CURRICULUM REVISION PROJECT

2012

TEACHER GUIDE FOR

(DESIGN OF MACHINE ELEMENT - 17610)

SIXTH SEMESTER MECHANICAL ENGINEERING GROUP

DECEMBER 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.

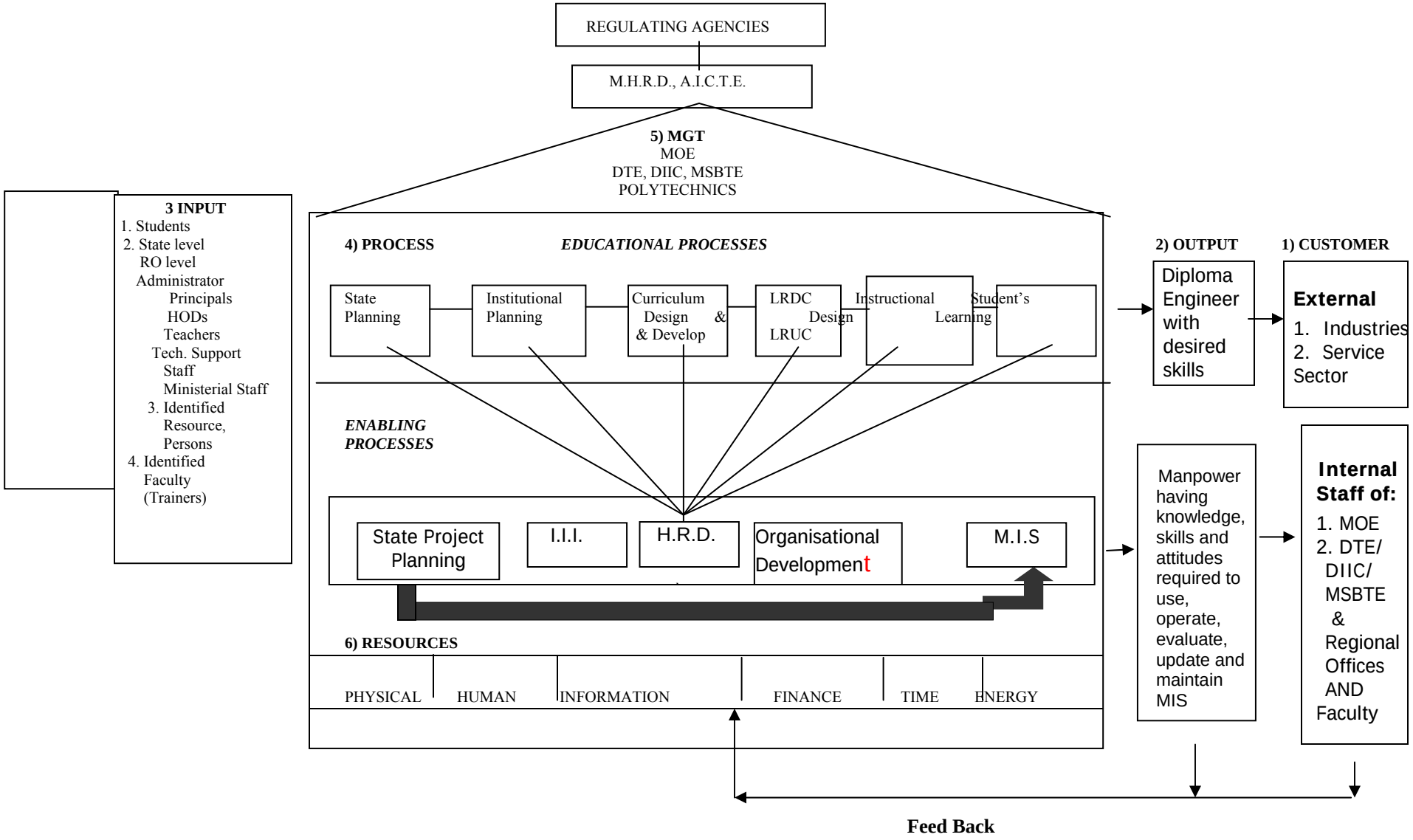


Fig 1 Systems Approach

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 Technological skills in order to satisfactorily perform duties assigned to them:

