CURRICULUM REVISION PROJECT

2012

TEACHER GUIDE FOR

(Design of Automobile Components (17525))

FIFTH SEMESTER AUTOMOBILE ENGINEERING GROUP

JUNE 2014

MAHARASHTRA STATE
BOARD OF TECHNICAL EDUCATION, Mumbai
(Autonomous) (ISO 9001:2008) (ISO/IEC 27001:2005)

1. APPROACH TO CURRICULUM DESIGN

1.1 Background:

MSBTE is introducing the revised curriculum under 'G' scheme from the academic year 2012-13.

There are many institutions in the state running different diploma courses. In order to ensure uniform and effective implementation of the curriculum it is necessary that every teacher is aware of approach for curriculum design, educational principles to be adopted, learning resources to be used and evaluation methods. The teacher guide prepared for each subject will provide the inputs related to above mentioned aspects to achieve uniform and effective implementation of curriculum of various subjects.

1.2 CURRICULUM PHILOSOPHY

MSBTE has adopted systems approach while designing the scientific based curriculum since 1995. The same approach has been adopted while revising the curriculum in semester pattern.

Fig. No. 1 shows the systems diagram. This diagram provides the holistic view for curriculum designing, development, implementation and evaluation

The input to polytechnic education system is the students having 10+ qualifications. The teaching learning process occurs in the institution for six/eight semesters. The output of the system i. e. Diploma pass out is normally the input to industries. (Some students do go for higher education). While designing the curriculum the expectations of the industries play a major role. Due to globalization and competition the industries expect that pass outs have generic and technological skills along with right attitude.

To fulfill the needs derived from systems approach following conceptual framework is considered:

1.3 Curriculum:

"Curriculum is an educational program designed and implemented to achieve specified educational objectives"

This definition takes into account the fact that

- Education is purposeful
- There is an organized plan of action contemplated
- Such a plan is translated into action through appropriate strategies of implementation.

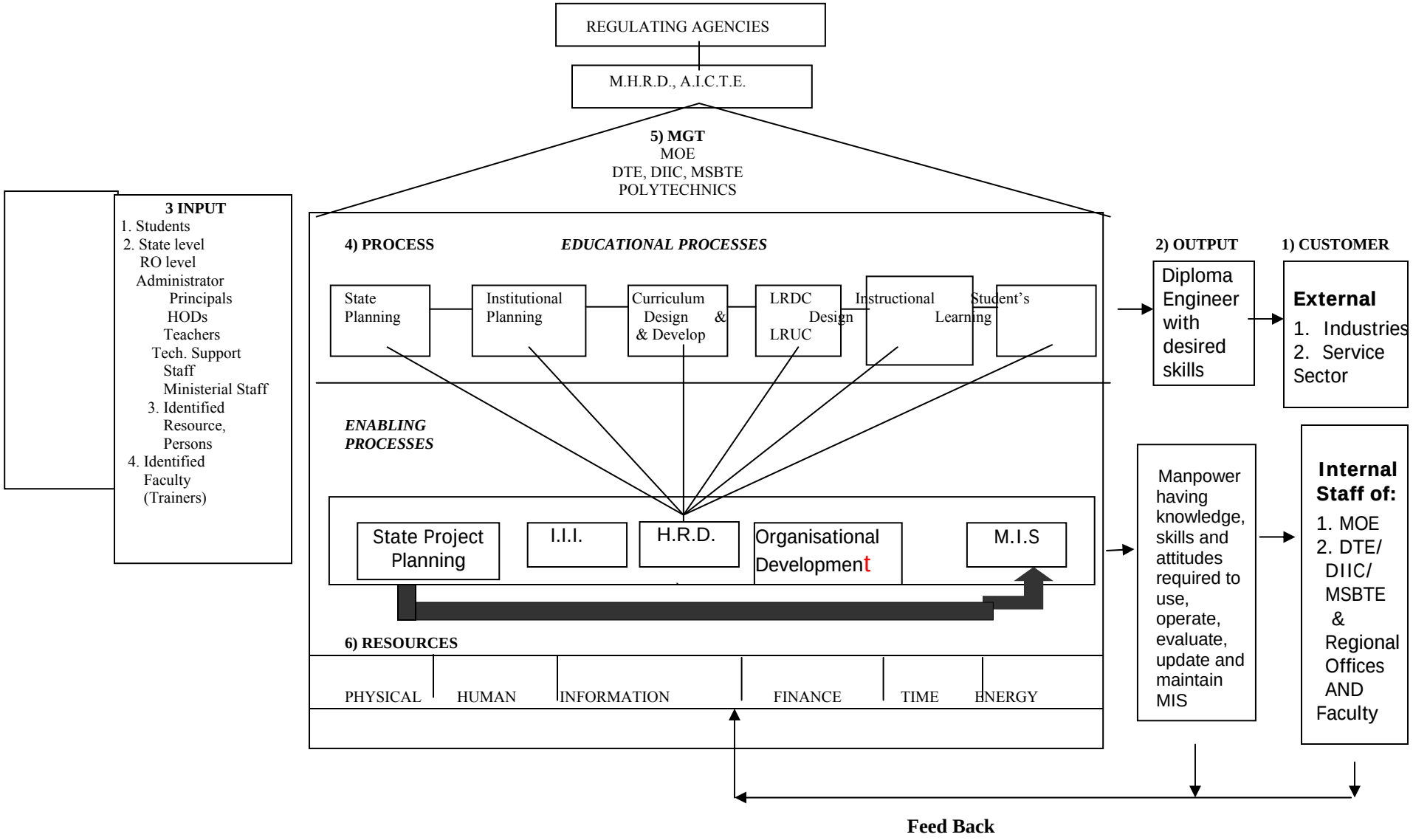


Fig 1 Systems Approach

1.4 Curriculum goals

1. To develop l. confidence in students by providing more exposure to industry experience and world of work at global leve
2. To provide conceptual knowledge and develop analytical ability
3. To develop communication skill with good English by providing sufficient practice
4. To enhance latest technical knowledge industry interaction and media
5. To develop learning to learn skills and life skills to cope up with industrial culture
6. To impart managerial skills by providing appropriate theoretical inputs
7. To develop problem solving ability through technical projects.

1.5 DESIRED SKILLS

Industries expect from the diploma engineer the abilities and skills of general nature and specific to the job performance. The curriculum aims at developing life skills and technological skills so that the diploma pass outs would be suitable for industry. The skills are listed below:

Life Skills:

- Search information from various sources
- Develop communication ability
- Develop Presentation skill
- Work as a member of a team/group and as leader
- Collect field data
- Develop Learning to learn
- Write report for given task/work/project
- Develop computer proficiency
- Develop observation skills

Technological Skills:

Diploma engineers should possess following intellectual and motor skills in order to satisfactorily perform duties assigned to them. It is required that each group should put the skills as identified in Scheme G.

A) Intellectual skills.

1. Read and interpret Automobile Engineering drawings.
2. Prepare estimates and bill of quantities.
3. Carryout Automobile engineering survey.
4. Design simple Automobile engineering structures.
5. Prepare tender documents.
6. Plan, execution of various construction activities.
7. Test engineering materials, prepare reports and interpret them.
8. Use various Automobile engineering software.
9. Follow various standards and codes.
10. Maintain records in various formats.
11. Carry out Automobile maintenance.
12. Prepare various Automobile plans as per requirements by using appropriate byelaws.
13. Supervise assembly work.
14. Select appropriate technique for quality control.

B) Motor Skills.

1. Prepare manual and Computer generated Automobile engineering drawings.
2. Use survey instruments, plot survey data and prepare drawings.
3. Handle testing of equipments.
4. Lay out of Automobile engineering structures.
5. Draw free hand sketches of Automobile engineering structures.

1.6 Salient Changes in the curriculum:

- For First Semester Basic Science is divided into two parts- Basic Physics and Basic Chemistry. Theory examination of both parts as well as practical examination of both parts will be conducted on separate days. Sum of theory marks of both parts shall be considered for passing theory examination of Basic Science. Similarly it is applicable to practical examination. It is mandatory to appear for theory and practical examination of both parts. Candidate remaining absent in any examination of any section will not be declared successful for that exam head.

- For second semester Applied Science is divided into two sections- Applied Physics and Applied Chemistry where the theory examination of 50 marks each and practical examination of 25 Marks each will be conducted separately and the minimum passing marks for Applied Science will be the combination of both the sections. . It is mandatory to appear for theory and practical examination of both parts. Candidate remaining absent in any examination of any section will not be declared successful for that exam head.
- The components of Development of Life Skills were taught in two semesters. In Development of Life Skills –I the topics related to personal development, such as Learning to Learn Skills, personality development, presentation skills etc. were included. In Development of Life Skills – II the topics related to Team Building, Leadership, group behavior etc. were covered. In the revised curriculum the scope of development of life skills has been broaden to include behavioral science component. Therefore the subject Development of Life Skills – II has been renamed and it is now included at Vth Semester in the revised curriculum under the title Behavioral Science.
- The subject of Professional Practices was introduced to integrate the skills acquired in Development of Life Skills, through technical subjects from second to sixth semester. The experience in implementing the contents of the subject shows that there are limited activities possible in second semester as the technical knowledge given to the students is very limited. Also at sixth semester the student are doing projects in which they are performing many activities included in the Professional Practices and therefore it is proposed that the subject of Professional Practices be prescribed only for three semesters vis. Third, fourth and fifth semesters.
- Introduction of Environment Studies at fourth Semester for all courses
- From the experience of implementation of Elective Subjects at V and VI semesters in last five years, it is proposed to have only one elective at the sixth semester for all courses. However the specialized courses like Medical Electronics, Electronics and Video Engineering will not have provision for electives. For elective, student will have to choose one from the given two/three subjects.
- While revising the curriculum redundant /obsolete topics/sub topics are being replaced by new/advance technology topics/sub topics.

