	Machine Drawing	Sidheshwar	McGraw Hill, New Delhi, 2009, ISBN : 9780074603376
7	Machine Drawing	Ajeet Singh	McGraw Hill Education, New Delhi, ISBN No.: 007065992-3
8	Engineering Drawing	Basant Agrawal, C.M. Agrawal	McGraw Hill Education, New Delhi 2009, ISBN No. 978-00-7066-863-8

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. sketch up 7 software for solid modelling
b. http://www.weldingtechnology.org
c. http://www.newagepublishers.com
d. Engineering graphics and Drawing v 1.0 from cognifront
e. http://www.youtube.com/watch?v=o1YPja2wCYQ
f. http://www.youtube.com/watch?v=9AGD4tihjCg&feature=plcp
g. http://www.youtube.com/watch?v=n65NU32inOU
h. http://www.youtube.com/watch?v=tyRVsSsNiUQ
i. http://www.youtube.com/watch?v=_M5eYB6056M
j. http://www.youtube.com/watch?v=UyROI-bAMu4
k. http://www.youtube.com/watch?v=eix8xbqb93s
l. http://www.youtube.com/watch?v=kWOl6ttDTBc
m. http://www.youtube.com/watch?v=gJbrO2jtoa8&feature=related
n. http://www.youtube.com/watch?v=PXgkBadGHEE
o. Engineering Graphics & Drawing v 1.0 from Cognifront