A) **Intellectual Skills**:

- Reading and interpretation of production drawings

- Planning for materials, tools, processes and quality control techniques.
- Use of Operation and Maintenance Manuals
- Operation of new equipment, machinery and instruments like CNC, PLC, controllers, Robotics, EDM, ECM, laser cutting/welding, etc
- Use of CAD for 2D drawings and familiarity with CAD software like Idea, Catia, Pro-E etc (Awareness level)
- Use of Moderns manufacturing techniques used in industry like 5S, Six sigma, TQM, TPM, ZD, JIT, Kanban, Poka-Yoke, Quality Control Charts, Reliability engineering, etc.
- Design of Machine Element
- Problem solving skills
- Cost Reduction techniques
- Use of standards (ISO-9000, QS14000, etc)

B) Motor Skills:

- Maintenance of modern equipments and machineries
- Develop drafting Skills
- Operate Lathes, Drilling Machines, CNC Machines, Milling amd Shaping Machines, Grinding Machines,
- Test Machine Performance
- Draw sketches of Civil engineering structures
- Carry out In process gauging
- Setting up of Automatic machines

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:

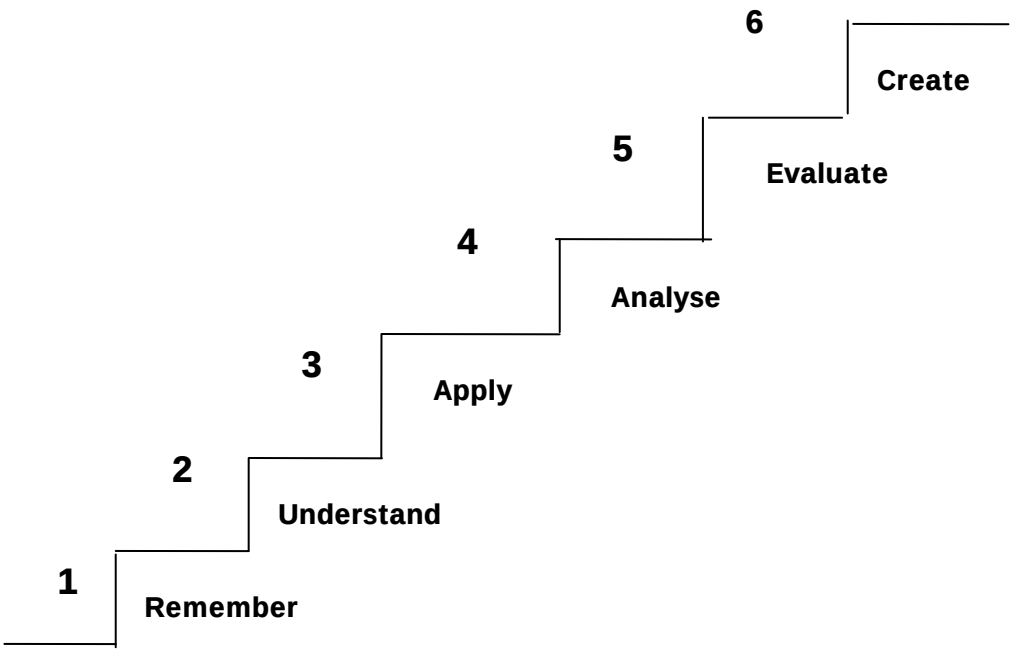
Question paper is a tool/ instrument designed to test the extent of learning of the student. Various questions set in a question paper should assess the abilities of students to respond to level of learning. Dr. Bloom a German educationist classified levels of learning in cognitive domain for the purpose 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	Knows common terms, specific facts, basic concepts, principles, methods & procedures	Define, describe, identify label, list, match, name, outline, reproduce, select, state

represents the lowest level of learning outcomes in the cognitive domain		
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 Mechanical Engineering
Course code : ME/MH/MI
Semester : Sixth for ME and Seventh for MH/MI
Subject Title : Design of Machine Elements
Subject Code : 17610

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS.	TH	PR	OR	TW	TOTAL
04	--	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:

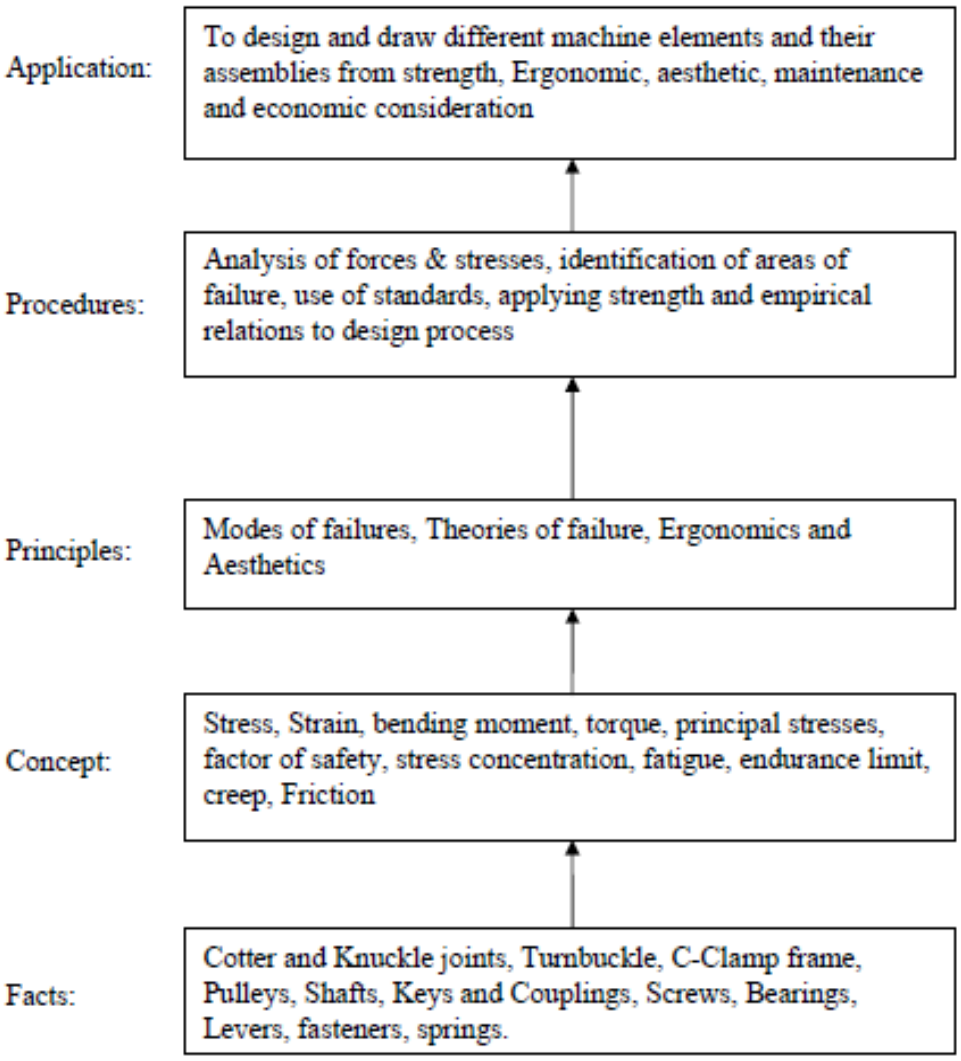
It is an applied technology subject. A diploma holder in mechanical discipline, is expected to design and draw simple machine components used in industries. Fundamental knowledge of Applied Mechanics, Strength of Materials, Engineering Materials and Theory of Machines is essential. Subject aims at developing analytical abilities to give solutions to engineering design problems.

Objectives:

The student will be able to:

1. Analyze the various modes of failure of machine components under different load patterns.
2. Design and prepare part and assembly drawings.
3. Use design data books and different codes of design.
4. Select standard components with their specifications from manufacturer's catalogue.
5. Develop drawings on CAD software.