- In Civil Engineering Group CAD and Building Materials have been added as an independent subject. Topics on Airport Engineering and Docks and Harbours have been added in the subject Transportation Engineering.

2. OBJECTIVES

2.1 Introduction

Objectives are the statements which describe the expected learning outcome. Such statements enable teachers to plan instructional process with appropriate resources. These objectives also provide a direction to frame proper questions to assess the learning outcome. During last decade there has been research on cognitive approach in psychology. This approach is based on biological structure of brain and meta-cognitive knowledge dimension. Important elements of this approach which form basics of learning are explained below.

2.2 Domains of Learning:

Learning is a process by which students develop relatively permanent change in mental associations through experience. This is how learning is defined by cognitive psychologists. Behavioral; psychologists define learning as a relatively permanent change in behavior.

There are following domains of learning:

A: Cognitive Domain relates to intellectual skills or abilities

B: Affective Domain relates to emotions, feelings, likes, dislikes etc.

C: Psychomotor Domain relates to manipulative skills of hands, legs. Eye-hand coordination in Engineering & Technology courses, endeavor is made to design curriculum with a focus on development of cognitive skills through classroom teaching. Where as manipulative (psychomotor) skills are developed in workshops, laboratories & seminars where students work individually or in a group. Development of affective skills attitudes and value is supposed to be acquired through projects and co curricular activities. These are also developed from the work culture or institutions.

How far a student has developed these abilities/skills especially from cognitive and psychomotor domains is assessed on the basis of suitable examinations. When classroom and laboratory teaching is viewed in this light, evaluation becomes an integral part of teaching – learning process.

2.3 LEVELS OF LEARNING:

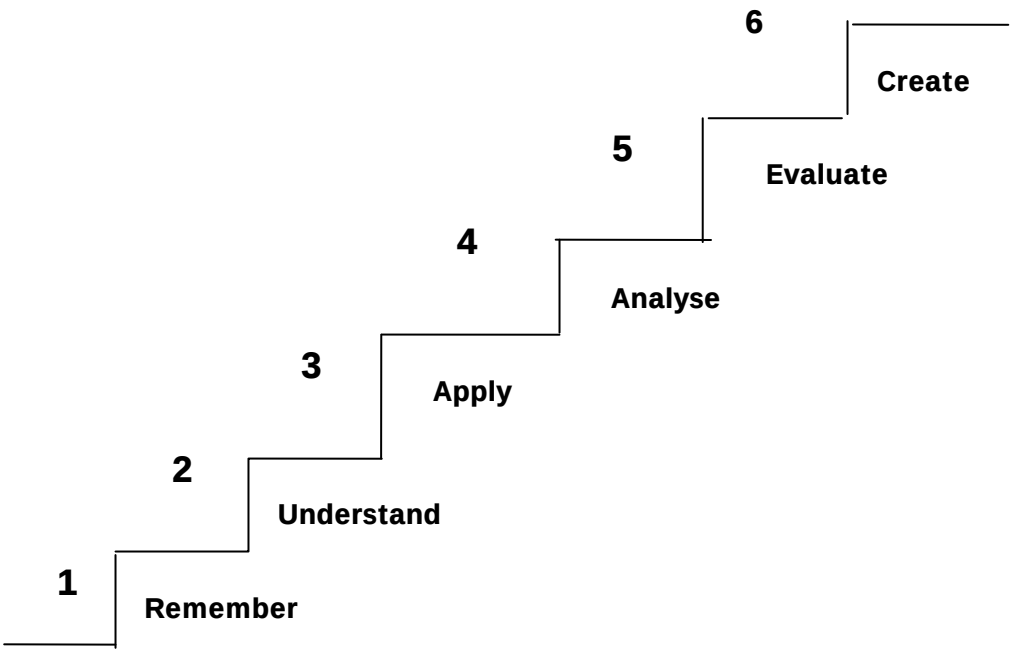
Question paper is a tool/ instrument designed to test the extent of learning of the student. Various questions set in a question paper should assess the abilities of students to respond to level of learning. Dr. Bloom a German educationist classified levels of learning in cognitive domain for the purpose of writing objectives and assessment. Dr. Bloom's revised taxonomy is based on

cognitive psychology and is two dimensional. First dimension is cognitive process dimension ad other is knowledge dimension. Details of these two dimensions are given below.

2.4.1 Cognitive Domain:

Dr. Benjamin Bloom (1956) analysed questions asked in various examinations in American situation and proposed a hierarchical arrangement of instructional objectives (Intellectual abilities) tested by these questions.

The lowest level of cognitive learning achieved by a student is demonstrated by the recall of information that the student retrieves from his long term memory. So, the storage and retrieval of specific facts, concepts, principles, laws, definitions, properties, procedures etc. directly from memory was classified as a knowledge level objective. Thus questions testing memory of students were treated as at the lowest level of the hierarchy of intellectual abilities. The other levels of hierarchy proposed by Dr. Bloom in 1956 relate to the degree of information processing required in the brain needed to provide answer to a question. The various levels in the cognitive hierarchy proposed by Dr. Bloom in 1956 and further revised in 2001 are given below in the diagrammatic form.



Following are the details of each level which indicate the general and specific objectives. Further appropriate verbs are given which are useful in setting good questions. In this table only four levels are considered for diploma students.

Description of the Major Levels in the cognitive Domain (Bloom's Taxonomy)	Illustrative General Instructional Objectives	Illustrative verbs for stating specific learning outcomes
Remember – Knowledge is defined as the remembering of previously learned material. This may involve the recall of a wide range of material, from specific facts to complete theories, but all that is required to mind of the appropriate information. This represents the lowest level of learning outcomes in the cognitive domain	Knows common terms, specific facts, basic concepts, principles, methods & procedures	Define, describe, identify label, list, match, name, outline, reproduce, select, state
Understand – This is defined as the ability to grasp the meaning of material. This may be shown by translating material from one form to another (words or numbers) by interpreting material (explaining or summarizing), and by estimating future trends (predicting consequences or effects). Draw sketches these learning outcomes go one step beyond the simple remembering of material and represent the lowest level of understanding.	Understands fact, principles Interprets verbal material, Interprets charts, tables, graphs. Translates verbal material to mathematical formula. Estimates consequences implied in data. Justifies methods & procedures.	Convert, distinguish estimate, explain, extend, generalize, give examples; infer, paraphrase, predict, rewrite, summarize, draw labeled sketches.
Apply – Application refers to the ability to use learned material in new and concrete situations. This may include the application of such things as concepts, principles, rules, methods, laws and theories. Learning outcomes in this area require a higher level of understanding than those under the level described earlier.	Applies principles to new situations. Applies theories to practical situations. Solves mathematical problem. Construct charts, graphs Demonstrates correct usage of a procedure	Change, compile, demonstrate, discover manipulate, modify operate, predict, prepare, produce, show, solve, use.
Analyze – Analysis refers to the ability to break down material into its component parts so that its organizational structure may be understood. This may include the identification of the parts, analysis of the relationship between parts, and recognition of the organizational principles involved. Learning outcomes here represent a higher intellectual level than "understand" and apply because they require an understanding of both the content and the structural form of the material.	Recognizes unstated assumptions and logical fallacies in reasoning. Distinguishes between facts and inferences. Evaluates relevance/ adequacy of data.	Breakdown, diagram, differentiate, discriminate, distinguish, identify illustrate, infer, outline, point out, relate, select, separate, subdivide.

2.4.2 Categories of Knowledge Dimension

After considering the various designations of knowledge types, especially developments in cognitive psychology that have taken place since the original framework of Bloom's taxonomy, knowledge is categorised in 4 types – Factual , Conceptual, Procedural and Meta-cognitive.

Factual Knowledge (A) is knowledge of discrete, isolated content elements. It includes knowledge of terminology and knowledge of specific details and elements. In contrast,

Conceptual Knowledge (B) is knowledge of "more complex, organised knowledge form". It includes knowledge of classifications and categories, principles and generalizations and theories, models and structures.

Procedural Knowledge (C) is "knowledge of how to do something". It includes knowledge of skills and algorithms, techniques and methods, as well as knowledge of criteria used to determine and/or justify "when to do what" within specific fields and disciplines.

Meta-cognitive knowledge (D) is "knowledge about cognition in general as well as awareness of and knowledge about one's own cognition. It encompasses strategic knowledge, knowledge about cognitive tasks, including contextual and conditional knowledge; and self-knowledge".

Assessment is required to be done on the basis of categories of knowledge and levels of learning. Table below indicates the two dimensional grid based on Blooms Taxonomy for setting questions

Knowledge Dimension	COGNITIVE PROCESS DIMENSION			
	1 Remember	2 Understand	3 Apply	4 Analyze
A. Factual Knowledge				
B. Conceptual Knowledge				
C. Procedural Knowledge				
D. Meta-cognitive Knowledge				

2.5 Components of Curriculum:

2.5.1 Rationale: It indicates the logical basis for the inclusion of the subject in the curriculum It also indicates the importance of the subject related to entire curriculum.