Learning Structure:



Contents: Theory

Topic and content	Hours	Marks
Topic 1: Introduction to Design Specific Objectives: ➢ State the need for the design ➢ List all parameters related to design ➢ Apply basic concepts in design procedure **1.1 Basic Design Considerations** **04 Marks** • Design philosophy and Procedures • General Considerations in Design • Types of loads, concepts of stress ,strain, Stress – Strain Diagram for Ductile and Brittle Materials, Types of Stresses such as Tension, Compression, Shear, Bearing pressure Intensity, crushing, bending and torsion, Principle Stresses (Simple Numericals) • Concept of Creep, Fatigue, S-N curve, Endurance Limit. **1.2 Factors in Design** **04 Marks** • Factor of Safety and Factors affecting its selection • Stress Concentration – Causes & Remedies • Converting actual load or torque into design load/torque using design factors **1.3 Properties of Engineering materials** **04 Marks** • Designation of materials as per IS and introduction to International standards, advantages of standardization, use of design data book, use of standards in design and preferred numbers series. **1.4 Theories of Elastic Failures** **04 Marks** • Principal normal stress theory, Maximum shear stress theory & maximum distortion energy theory. **1.5 Modern Design considerations** **04 Marks** • Design for safety, Ecology, societal consideration & Concept of Product Design, System Design & Creativity in Design, Ergonomics and aesthetic considerations in design	12	20
Topic 2: Design of Joints, Levers & Offset Links Specific Objectives: ➢ Design a joint for a given load to be transmitted ➢ Calculate dimensions of lever/link using allowable bending and shear stress **2.1** Design of Cotter Joint, Knuckle Joint, Turnbuckle **06 Marks** **2.2** Design of Levers:- Hand/Foot Lever & Bell Crank Lever, **06 Marks** Lever for lever safety valve, Design of Off-set links, C - Clamp, Overhang Crank.	08	12

Topic 3. Design of Shafts, Keys and Couplings Specific Objectives: ➢ Design the diameter of a shaft on the basis of equivalent twisting/bending moment and allowable shear stress ➢ Design the section of most commonly used rectangular key on the basis of torque transmitted, allowable shear stress and crushing stress ➢ Design a rigid/flexible coupling for connecting two shaft on the basis of torque and allowable shear stress ➢ Design spur gear by taking into account effective tooth load **3.1 Design of shaft** **06 Marks** • Types of Shafts, Shaft materials, Standard Sizes, • Design of shafts (Hollow and Solid) using strength and rigidity criteria, • ASME code of design for line shafts supported between bearings with one or two pulleys in between or one overhung pulley **3.2** Design of key **04 Marks** • Types of keys • Design of rectangular, parallel sunk keys, • Effect of Keyways on strength of shaft. **3.3** Design of Couplings **06 Marks** • Flanged couplings – unprotected and protected types • Bush-pin type flexible coupling. **3.4** Design of spur gear **08 Marks** • Lewis equation for static beam strength of spur gear teeth • Power transmission capacity of spur gears in bending • Gear tooth failure modes – Scoring, scuffing Pitting & Teeth Breakage	14	24
Topic 4: Design of Power Screws Specific Objectives: ➢ Draw the different thread profiles used in power screws and state their merits and demerits ➢ Bring out the difference between self locking and overhauling ➢ Design the screw jack/toggle jack under a given loading conditions. **4.1 Basic concepts** Thread Profiles used for power Screws, relative merits and demerits of each, Self locking and overhauling properties Torque required to overcome thread friction, efficiency of power screws, types of stresses induced. **06 Marks** **4.2** Design of Screw Jack, Toggle Jack (only screw and nut). **06 Marks**	10	12
Topic 5: Design of springs Specific Objectives: ➢ Classify the springs on the basis of different criteria ➢ Design Helical spring based on given load conditions **5.1** Classification and Applications of Springs, Spring - terminology, materials specifications. Stresses in helical tension and compression springs, Wahl's correction factor, Deflection of springs, Energy stored in springs. **04 Marks** **5.2** Design of Helical tension and compression springs subjected to concentric applied loads like I.C. engine valves, weighing balance, railway buffers	08	12

and governor springs. **06 Marks** **5.3** Leaf springs - construction and applications **02 Marks**		
Topic 6: Design of Threaded and Welded Joints Specific Objectives: ➢ State the applications of fasteners ➢ Design threaded/welded joints under different load conditions **6.1** Stresses in Screwed fasteners, bolts of Uniform Strength, Design of Bolted Joints subjected to eccentric loading. **06 Marks** **6.2** Design of parallel and transverse fillet welds, axially loaded symmetrical section, Merits and demerits of screwed and welded joint **06 Marks**	08	12
Topic 7: Antifriction Bearings Specific Objectives: ➢ Classify the bearings ➢ Select rolling bearings, for specific applications, using manufacturers catalogue. Classification of Bearings – Sliding contact & rolling contact. Terminology of Ball bearings – life load relationship, basic static load rating and basic dynamic load rating, limiting speed. Selection of ball bearings using manufacturer's catalogue.	04	08
Total	**64**	**100**