Rationale tells the students the connection of subjects related to study of higher level subjects and also the use in their job/profession.

2.5.2 Objectives: Objectives indicate what the student will be able to do/perform after he/she completes the study of the subject. It also in other words indicates the scope of the subject.

Objectives indicate what is achievable and hence gives direction to the student about how to study the subject, what important things are to be observed and performed during practicals.

Just as rationale indicates the use of the knowledge gained while studing the subject, objectives indicate how efficiently and effectively one can work if the objectives are fulfilled while studying the subject.

2.5.3 Learning Structure: It graphically/pictorially indicates the content of the curriculum of the subject and what is to be learnt in the subject. As you know that Cognitive Domain knowledge is divided in four components as mentioned in the Two dimensional grid. Of this Factual, Conceptual and Procedural knowledge components are identified in the curriculum of the subject along with the applications.
Facts, Concepts, Principles are used in developing procedures and applications. So these are given sequentially below procedure as Principles, Concepts and Facts in their order. Learning structure also provide an idea about how to develop the subject logically to achieve the objectives.

2.5.4 Contents: List of topics and subtopics to be included in the curriculum of the subject is given in the contents. This helps in achieving the rationale and objectives identified. Contents indicate the importance of the topics, sub topics in development of the subject and accordingly weightages in terms of Hours required to teach the subject components, so that the desired learning takes place. Marks to be allotted while testing the knowledge gained by the student are also indicated.

2.5.5 Practicals: While designing the curriculum the objectives are identified. To achieve these objectives students have to develop certain intellectual and motor skills. These skills are developed through well designed Practicals. So in the curriculum the list of the skills to be developed through Practicals is given. The list of Practicals is so developed that after performing the Practicals identified skills will be developed. Here it is necessary that the teacher gives enough opportunity to all the students to perform the practical properly to develop the skills in each one of them.

The skills will be developed if the students actually perform certain activities or tasks. Therefore it is necessary that any practical included in the curriculum necessarily involve some activities to

be done by the students. So one has to think and innovate to modify the study experiments so that students will be asked to perform some activity. It could be in terms of identifying components, listing of materials used for manufacturing the components, stating importance of use of certain materials etc.

So any curriculum of a subject is so designed that it achieves the objectives of that subject as well as fulfill the objectives of the entire curriculum

3. CONTENT ANALYSIS

3.1 Components of Content Analysis:

As we have discussed earlier, any curriculum or syllabus of a SUBJECT given to the teacher is organised in terms of UNITS which include TOPICS or SUB-TOPICS as the case may be indicating the TIME in which it is expected to be taught to the students. Components of a topic or part thereof are analysed here at a micro level.

Before we begin actual teaching of any topic (lesson), we must carefully and critically analyse it so that we can plan for teaching - select appropriate media, methods and techniques of teaching and arrange the suitable resources to be required. This analysis of the content of a Topic results in identification of the following components of the content:

1. Facts
2. Concepts
3. Principles (rules, laws, theories)
4. Applications
5. Procedures
6. Skills (Psychomotor Skills), and
7. Attitudes (underlying affective behaviors as quite often these are not specifically mentioned in the curriculum, still they are to be developed lesson after lesson gradually).

When we undertake the exercise of content analysis, we ourselves understand the subject fully well and at the same time we become clear as to what we are going to teach. It also gives us an idea as to which methods of teaching and media of instruction we should prepare and use and also what resources including time we will require. This analysis will also enable us to design assignments as well as how we are going to assess students learning.

Since the nature of the components of content (1 to 7) differs from one another. These are learned by the students differently as different mental processes are involved in learning these components. The immediate implication of this varying nature of components is that these need to be taught differently and assessed differently. For example, if you look at components I to 5 all of which belong to Cognitive Domain of Learning; Component 6 belongs to Psychomotor Domain and Component 7 belongs to Affective Domain (cannot be taught as these attitudes are caught), you will find that these differ from one another. The classification of human behaviors (activities) into the above three domains of learning entails the use of entirely different methods and media of instruction. Different locations of learning (classroom, laboratories, workshops, field visits) need to be selected.

Now we will discuss these components in some detail and see how each one of these should be taught and assessed differently.

3.1.1 FACTS:

These are universally accepted and commonly understood items about which there cannot be much argument and discussion. These are required only to be informed. For example: The sun rises in east and sets in the west; names of scientists and the year in which their theories were propounded; the rules and regulations of admission and examination prescribed by the University are some of the examples of facts. Sometimes, they need not be emphasised in the class as the students already know them. But information can be passed on by word of mouth, if deemed necessary.

3.1.2 CONCEPTS:

A concept is an abstraction or an idea that permits the learner to classify a variety of related phenomena into a convenient and meaningful category. Concept of something is like a picture formation of that thing which helps in conceptualizing it. Gagne says that concept learning produces a certain fundamental change in human performance that is independent of subject or content. Concepts can be divided into the following two categories:

1. **Concrete Concepts:** those which can be seen, touched and manipulated e.g. house, book, table, chair, cat, dog, any machine or apparatus, overhead projector, chalkboard and duster.

2. Abstract Concepts: those which cannot be seen and touched and handled but can only be imagined e.g. force, work, fractions, decimal, bending moment, moment of inertia, friction, heat, and induction. Teaching of concrete concepts is not that difficult because the teacher can show the object physically or its picture. On the contrary, teaching of an abstract concept offers difficulty to the teacher as well as for students to understand. These concepts can be learned by heart without understanding as children mug up Nursery Rhymes without understanding even a single word. But at the stage of higher tearing, this type of rote learning is not desirable. Adolescents (teenagers) and adults do not accept things without understanding.

3.1.3 Concept Attributes:

We identify a concept and understand it, once we are told about its qualities characteristics, and features. They are technically called concept attributes. While teaching a concept to our students we must spell out as many attributes as possible for better understanding of the concept.

Example: The Concept **of Friction**

Attributes:

1. Friction is a resistive force.
2. Frictional force acts in the direction opposite to the direction of the applied force.
3. Frictional force is more when the surfaces in contact are rough.
4. Smooth surfaces (perfect) have zero friction.
5. Frictional force is self-adjusting to a limit.

Towards the end of this Theme Paper a number of examples of concept attributes are given for your guidance.

The following questions pertaining to a concept (object or process) will be helpful in writing concept attributes:

1. What it is.
2. What are its constituent parts.
3. How it works.
4. How it is similar to and different from other known concepts.
5. What are its uses?

3.1.4 PRINCIPLES:

A principle is a statement of relationship between two or more concepts. Principles are sometimes called rules, laws or generalizations. In others words, relationship between two or more concepts which is scientific and universally true is called a Principle.

For Example: (related concepts are underlined)

1. Actions and reactions are equal and opposite.
2. Ohm's law I = V/R is a principle, where I (Current), V (Voltage), and R (Resistance) are the concepts. While teaching a principle we must recall the concepts which it involves. These concepts might have been taught in the previous lesson. As you already know, concept learning is a prerequisite to Principle learning. Thus we recall the concepts of current, voltage and resistance by asking questions to the students. Only after that we must tell the relationship among these i.e. Ohm's Law.

3.1.5 APPLICATIONS:

Whatever principles, laws and theories have been learned are only academic exercises unless these are applied to solve a practical problem. In other words, we call this application transfer of learning to a new situation. If you recall, the process of learning dealt with in Theme Paper 2, you will appreciate that the litmus test of learning having occurred is its application in a new situation or solving a new problem.

For example:

1. Ohm's law can be applied to find out the unknown quantity (voltage, current, and resistance).
2. Design of a structure can be made based on related principles and theories.
3. Principles of learning and events of instruction can be applied in ‘Designing a lesson Plan' and 'Presenting the lesson in the classroom".
4. The above principles can also be applied while preparing textbooks, workbooks, learning packages and laboratory manuals to be used by the students.

3.1.6 PROCEDURES:

While analysing the content of a topic you might come across certain standard procedures which are prescribed to perform an operation or a given task. These procedures should be

clearly identified and taught accordingly not to be left to chance. We should not pre-suppose that the students understand them. We cannot afford to take these things for granted.

For Example:

1. Procedure of setting up of an apparatus.
2. Procedure to start an engine.
3. Procedure to operate a machine (a lathe).

3.1.7 SKILLS (PSYCHOMOTOR):

A skill is an ability to perform a task expertly and well. The skilled performance; must meet a pre-specified standard of acceptable performance. A skill has the following three characteristics:

1. It represents a chain of motor responses;
2. It involves the co-ordination of hand and eye movements, and
3. It requires the organization of chains into complex response patterns.

Skills could be intellectual (thinking, understanding); interactive (communication skills) and social (socialising, mixing up with others) also. But normally when we use the word skills, it refers to psychomotor skills.

For Example:

1. Welding a butt joint,
2. Setting a theodolite at a station,
3. Making proper circuit connections, and
4. Turning a job on a lathe machine.

Laboratories and workshops of Polytechnics are the locations where these skills are developed among the students under the guidance of expert instructors *of* operators. Drill and practice are the main methods of teaching and learning these skills through model demonstrations and careful observations thereof.

Alongside developing these skills, desirable attitudes like cooperation, team work, leadership, safety, cost consciousness are also developed.

3.2 TEACHING OF CONCEPTS;

In order to teach concepts effectively the following steps have been suggested by De Cecco & Crawford (1974).

Steps Suggested:

1. Describe the performance expected of the student after he has learned the concept.
2. Reduce the number of attributes to be learned in complex concepts and make important attributes dominant.
3, Provide the student with verbal indicators (explanation).
4. Provide positive and negative examples (non-examples) of the concept.
5. Present the examples in close succession or simultaneously.
6. Provide occasions for student responses and the reinforcement of these responses, and
7. Assess the learning of the concept.

3.3 TEACHING OF PRINCIPLES:

De Cecco & Crawford (1974) has suggested the following steps for teaching principles effectively.

Steps:

1. Describe the performance expected of the student after he has learned the principle.
2. Decide and indicate which concepts or principles the students must recall in learning the new principle.
3. Assist the student in the recall of component concepts.
4. Help the student in the recall of component concepts.
5. Help the student to combine the concepts and put them in a proper order.
6. Provide for practice of the principle and for reinforcement of student responses.
7. Assess the learning of the principle.

3.4 CONCLUSION:

To sum up, it can be said that. it is essential for the teachers to develop the skills of 'Content Analysis' of their subjects. It brings content clarity among teachers themselves. More importantly, Content Analysis will be a pre-requisite for writing Instructional Objectives of the topic to be taught. You will study Instructional Objectives in a separate Theme Paper in detail. Teaching and learning process is bound to be effective once these crucial academic activities are undertaken.

4. CURRICULUM:

Course Name : Diploma in Automobile Engineering

Course Code : AE

Semester : Fifth

Subject Title : Design of Automobile Components

Subject Code : 17525

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
03	--	02	04	100	--	25#	25@	150

NOTE:

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).**

Rationale:

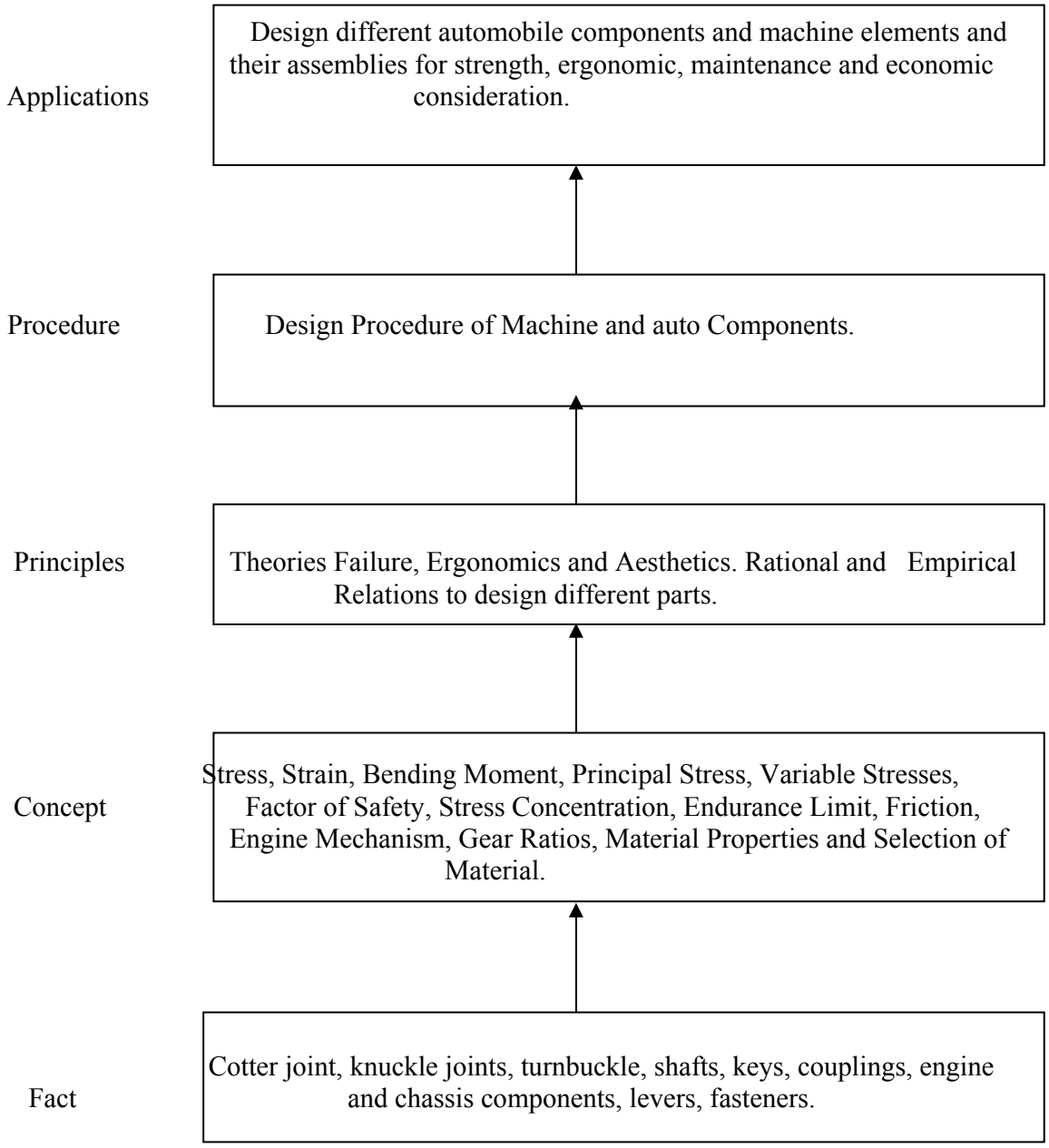
Automobile component design is applied technology subject, which requires knowledge of Mechanisms, Strength of materials, Material sciences- Manufacturing processes and Mechanical engineering drawing. This subject deals with fundamental principles of machine design applied to automobile components. It also gives exposure to standard codes of practices and Use of Design Data Book.

General Objectives:

Student will be able to

1. Analyze the loads, type of induced stresses, resisting areas and hence the modes of failure.
2. Identify and apply modes of failure and relevant theory of failure for problem solving.
3. Analyze practical problems and selection of materials, strength equations, factor of safety, stress concentration factors etc.
4. Know the design process.

Learning Structure:


Applications
Design different automobile components and machine elements and their assemblies for strength, ergonomic, maintenance and economic consideration.
Procedure
Design Procedure of Machine and auto Components.
Principles
Theories Failure, Ergonomics and Aesthetics. Rational and Empirical Relations to design different parts.
Concept
Stress, Strain, Bending Moment, Principal Stress, Variable Stresses, Factor of Safety, Stress Concentration, Endurance Limit, Friction, Engine Mechanism, Gear Ratios, Material Properties and Selection of Material.
Fact
Cotter joint, knuckle joints, turnbuckle, shafts, keys, couplings, engine and chassis components, levers, fasteners.

Theory:

Topic and Content	Hours	Marks
1: Fundamentals of Design. Specific Objectives: ➢ Know the concept and process of engineering design and concept of post design aspect. ➢ Use of design factors. ➢ Select materials for various automobile components. Content: 1.1 Introduction to design 4 Marks • Classification of design (system design, component design, product • design) • Design consideration (Mode of Failure- strength, deformation, fracture, • corrosion and wear) • Design procedure • Types of Load- Actual and design loads. Factors to find design loads such • as service factor, overload factor, velocity factor and factor of safety. • Stress concentration - causes and remedies • Bolts of uniform strength 1.2 Stress analysis:(Revision only) • Types of external loads • Types of induced stresses: tensile, compressive, shear, Crushing and • bearing pressure, bending, torsion, thermal stresses, principal stresses. • Stress – strain diagram for ductile and brittle material and it's use 1.3 Variable stresses in machine parts. 4 Marks • Fatigue and endurance limit, S-N diagrams for variable stresses • Working stresses for static load, variable or fatigue load. • Factor of safety and its selection. 1.4 Introduction to theories of failure. 4 Marks • Maximum principal stress theory. • Maximum shear stress theory. • Distortion energy theory. (Simple numerical only) 1.5 Materials and other considerations in design. 8 Marks • Selection of material for Automobile components and its justifications on • the basis of mechanical, thermal properties, manufacturing, wear • considerations, cost. • Concept of standardization, preferred numbers and interchangeability in • design practice. • Principles of Ergonomics, Aesthetics in designing automobile	**10**	**20**
2: Design of Joints. Specific Objectives: ➢ Find induced stress and resisting area for various cross sections. ➢ Find the dimensions of components of joints Content: • Design of socket and spigot type cotter joint. • Design of knuckle joint • Design of Turn buckle • Applications of above joints in the automobile.	**06**	**12**

3: Design of shafts, keys and Coupling. Specific Objectives: ➢ Differentiate between shaft, axle and spindle ➢ Know design procedure of shaft, keys and couplings. ➢ Understand concept of critical speed and whirling of shaft. Content: 3.1 Shafts and Keys 10 Marks • Types - Transmission, machine, axle, spindle. • Design considerations of shaft –strength, rigidity (lateral and torsional) • Design of propeller shaft, Rear axle. • Concept of whirling and critical speed of the shaft • Types of keys and their applications,, • Design of sunk key. • Effect of keyways on shaft strength. 3.2 Design of couplings- flange, and bush pin type flexible coupling 08 Marks	**08**	**18**
4: Design of levers. Specific Objectives: ➢ Identify various types of levers. ➢ Find the dimensions of components of levers Content: • Types of levers – simple, compound, differential, acute and obtus angle • lever, hand levers and foot pedals. • Design of rocker arm, bell crank lever.	**04**	**08**
5: Design of Chassis Component Specific Objectives: ➢ Calculate diameters of clutch plate ➢ Calculate number of teeth on each gear in the gear box. ➢ Calculate dimension of semielliptical leaf spring. Content: 5.1 Design of clutch 6 Marks • Single plate and Multi plate, using uniform pressure and wear condition. 5.2 Gearbox 6 Marks • Teeth calculation of gears for sliding mesh/constant mesh gear box • Concept of minimum number of teeth on spur pinion 5.3 Leaf Spring 6 Marks • Concept of nipping. • Design of semi elliptical leaf spring.	**08**	**18**
6: Design of engine components Specific Objectives: ➢ Calculate various loads acting on different components of engine and find out their dimensions. Content: 6.1 Cylinder and cylinder head 6 Marks • Data of engine specifications and calculations of cylinder dimensions for • given power. • Design of cylinder head thickness 6.2 Piston 10 Marks • Design of piston crown by bending strength and thermal considerations.	**12**	**24**