Skills to be developed in Practicals

Intellectual Skills:

1. Understand the basic philosophy and fundamentals of Machine Design.
2. Apply and use the basic knowledge of earlier subjects like mechanical Engineering materials, strength of materials and theory of machines.
3. Analyze and evaluate the loads, forces, stresses involved in components and subassemblies and decide the dimensions.
4. Understand the modes of failures of m/c components and decide the design criteria and equations.
5. Understand the concept of standardization and selecting standard components.
6. Understand the methods of computer aided design practices.
7. Use of different design data books and IS codes.

Motor Skills:

1. Draw the components assembly as per the designed dimensions.
2. Modify drawings and design as per requirement.
3. Use the different design software.

List of Practicals:

1. Analyse the various modes of failure of machine components under different load patterns
2. Understand different codes used for design of machine elements.
3. Select the material for given applications using design data book.
4. Design and draw mechanical joints for given load.
5. Design and draw mechanical levers for given load.
6. Design project - 1
   Design and prepare the drawing on drawing sheet of transmission systemby observing transmission of power through shaft, keys, coupling, pulley and belt drive etc.
7. Design project - 2

Design and prepare the CAD drawing of transmission system by observing transmission of power through Power screw.

8. Design of springs.
9. Design of fasteners.

Learning Resources:

1. **Books:**

Sr. No.	Title	Author	Edition	Publisher
1	Machine Design	RS Khurmi and Gupta	14th	S. Chand
2	Machine Design	VB Bhandari	3rd	Tata McGraw Hill
3	Machine Design	U C Jindal	2 reprint	Pearson Education India
4	Mechanical Engg. Design	Richard G Budynas,J. Keith Nisbett	9th	Tata McGraw Hill
5	Theory and problems of Machine Design	Hall,Holowenko, Laughlin	Reprint 2005	McGraw Hill
6	Design Data Book	PSG	8th	PSG College of Technology Coimbatore
7	Fundamentals of Machine Components Design	Robert C.Juvinall Kurt M Marshek	3rd	Wiley India Edition

2. **IS Codes:**
   1) IS 4218: 1967 ISO Metric Threads
   2) IS 2693: 1964 Cast Iron Flexible Couplings
   3) IS 2292: 1963 Taper keys & Keyways
   4) IS 2293: 1963 Gib Head Keys & Keyways
   5) IS 2389: 1963 Bolts, Screws, Nuts & Lock Nuts
   6) IS 4694: 1968 Square threads
   7) IS 808: 1967 Structural Steel
   8) SKF Catalogue for Bearings

4.1 Sample Lesson Plan:

- Irrespective of teaching experience every teacher must plan each and every lecture to be delivered by him / her.
- The lesson planning may be noted on the paper or in case of senior teachers it may be planned in the mind.
- Sample format of lesson planning is given below:

Sr. No.	Phase	Events	Time to be allotted
1.	Introduction	• Recall of different Materials, properties • Design, Importance/Need, Types • Applications of simple components	5 to 10 Minutes

2.	Development	• Design Philosophy, Procedural steps with application/examples • General consideration in design	40 to 50 Minutes
3.	Consolidation	• Summarizing of design • Application of design concept for simple component/parts	5 to 10 Minutes

5. IMPLEMENTATION STRATEGY:

5.1 Planning of Lectures for a Semester with Content Detailing:

Topic I — Name**: INTRODUCTION TO 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 more meaningful.

e.g.