• Design of piston rings and skirt length • Design of piston pin for bearing, bending and shear considerations 6.3 Connecting Rod 8 Marks • Design of connecting rod cross -section (I section). • Design of connecting rod small end • Design of big end, cap and bolts.		
Total	**48**	**100**

Practical:
Skills to be developed:

Intellectual Skills:

1. Analyze the loads, resisting areas, types of induced stresses on automobile components
2. Identify the engine and chassis components which may fail due to stress concentration,
3. Calculate the dimensions of automobile components.
4. Identify different engine and chassis components.
5. Identify different fasteners used in automobiles.

Motor Skills:

1. Draw various automobile components as per the designed dimensions.
2. Suggest materials for automobile components.
3. Use design data book to standardize component dimensions.

List of Practical:

1. Design any one joint and coupling for specified data. Select suitable materials and prepare assembly-detail drawings indicating overall dimensions, tolerances, hardness and surface finish. Prepare bill of material.
2. Design of Automobile components:
   a) Engine components: - Piston and connecting rod.
   b) Design of chassis components: - Clutch, Propeller shaft and rear axle, leaf spring for specified data.
   For the above components select suitable materials, prepare drawing indicating overall dimensions, tolerances, hardness and surface finish.
3. Design any one of the following systems: Transmission system, Valve Mechanism, Suspension system.

List of Assignments:

1. Identify and classify the different engine and chassis components according to the type of load to which they are subjected. Also state the types of induced stresses in them.
2. Identify the different engine and chassis components which may fail due to stress

concentration, observe and state remedy to reduce stress concentration

3. Suggest materials with justifications for components like gears, piston, piston rings, leaf springs, cylinder head and engine block, chassis, valves etc.
4. Identify different fasteners used in an automobile, justify their locations.

Learning Resources:

Books:

Sr.No.	Author	Title	Publisher / Edition
1	P.Kannaiah	Machine Design.	Scitech
2	U.C. Jindal	Machine Design.	Pearson Publication
3	PSG Coimbtore	Design data book	PSG Technical Institute
4	R. B Gupta	Auto design	Satya Prakashan
5	K.Ganesh Babu/K. Srithar	Design of machine elements	Tata McGraw Hill
6	B.V.Bhandari	Design of machine elements	Tata McGraw Hill
7	J. E. Shigley	Machine Design	Tata McGraw Hill

5. IMPLEMENTATION STRATEGY:

5.1 Planning of Lectures for a Semester with Content Detailing

Topic I — Name**: Fundamentals of Design.**

Teacher shall implement the methodology/ techniques mentioned in the following table while teaching the topics. Along with this teacher may use additional/alternative methods to make students learning meaningful.

Knowledge Category	Example/s of category	Teaching methodology
FACT	Bolts ,Keys ,Fasteners I.C. engine ,suspension system ,Transmission system ,Piston, Connecting rod, Bearing	Explanation with chalk & board. Actual demo of parts or models in classroom and allow the students to handle.
CONCEPT	Load, yielding, fracture corrosion ,creep, interchangeability, standardization , Aesthetics	Explanation with chalk & board initially. Demonstrate their effects by using model/ Photos/actual elements
PRINCIPLE	Stress- strain relationship, stress concentration , Factor of safety, Mechanisms and inversions, Ergonomics	Explanation with chalk & board . Explain with figures and charts , models
PROCEDURE	General design procedure, Theories of failure.	Explanation step wise procedure with chalk & board

	APPLICATION	Determination of different dimensions of various parts like Bolts , plate ,pin etc.Selection of materials, application of Ergonomics, Aesthetics in designing automobile	Explain application in classroom by bringing actual sample or by showing the application part in laboratory

Learning Resources:

Books: Machines design : Khurmi, Gupta
Design of machine elements.: B.V.Bhandari
Machine Design.: P.Kannaiah
Machine Design :U.C. Jindal
Design of machine elements.: K.Ganesh Babu/K. Srithar

Teaching Aids: Chalk Board, , Charts, models ,pictures

PPT with Sample:

Websites: www.slideshare.net
www.nptel.ac.in

Lecture No.	Topic/ Subtopic to be covered
1	Introduction of design , Classification of design, Design consideration (Mode of Failure-strength, deformation, fracture, corrosion and wear)
2	Design procedure , Types of Load- Actual and design loads. Factors to find design loads such as service factor, overload factor, velocity factor and factor of safety. Stress concentration - causes and remedies, Bolts of uniform strength,
3	Stress analysis:(Revision only) Types of external loads, Types of induced stresses: tensile, compressive, shear, Crushing and bearing pressure, bending, torsion, thermal stresses, principal stresses. Stress – strain diagram for ductile and brittle material and it's use
4&5	Variable stresses in machine parts. : Fatigue and endurance limit, S-N diagrams for variable stresses. Working stresses for static load, variable or fatigue load. Factor of safety and its selection.
6	Theories of failure. : Maximum principal stress theory. Maximum shear stress theory. Distortion energy theory.
7	Simple numerical on Theories of failure.
8	Materials and other considerations in design Selection of material for Automobile components and its justifications on the basis of mechanical, thermal properties, manufacturing, wear considerations, cost.
9	Standardization, preferred numbers and interchangeability in design practice.
10	Principles of Ergonomics, Aesthetics in designing automobile
Topic 2	Name**: Design of Joints.** **Teacher shall implement the methodology/ techniques mentioned in the following table while teaching the topics. Along with this teacher may use**

additional/alternative methods to make students learning meaningful.

Knowledge Category	Example/s of category	Teaching methodology
FACT	Socket and spigot cotter joint., knuckle joint. Turn buckle	Explanation with chalk & board ,Actual demo of models in classroom and allow the students to handle
CONCEPT	Load, Fracture due to tensile ,shear ,cursing stresses ,bending failure	Explanation with chalk & board. Demonstrate their effects by using model/Photos/actual elements or with sketches on board
PRINCIPLE	Principle of tensile,shear,cursing, bending failure .	Explanation with chalk & board. Demonstrate their effects by using model/Photos/actual elements or with sketches on board
PROCEDURE	Design procedure, use of imperial relations	Explanation step wise procedure with chalk & board
APPLICATION	Application of Socket and spigot cotter joint., knuckle joint. Turn buckle etc in automobile assemblies like transmission chain ,tie rod, all connections of linkages , ,stub axle ,front axle and kig pin connections	Explain application in classroom by bringing actual sample or by showing the application part in laboratory

Learning Resources:: Books , Charts ,Models

Books: Machines design : Khurmi, Gupta
Design of machine elements.: B.V.Bhandari

Teaching Aids: Chalk Board, Drawing Instruments, Charts, models

PPT with Sample:

Websites: www.slideshare.net
www.nptel.ac.in

Lecture No.	Topic/ Subtopic to be covered
1	Design of socket and spigot type cotter joint.

2	Numerical on design of socket and spigot type cotter joint.
3	Design of knuckle joint
4	Numericals on design of knuckle joint
5	Design of Turn buckle
6	Numericals on design of Turn buckle . Applications of above joints in the automobile

Topic III

Name**: Design of shafts, keys and Coupling.**

Teacher shall implement the methodology/ techniques mentioned in the following table while teaching the topics. Along with this teacher may use additional/alternative methods to make students learning meaningful.

Knowledge Category	Example/s of category	Teaching methodology
FACT	Shaft,axle,spindle,key,coupling	Explanation with chalk & board ,Actual demo of models in classroom and allow the students to handle
CONCEPT	Whirling and critical speed of the shaft, Torsional shear stress, bending stress,combined stresses , Strength, rigidity	Explanation with chalk & board. Demonstrate their effects by using model/Photos/actual elements or with sketches on board
PRINCIPLE	Power transmission, Gear ratio, Principle of tensile, shear, cursing, bending failure.	Explanation with chalk & board. Demonstrate their effects by using model/Photos/actual elements or with sketches on board
PROCEDURE	Design procedure , use of imperial relations	Explanation step wise procedure with chalk & board
APPLICATION	Application such as propeller shaft, Rear axle, sunk key in flywheel boss and crank shaft, woodruff key in tapered shaft ,flexible coupling in between steering column and rack	Explain application in classrolom by bringing actual sample or by showing the application part in laboratory

Learning Resources:

Books: Machines design : Khurmi, Gupta
Design of machine elements.: B.V.Bhandari
Auto design: R. B Gupta
Machine Design.: P.Kannaiah

Teaching Aids: Chalk Board, Charts ,models ,pictures

	PPT with Sample: Websites: www.slideshare.net www.nptel.ac.in
Lecture No.	Topic/ Subtopic to be covered
1	Types - Transmission, machine, axle, spindle. Design considerations of shaft –strength, rigidity (lateral and torsional)
2	Design of propeller shaft, Rear axle. Whirling and critical speed of the shaft
3	Types of keys and their applications, Design of sunk key.
4	Numerical on propeller shaft, Rear axle, sunk key
5	Design of flange Couplings
6	Numerical on flange Couplings
7	Design of Bushed pin type flexible Couplings
8	Numerical on Bushed pin type flexible Couplings
Topic IV	Name**: Design of levers.** **Teacher shall implement the methodology/ techniques mentioned in the following table while teaching the topics. Along with this teacher may use additional/alternative methods to make students learning meaningful.**

Knowledge Category	**Example/s of category**	**Teaching methodology**
FACT	Rocker arm, bell crank lever. accelerator pedal, cranking hand lever,	Explanation with chalk & board ,Actual demo of models in classroom and allow the students to handle
CONCEPT	Fulcrum ,load ,Effort, Reaction at the fulcrum, load arm ,effort arm , section of modulus	Explanation with chalk & board. Demonstrate their effects by using model/Photos/actual elements or with sketches on board
PRINCIPLE	Mechanical advantage, Leverage,	Explanation with chalk & board. Demonstrate their effects by using model/Photos/actual elements or with sketches on board
PROCEDURE	Design procedure , use of imperial relations**.**	Explanation step wise procedure with chalk & board
APPLICATION	Rocker arm, bell crank lever,plier, accelerator pedal, clutch pedal ,gear shifter	Explain application in classroom by bringing actual sample or by showing the application part in laboratory

Learning Resources:: Books , Charts ,Models

Books: Machines design : Khurmi, Gupta
Design of machine elements.: B.V.Bhandari
Machine Design.: P.Kannaiah
Machine Design :U.C. Jindal
Design of machine elements.: K.Ganesh Babu/K. Srithar

Teaching Aids: Chalk Board, , Charts ,models ,pictures

PPT with Sample:

Websites: www.slideshare.net
www.nptel.ac.in

Lecture No.	Topic/ Subtopic to be covered
1	Types of levers – simple, compound, differential, acute and obtus angle lever, hand levers and foot pedals.
2	Design of rocker arm,
3	Design of bell crank lever.
4	Numerical on design of rocker arm and bell crank lever.

Topic V

Name: **Design of Chassis Component**

Teacher shall implement the methodology/ techniques mentioned in the following table while teaching the topics. Along with this teacher may use additional/alternative methods to make students learning meaningful.

Knowledge Category	Example/s of category	Teaching methodology
FACT	Clutch, Gear Box, Leaf Spring, Gears	Explanation with chalk & board ,Actual demo of models in classroom and allow the students to handle
CONCEPT	Uniform pressure and Uniform wear conditions, Gear and spring terminology	Explanation with chalk & board. Demonstrate their effects by using model/Photos/actual elements or with sketches on board
PRINCIPLE	Friction, Thrust, torque and power lost in friction, law of gearing, gear ratio .	Explanation with chalk & board. Demonstrate their effects by using model/Photos/actual elements or with sketches on board
PROCEDURE	Design procedure of Single plate clutch, multi plate clutch, semielliptical leaf spring,teetch	Explanation step wise procedure with chalk & board

	calculations for gear box	
APPLICATION	Application such as automotive clutch , gear box, suspension system	Explain application in classroom by bringing actual sample or by showing the application part in laboratory

Learning Resources:: Books , Charts ,Models

Books: Machines design : Khurmi, Gupta
Design of machine elements.: B.V.Bhandari
Auto design : R. B Gupta

Teaching Aids: Chalk Board, Drawing Instruments, Charts, Models

PPT with Sample:

Websites: www.slideshare.net
www.nptel.ac.in

Lecture No.	Topic/ Subtopic to be covered
1	Design of Single plate and Multi plate clutch using uniform pressure and wear condition.
2	Design of clutch spring
3 &4	Numerical on Design of Single plate clutch and Multi plate clutch
5	Gear terminology, , Teeth calculation of gears for sliding mesh/constant mesh gear box
6	Numerical on Teeth calculation of gears for sliding mesh/constant mesh gear box
7	Concept of nipping. Design of semi elliptical leaf spring.
8	Numerical on Design of semi elliptical leaf spring.
Topic VI	Name: **Design of engine components** **Teacher shall implement the methodology/ techniques mentioned in the following table while teaching the topics. Along with this teacher may use additional/alternative methods to make students learning meaningful.**

Knowledge Category	**Example/s of category**	**Teaching methodology**
FACT	Piston, cylinder head, piston rings, piston pin, connecting rod	Explanation with chalk & board ,Actual demo of models in classroom and allow the students to handle

	CONCEPT	Load, yielding, fracture corrosion ,creep, Bending strength and thermal considerations, bearing, bending and shear considerations, inertia force	Explanation with chalk & board. Demonstrate their effects by using model/Photos/actual elements or with sketches on board
	PRINCIPLE	Bending strength and thermal conductivity, bearing, bending and shear considerations, Principle of Rankine's formula, crippling, Moment of inertia,	Explanation with chalk & board. Demonstrate their effects by using model/Photos/actual elements or with sketches on board
	PROCEDURE	Design procedure for Piston**,** cylinder head, piston rings, piston pin, connecting rod and use of imperial relations	Explanation step wise procedure with chalk & board
	APPLICATION	Automotive I.C.engine component	Explain application in classroom by bringing actual sample or by showing the application part in laboratory
	Learning Resources:: Books , Charts ,Models Books: Machines design : Khurmi, Gupta Design of machine elements.: B.V.Bhandari Machine Design: P.Kannaiah Teaching Aids: Chalk Board, , Charts, Models PPT with Sample: Websites: www.slideshare.net www.nptel.ac.in		
Lecture No.	Topic/ Subtopic to be covered		
1	Data of engine specifications and calculations of cylinder dimensions for given power, Numerical on Design of engine specifications		
2	Design of cylinder head thickness		
3	Numerical on Design of cylinder head thickness		
4	Design Considerations for a Piston ,		
5	Design of piston rings and skirt length		
6	Design of piston pin for bearing, bending and shear considerations		
7&8	Numerical on Design of piston, piston rings, piston pin		

9	Design of connecting rod cross -section (I section).
10	Design of connecting rod small end and big end, cap and bolts.
11&12	Numerical on Design of connecting rod cross –section, small end and big end, cap and bolts.

5.2 Planning and Conduct of Test:

a) The time table and sample test paper for the test should be displayed minimum 10 days before the test.
b) Each test will be of 25 marks.
c) First test should cover about 40% of curriculum and second test should cover remaining curriculum.
d) Format for question paper should be as per the sample question paper supplied by MSBTE.

e) Guidelines for Setting Class Test Question Paper:
- Question no.1 Attempt any three out of four (3X3=9 Marks)
- Question no.2 Attempt any two out of three (2X4=8 Marks)
- Question no.3 Attempt any two out of three (2X4=8 Marks)

5.3 Details about conduct of assignments:

Teacher should give assignment on fundamentals of design. Assignment should based on MSBTE Curriculum.

5.4 Strategies for Conduct of Practical:

5.4.1 Suggestions for effective conduct of practical and assessment:

1. The planning of design practical should be ready well in advance before the date of practical.
2. A batch of students shall be divided into subgroups so the each subgroup will contain 4-5 students as per the present students.
3. Teacher should explain the design procedure of machine element under consideration before starting the actual practical.
4. Teacher should assign different design problems to different groups .
5. Students are supposed to select data required such as material, allowable Stresses, empirical relations by referring design data book.
6. Subject teachers shall check the tasks performed for each group separately and sign it.
7. By using the designed dimensions students will prepare assembly-detail drawings indicating overall dimensions, tolerances, hardness and surface finish and bill of material.
8. At the end of practical teacher shall assess the individual student.
9. The teacher shall schedule the practical dates and display the same in advance.
10. The continuous assessment shall be done as per CIAAN Norm

5.4.3 Preparation for conduct of practical

6. Mode of assessment:

6.1.1 Class Test:

- There will be two tests each of 25 marks.
- The tests will be conducted as per the MSBTE schedule.
- Teacher should prepare model answer of class test question papers.
- After completion of test, subject teacher should display model answer on Department Notice Board.
- Teacher should show the answer paper of class test to the student and discuss about the mistakes.
- Teacher should maintain the record of class test as per MSBTE norms (CIAAN)

6.1.2 Sample Test Papers:

Sample Test Paper I

Roll No.				

17525

Institute Name:

Course Name: **Automobile Engineering** Course Code: AE

Semester : Fifth

Subject**: Design of Automobile Components**

Marks: **25** Time:**1 hour**

Instructions:

1. All questions are compulsory
2. Illustrate your answers with neat sketches wherever necessary
3. Figures to the right indicate full marks
4. Assume suitable data if necessary
5. Preferably, write the answers in sequential order

Q1. Attempt any Three **9**

a. Define fatigue ,endurance limit and creep
b. Describe maximum principal stress theory .
c. Define whirling and critical speed .Why they should be considered for designing rotating shafts
d. Compare joints and couplings.

Q2. Attempt any Two **8**

a. Write the design procedure of turn buckle.
b. List and draw sketches of any four types of keys and write their applications
c. Define standardization and state its advantages**.**
d. Write design procedure for designing pin of bush pin flexible coupling.