Knowledge Category	Example/s of category	Teaching methodology
FACT	**materials , material failure, Standard parts, Design data book**	Explain by showing different available material, standard parts. Use of design data book.
CONCEPT	**Load, stress, strain material properties, stress concentration, creep, factor of safety, Ergonomics**	Explain by taking simple numerical. Explain Ergonomics using suitable examples (Like Design of desk bench, pen etc.)
PRINCIPLE	**Modes and Theories of failure**	Explain Modes and Theories of failure using chalk, simple available components.
PROCEDURE	**Analysis of forces & stresses, Identification of failure area and their strength equation.**	Explain by solving numerical
APPLICATION	**Design of simple machine elements.**	Explain by giving practical examples like shaft, key etc.

Learning Resources:

Books:

Title: 1) Machine Design - RS Khurmi and Gupta - S. Chand publication

	2) Machine Design - VB Bhandari - Tata McGraw Hill publication 3) Design Data Book - PSG - PSG College of Technology Coimbatore Teaching Aids: 1. Chalk Board 2. Power Point Presentation 3. Standard available designed components PPTs: Teacher to develop the power point presentations for the topics Websites :- www.slideshare.net to get the relevant power points.
Lecture No.	Topic/ Subtopic to be covered
1	Basic Design Considerations Design philosophy and Procedures General Considerations in Design
2	Types of loads, concepts of stress ,strain, Stress – Strain Diagram for Ductile and Brittle Materials,
3	Types of Stresses such as Tension, Compression, Shear, Bearing pressure Intensity, crushing, bending and torsion, Principle Stresses (Simple Numericals)
4	Concept of Creep, Fatigue, S-N curve, Endurance Limit.
5	Factors in Design Factor of Safety and Factors affecting its selection Stress Concentration – Causes & Remedies
6	Converting actual load or torque into design load/torque using design factors Properties of Engineering materials
7	Designation of materials as per IS and introduction to International standards, advantages of standardization, use of design data book, use of standards in design and preferred numbers series.
8	Theories of Elastic Failures Principal normal stress theory, Maximum shear stress theory & maximum distortion energy theory.
9	Modern Design considerations Design for safety, Ecology, societal consideration
10	Concept of Product Design, System Design & Creativity in Design, Ergonomics
11	Aesthetic considerations in design
12	Revise the Basic Design Considerations, Factors in Design, Modern Design considerations, suggest possible questions on the topic and the method of writing the answers during examination.
Topic II	Name**: DESIGN OF JOINTS, LEVERS AND OFFSET LINKS** **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 more meaningful. e.g.

Knowledge Category	Example/s of category	Teaching methodology
FACT	**Joints and Levers**	Explain by showing different available joints and levers.
CONCEPT	**Cotter joint, knuckle joint, turn buckle, hand and foot lever, bell crank lever, C-clamp, over head crank.**	Explain different parts, their use in the particular type of joints and levers by showing models or ppts
PRINCIPLE	**Modes and Theories of failure of different joints and levers**	Explain Modes and Theories of failure using simple available joints and levers.
PROCEDURE	**Analysis of forces & stresses, Identification of failure area and their strength equation.**	Explain design procedure of different joints and levers. Also solve simple numerical
APPLICATION	**Design of Cotter joint, knuckle joint, turn buckle, hand and foot lever, bell crank lever, C- clamp, over head crank.**	Explain by actually designing the different joints and levers.

Learning Resources:

Books:

Title: 1) Machine Design - RS Khurmi and Gupta - S. Chand publication
2) Machine Design - VB Bhandari - Tata McGraw Hill publication
3) Design Data Book - PSG - PSG College of Technology Coimbatore
Theory and problems of Machine Design - Hall,Holowenko,Laughlin-McGraw Hill

Teaching Aids:
1. Chalk Board
2. Power Point Presentation
3. Models and standard parts