Q3. Attempt any One **8**

a. Design the knuckle joint required to withstand a tensile load of 25000 N, if Permissible stress are σ_t =56 N/mm^2, τ =40 N/mm^2, σ_c =70 N/mm^2
b. Write design procedure for bushed pin flexible coupling.

Sample Test Paper II

Course Name: **Automobile Engineering** Course Code: AE

Semester : Fifth

Subject**: Design of Automobile Components**

Marks: **25** Time: **1 hour**

Instructions:

1. All questions are compulsory

2. Illustrate your answers with neat sketches wherever necessary
3. Figures to the right indicate full marks
4. Assume suitable data if necessary
5. Preferably, write the answers in sequential order

Q1. Attempt any Three **9**

a. Define lever. Describe any two basic types of levers.
b. Define module, circular pitch and state relation between module, center distance and number of teeth on gear pair .
c. Define I.P., B.P., F.P.
d. Compare single plate clutch with multi plate clutch. (any three points)

Q2. Attempt any Two **8**

a. Design the connecting rod cross section for following data for petrol engine:
Maximum pressure inside the cylinder = 4.5N/mm^2
Piston diameter = 70 mm, Stroke length =80 mm,
Effective length of connecting rod=140 mm
Ultimate crushing stress in rod material =300 N/mm^2 Factor of safety =3
Take rankine constant for steel = 1/1600

b. Explain stepwise design procedure for bell crank lever .
c. A single plate with both sides effective, has outer and inner diameter 300 mm and 200 mm respectively. the maximum intensity of pressure at any point of contact is not to exceed 0.2 N/mm2. If the coefficient of friction is 0.3. Determine the power transmitted by clutch at shaft speed 2500 rpm.

Q3. Attempt any One **8**

a. A four stroke diesel engine has the following specifications :
Brake power = 5 kW ; Speed = 1200 r.p.m. ;
Indicated mean effective pressure = 0.35 N / mm^2 , Mechanical efficiency = 80 %.
Determine : 1. bore and length of the cylinder ; 2. thickness of the cylinder head ;
3. size of studs for the cylinder head.
b. A truck springs has 12 numbers of leaves, two of which are full length leaves. The spring supports are 1.05 m apart and the central band is 85 mm wide. The central load is to be 5.4 kN with a permissible stress of 280 N/mm^2. Determine the thickness and width of steel spring leaves. The ratio of the total depth to the width of the spring is 3. Also determine the defection of the spring.

6.2 End of Semester Theory Paper

6.2.1 Characteristics of a Good Examination Question Paper

6.2.1.1 Introduction

While a student answers a question, he refers to his Long Term Memory (LTM) and sees if the answer could be readily available from the memorised data. If this is not possible, the

student processes information from his LTM and then provides the answer. All these activities are related to processes taking place in the brain. Through question paper, we are trying to measure intellectual activities which may not have precise measurement. The question paper which we use to measure learning of a certain topic is usually called an instrument or a tool. The question paper or the instrument we are designing to measure achievement in a given subject/content should have certain qualities which will ensure a fair degree of confidence on the results of the examination.

Standard of any examination depends upon quality of question paper and therefore efforts must be made to see that question paper is set on scientific principles. A question paper can be called a good quality question paper if it possesses the following essential characteristics.

- Validity
- Reliability
- Objectivity
- Usability

6.2.1.2 Validity

Validity refers to the extent to which it measures what it intents to measure. If we design a test or a question paper to measure what students have learnt in a subject, say "Applied Mechanics", it should measure their achievement in Applied Mechanics only, nothing else; and the scores in this subject are not distorted by irrelevant factors. Basically, the, validity is always concerned with the specific use of the test results and the soundness of our proposed interpretations.

There are different types of validities of a test/question paper. In our examination question paper it is adequate and appropriate to consider only one type of validity i.e. content validity. The content validity is related to the extent to which the question paper conforms to the curriculum content and the pre-determined objectives. This validity is ensured by designing question paper that matches with the specification table, which contains content matter to be tested and the cognitive levels at which this content is to be tested.

6.2.1.3 Reliability

Reliability refers to the consistency of measurement i.e. the consistency with which an examination question paper measures whatever it measures. If a teacher gives today an achievement test in a subject to his students, how similar would have been the student's scores had this test been given yesterday or tomorrow? How would the scores have varied had the teacher selected a different sample of equivalent questions? If it were a question paper containing

essay type question, how would the scores have differed had a different teacher scored / evaluated it? These are the types of questions with which reliability is concerned. Unless the measurement can be shown to be reasonably consistent over different occasions or over different samples of the same performance domain, we can have little confidence in the results.

While measuring length, can any one get consistent results while using a tape made of elastic material? Depending upon how much the tape is stretched; different lengths would be obtained on each occasion. Reliability estimates of a question paper refer to the results of measurement. A reliable (consistent) measure is not necessarily valid. Reliability is strictly a statistical concept.

Reliability or the amount of faith which can be placed on the scores/marks of a question paper depends upon a number of factors. Some of these factors are –

i) **Clarity, Definiteness and Objectivity of the question paper**

Question paper which permits students to make widely divergent interpretations of what is expected of them (in their answer) is not likely to yield highly reliable results. For example, teacher assessing the answer books may have different expectations from students, if the questions are not specific, and are worded vaguely.

ii) **Examiners Objectivity**

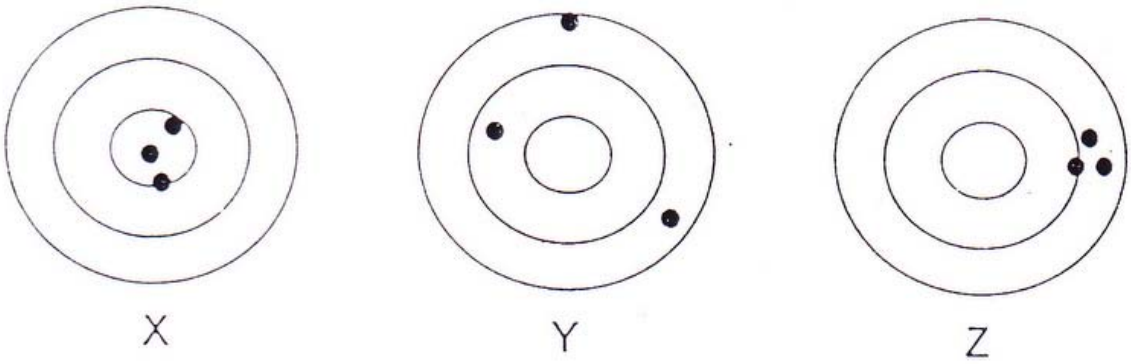
This relates to consistency with which examiners examine and mark the answer scripts/books. If marks assigned to answers are greatly influenced by the examiner's state of mind at that moment, no one will keep faith in the assigned marks, and reliability of marking is adversely affected.

iii) **Number of Questions**

Researchers have shown that more number of questions in a question paper lead to more reliability. Reliability also depends upon the spread of scores, difficulty level of the question paper and objectivity of scoring.

The relation between validity and reliability is sometimes confusing to persons who come across these terms for the first time. Reliability (consistency) of measurement is needed to obtain valid results but we can have reliability without validity. The target shooting illustration, in the figure below, shows the concept that "reliability is a necessary but not a sufficient condition for validity"

Target Target Target



Reliable & Valid Unreliable & Invalid Reliable but invalid

Shooting Shooting Shooting

Three shooters X, Y, Z shoot at the target, each getting three shots. Shooter Y Shoots at different places far away from the bull's eye. Z consistently shoots at the border spot. X consistently shoots close to the bull's eye.

6.2.1.4 Objectivity

This concept is related to marking of answer scripts. When answer scripts are assessed and marked in such a way that the total score obtained by students to not change appreciably, we say that the marking is objective. As against this, if extraneous personal biases and preferences of examiners influence marking of answer scripts, the assessment is subjective in nature. Thus objectivity implies assessment free from all extraneous factors and is opposite to subjectivity.

The element of subjectivity can be substantially reduced and objectivity improved, if the following steps are taken.

1. Designing an assessment scheme for a course.
2. Developing specification table for question paper indicating distribution of marks for different topics and levels.
3. Preparing a format of question paper showing distribution of topics in different questions, and indicating types of questions for abilities to be tested.
4. Designing question paper as per specification table.

5. Editing the question paper so that it meets all the criteria and conform to the specification table.
6. Developing scheme of marking for the answers to supply type questions (i.e. questions which make students to provide answers in sentence/figural/graphical form). This is the most necessary requirement for reducing subjectivity.

6.2.1.5 Usability or Practicability

An examination system should be so designed that it is possible to implement it without much problems or difficulties. The system should not be something that looks good or ideal on paper but can't be implemented. In addition to providing examination results that possess a satisfactory degree of reliability and validity, an examination system should also satisfy certain other practical requirements, given below.

i) The system is economical from the point of view of both money and time.
ii) It should be easy for administration and marking.
iii) The system should be simple enough to be properly understood by all the concerned persons.

6.2.1.6 How to Ensure Reasonable Validity?

In order to have a valid test or an evaluation procedure, we must ensure that it is relevant to the purpose for which it is to be used; it means that there should be a close relationship between validity of a question paper and objectives of the test. In simpler words, by test validity we mean the *accuracy, conformity and effectiveness* with which the test measures *what it intends to measure* (Objectives).

The following steps can help to ensure reasonable degree of validity:

a) Specify the purpose of assessment.
b) Clearly define the objectives.
c) Divide the course content into convenient chapters.
d) Provide proportional weightage to each chapter.
e) Provide proportional weightage to different objectives and their levels.
f) Develop question on each of the sampled cognitive process dimension in each unit in accordance with the weightage assigned.
g) Avoid providing free option like 'attempt any 6 out of 9'. However, internal option of "either", "or" type can be given with proper care of content and objectives.

It can be noticed that the only assurance we have that a test is a *valid* measure of the intended learning outcomes, is to use a systematic procedure for obtaining a representative

sample of the curriculum in the question paper. The table of specifications is a device which provides the procedure for obtaining a representative sample of curriculum in the question paper and thus ensures content validity.

6.2.2. Approach for Designing Good Question Paper

6.2.2.1 Concept of Specification Table

A table of specification is a blue print for test or question paper design. Just as an engineer prepares a blue print before constructing a structure, a specification table is prepared in advance of the examination, so that a valid test could be designed.

In fact, a Table of Specifications is a sampling plan of the objectives to be tested in the test. This ensures following things:

- All important topics of the subject matter are adequately represented.
- There is no undue weightage given to any particular topic/topics.
- No content area worthwhile for testing is omitted from the test.
- The test samples adequate proportion of abilities at different taxonomy levels, in each part.

6.2.2.2 Guidelines for Preparing Specification Table

1. Study the two dimensional table of objectives
2. Use the weightages of marks (out of 80) for each chapter/topic in the subject
3. In assigning relative weightages to each topic and level of learning outcomes, a number of factors have been considered. These factors are:
   - How important is each topic in relation with total learning experience?
   - How much time is expected to be devoted to each topic during instructions?
   - What relative importance does curriculum assign to each topic?
   - At what levels is the topic taught?
   - What amount of emphasis is given for each topic at what levels?

   Specification table should consider the following:
   - Content to be observed
   - Objectives to be achieved
   - Levels of objectives
   - Total time and marks for the paper

1. The specification table consists of chapters/topics and levels of cognitive process dimension like R, U, A.

   These cognitive process dimensions are –

R = Remember

U = Understand

A = Analyse / Apply

5. Review the chapter/topic and think about probable distribution of marks at the three levels (R, U, A,) for assessment. Normally distribution be done in multiples of two marks. Enter marks for each topic under the levels R, U, A.
6. Make total of vertical columns R, U, A. Suggested distribution is R=10% to 30%, U=40% to 55% and A=30% to 45% depending upon the level of the students.

   A Sample Classification Table is given below with arbitrary marks.

Sample Question Paper:

Exam Seat No.									

17525

Maharashtra State Board of Technical Education

Course Name: Automobile Engineering Course Code: AE
Semester: Fifth
Title of the Subject: **Design of Automobile Components** Subject Code: 17525
Marks: 100 Time: 4 hrs

Instructions:

1. All questions are compulsory
2. Illustrate your answers with neat sketches wherever necessary
3. Figures to the right indicate full marks
4. Assume suitable data if necessary
5. Preferably, write the answers in sequential order

Q1a. Attempt any Three **12**

i. Describe modes of failure.
ii. Define Factor of Safety. What factors affect its selection?
iii. Derive the relation to determine induced bending stress in cotter .
iv. Define Shaft , Axle**,** Spindle, Coupling.

Q1b. Attempt any One **6**

i Derive the relation for torque to be transmitted by single plate clutch considering uniform wear condition
ii Compare Clutch and Coupling from design point of view (Any Six Point)

Q2. Attempt any Four **16**

a. Draw thrust and non-thrust sides of I.C. Engine piston .
b. Draw a stress strain diagram for ductile material and state its importance.
c. Write the design procedure for cotter only.
d. Figure I shows a lever. Determine leverage ,M.A. and reaction at fulcrum, identify type of lever .

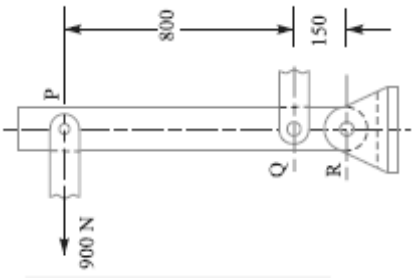


Figure I

e. Classify levers and give example of each.

Q3. Attempt any Four **16**

a. A knuckle joint transmits a load of 150 KN. The rod diameter is 52 mm. Determine all dimensions of knuckle joint and induced shear stress ,bending stress in knuckle pin .
b. Draw a labeled sketch of four speed sliding mesh gear box.
c. Estimate length of piston.
d. Design the turn buckle rod diameter only to withstand a load of 1600N, permissible stresses are 70N/mm^2 and 60 N/mm^2 in tension and shear respectively.
e. State types of keys with their appropriate applications

Q4 A. Attempt any Three **12**

i. Describe Nipping of leaf springs with neat sketch. Why it is carried out?
ii. Recommend suitable material with justification for I.C. Engine
a) piston b)cylinder head c)piston pin d)connected rod .
iii. State two application of each of knuckle joint and turn buckle in an automobile.
iv. Write design stepwise procedure for propeller shaft. Why propeller shafts are generally made hallow?

Q4 B . Attempt any One **6**

i. Explain aesthetic considerations in designing automobile components.

ii. Write stepwise design procedure for flange coupling

Q 5. Attempt any Two **16**

a. A mild steel shaft of 50 mm diameter is subjected to a bending moment of 2000 N-m and a torque T. If the yield point of the steel in tension is 200 MPa, find the maximum value of this torque without causing yielding of the shaft as per;
[i] Maximum principal stress theory And
[ii] Maximum shear stress theory.

b. Draw the neat sketch of the fully floating rear axle. And design the diameter of rear axle shaft for fully floating type with the following data
Engine Power = 10 kW at 300 rpm.Gear box ratio = 4:1,2.4:1,1.5:1 And 1:1
Differential Reduction =6:1. Shear stress for the shaft = 70 N/mm^2

c. Determine the thickness of plain cylinder head for 0.3 m cylinder diameter. The maximum gas pressure is 3.2 N/mm^2 .Design the studs and cylinder cover. Take allowable tensile stress for cylinder cover and bolt equal to 42 N/mm^2 and 63 N/mm^2 respectively

Q 6. Attempt any Two **16**

a. Write design procedure for connecting rod .

b. Design of piston pin with following data. Maximum gas pressure = 4N/mm^2. Diameter of piston =70mm, allowable stresses due to bearing, bending and shear are given 30 N/mm^2, 80 N/mm^2, 60 N/mm^2 respectively.

c. A multiple disc clutch has five plates having four pairs of active friction surfaces. If the intensity of pressure is not to exceed 0.127 N/mm2,find the power transmitted at 500 r.p.m. The outer and inner radii of friction surfaces are 125 mm and 76 mm respectively. Assume uniform wear and take coefficient of friction = 0.3.

Sample Question Paper Marking scheme 17525

Sr.No.	Que. No.	Sub Que No.	Marks Allocate	Marks distribution
1	Q 1A	i	4	1 mark for Each mode
2		ii	4	1 mark for definition 3 mark for any 3 factors
3		iii	4	Load distribution fig. 1 mark Bending moment 1 mark Section modulus 1 mark Relation 1 mark
4		iv	4	1mark for each definition
5	Q1B	i	6	fig. 1 mark Notation 1 mark Frictional torque on elemental ring 1 mark Axial load 1 mark Total torque 1 mark Relation 1 mark
6		ii	6	1mark for Each point
7	Q 2	a	4	2 marks for Each side
8		b	4	fig. 1 mark 3mark for any 3 importance's
9		c	4	fig. 1 mark stepwise procedure 3marks
10		d	4	1mark for Each point
11		e	4	Classification 2 marks Examples 2 marks
12	Q 3	a	4	Determine all dimensions 1 mark shear stress 1 mark bending stress 2 marks
13		b	4	Correct and neat sketch 3 marks Labels 1 mark
14		c	4	L1 -1 mark L2 -1 mark L3 -1 mark L -1 mark
15		d	4	Design load -1 mark Core diameter -2 marks Diameter of rod -1 mark
16		e	4	Types -2 marks Applications -2 marks
17	Q 4 A	i	4	Neat sketch -2marks Description and reasoning -2marks
18		ii	4	1mark for Each point
19		iii	4	2 marks for Each point
20		iv	4	procedure -2 marks reasoning -2 marks

21	Q 4B	i	6	2 marks for Each point
22		ii	6	fig. 2 marks stepwise procedure 4 marks
23	Q 5	a	8	Maximum principal stress theory - 4 marks Maximum shear stress theory. -4 marks
24		b	8	Neat sketch -3marks Solution -5 marks
25		c	8	thickness of plain cylinder head-2 marks No. of bolts-2 marks Dia. Of bolt -2 marks Checking dia. -2 marks
26	Q 6	a	8	Dimension of I- section of the connecting rod-3 marks Dimensions of the crankpin or the big end bearing and piston pin or small end bearing- 2 marks Size of bolts for securing the big end cap -2 marks Thickness of the big end cap-1marks
27		b	8	Maximum gas load-1 mark Design the piston pin on the basis of bearing pressure-2 marks Designing the piston pin on the basis of bending-2 marks on the basis of shear stress2 marks total length of piston pin-1 mark
28		c	8	Axial load – 3 marks Torque -3 marks Power -2 marks