PPTs: Teacher to develop the power point presentations for the topics

Websites :- www.slideshare.net to get the relevant power points

1	Design of Cotter Joint,
2	Design of Knuckle Joint
3	Design of Turnbuckle
4	Design of Levers:- Hand/Foot Lever

<table>
<tr><td>5</td><td>Design of Bell Crank Lever, Lever for lever safety valve</td></tr>
<tr><td>7</td><td>Design of Design of Off-set links</td></tr>
<tr><td>8</td><td>Design of C - Clamp, Overhang Crank</td></tr>
<tr><td>Topic III</td><td>Name: DESIGN OF SHAFTS, KEYS AND COUPLINGS
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 more meaningful.
e.g.
<table>
<tr><th>Knowledge Category</th><th>Example/s of category</th><th>Teaching methodology</th></tr>
<tr><td>FACT</td><td>Shaft, Key, Coupling, Gear</td><td>Explain by showing different available Shaft, Key, Coupling, Gear</td></tr>
<tr><td>CONCEPT</td><td>Stresses in Key, Coupling, Shaft and Gear</td><td>Explain different Shaft, Key, Coupling, Gear parts, their uses by showing models or ppts</td></tr>
<tr><td>PRINCIPLE</td><td>Modes and Theories of failure of Shaft, Key, Coupling, Gear</td><td>Explain Modes and Theories of failure of Shaft, Key, Coupling, Gear</td></tr>
<tr><td>PROCEDURE</td><td>Analysis of forces & stresses, Identification of failure area and their strength equation.</td><td>Explain design procedure of Shaft, Key, Coupling, Gear Also solve simple numerical</td></tr>
<tr><td>APPLICATION</td><td>Design of Shaft, Key, Coupling, Gear</td><td>Explain by actually designing the Shaft, Key, Coupling, Gear</td></tr>
</table>
Learning Resources:

Books:

Title: 1) Machine Design - RS Khurmi and Gupta - S. Chand publication
2) Machine Design - VB Bhandari - Tata McGraw Hill publication
3) Design Data Book - PSG - PSG College of Technology Coimbatore
4) Machine Design - U C Jindal - Pearson Education India

Teaching Aids:
1. Chalk Board
2. Power Point Presentation
3. Models and standard parts

PPTs: Teacher to develop the power point presentations for the topics

Websites :- www.slideshare.net to get the relevant power points</td></tr>
<tr><td>1</td><td>Types of Shafts, Shaft materials, Standard Sizes,
Design of shafts (Hollow and Solid) using strength and rigidity Criteria.</td></tr>
<tr><td>2</td><td>ASME code of design for line shafts supported between bearings with one or two</td></tr>
</table>

<table>
<tr><td></td><td>pulleys in between or one overhung pulley</td></tr>
<tr><td>3</td><td>Simple numerical on Design of shaft</td></tr>
<tr><td>4</td><td>Types of keys
Design of rectangular keys</td></tr>
<tr><td>5</td><td>Design of parallel sunk keys
Effect of Keyways on strength of shaft.</td></tr>
<tr><td>6</td><td>Simple numerical on Design of key</td></tr>
<tr><td>7</td><td>Couplings:- Their uses, classification and comparison
Design of Couplings :-Flanged couplings</td></tr>
<tr><td>8</td><td>Design of Couplings:- unprotected and protected types</td></tr>
<tr><td>9</td><td>Design of Bush-pin type flexible coupling.</td></tr>
<tr><td>10</td><td>Simple numerical on above Couplings</td></tr>
<tr><td>11</td><td>Gears and its nomenclature
Design of spur gear
Lewis equation for static beam strength of spur gear teeth</td></tr>
<tr><td>12</td><td>Power transmission capacity of spur gears in bending</td></tr>
<tr><td>13</td><td>Gear tooth failure modes – Scoring, scuffing Pitting & Teeth Breakage</td></tr>
<tr><td>14</td><td>Simple numerical on Design of spur gear</td></tr>
<tr><td>Topic IV</td><td>Name: DESIGN OF POWER SCREW
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 more meaningful.
e.g.
<table>
<tr><th>Knowledge Category</th><th>Example/s of category</th><th>Teaching methodology</th></tr>
<tr><td>FACT</td><td>Power screw, screw jack, toggle jack</td><td>Explain by showing different thread profiles by ppt. and uses</td></tr>
<tr><td>CONCEPT</td><td>Stresses in screw.</td><td>Explain different stresses developed in the power screw by application of torque by ppt.</td></tr>
<tr><td>PRINCIPLE</td><td>Modes and Theories of failure of different parts of Screw Jack and Toggle Jack</td><td>Explain Modes and Theories of failure of different parts of Screw Jack and Toggle Jack by actual drawing the failure areas on board.</td></tr>
<tr><td>PROCEDURE</td><td>Analysis of forces & stresses, Identification of failure area and their strength equation.</td><td>Explain design procedure of screw jack, toggle jack Also solve simple numerical</td></tr>
<tr><td>APPLICATION</td><td>Design of screw jack, toggle jack</td><td>Explain by actually designing the screw jack, toggle jack</td></tr>
</table>
Learning Resources:

Books:</td></tr>
</table>

	Title: 1) Machine Design - RS Khurmi and Gupta - S. Chand publication 2) Machine Design - VB Bhandari - Tata McGraw Hill publication 3) Design Data Book - PSG - PSG College of Technology Coimbatore 4) Machine Design - U C Jindal - Pearson Education India Teaching Aids: 1. Chalk Board 2. Power Point Presentation 3. Models and actual instruments PPTs: Teacher to develop the power point presentations for the topics Websites :- www.slideshare.net to get the relevant power points
1	**Basic concepts of screw and its terminology** Thread Profiles used for power Screws, relative merits and demerits of each
2	Self locking and overhauling properties Torque required to overcome thread friction for lowering and raising the load
3	Efficiency of power screws, types of stresses induced
4	Importance and applications of Screw Jack, different parts & materials, their empirical relations.
5	Screw Jack, details and assembly, failure equations.
6	Design of Screw Jack to get the unknown dimensions of parts of screw jack
7	Simple numerical on Design of screw jack (only Screw and nut)
8	Importance and applications of Toggle Jack, different parts & materials, their empirical relations.
9	Toggle Jack, details and assembly, failure equations.
10	Simple numerical on Design of Toggle jack (only Screw and nut)
Topic V	Name**: DESIGN OF SPRINGS** **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 more meaningful.** **e.g.**

Knowledge Category	Example/s of category	Teaching methodology
FACT	**Spring and its classification**	Explain by showing different available Springs
CONCEPT	**Stresses in different springs**	Explain different Springs their uses by showing actual springs or ppts
PRINCIPLE	**Modes and Theories of failure of different helical springs**	Explain Modes and Theories of different helical springs
PROCEDURE	**Analysis of forces & stresses, Identification of failure area and their strength equation.**	Explain design procedure of different helical compression and tension springs Also solve simple numerical

APPLICATION	**Design of different helical springs**	Explain by actually designing the different helical springs for different applications.

Learning Resources:

Books:

Title: 1) Machine Design - RS Khurmi and Gupta - S. Chand publication
2) Machine Design - VB Bhandari - Tata McGraw Hill publication
3) Design Data Book - PSG - PSG College of Technology Coimbatore
4) Machine Design - U C Jindal - Pearson Education India

Teaching Aids:
1. Chalk Board
2. Power Point Presentation
3. Models and standard parts

PPTs: Teacher to develop the power point presentations for the topics

Websites :- www.slideshare.net to get the relevant power points

1	Definition**,** Classification and Applications of Springs,
2	Spring - terminology, materials specifications.
3	Stresses in helical tension and compression springs,
4	Wahl's correction factor, Deflection of springs, Energy stored in springs**.**
5	Design of Helical tension and compression springs for I.C. engine valves, weighing balance
6	Design of Helical tension and compression springs for railway buffers and governor springs
7	Simple numerical on Helical tension and compression Spring.
8	Leaf springs - construction and applications

Topic VI

Name**: DESIGN OF THREADED AND WELDED 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 more meaningful.

e.g.

Knowledge Category	**Example/s of category**	**Teaching methodology**
FACT	**Screw fasteners and welded joints**	Explain by showing different available fasteners and small welded components
CONCEPT	**Stresses in different fasteners and welded joints**	Explain different fasteners and small welded components by showing actual fasteners and small welded

		components or ppts
PRINCIPLE	**Modes and Theories of failure of different fasteners and welded joints**	Explain Modes and Theories of different fasteners and welded joints
PROCEDURE	**Analysis of forces & stresses, Identification of failure area and their strength equation.**	Explain design procedure of different fasteners and welded joints Also solve simple numerical
APPLICATION	**Design of different fasteners and welded joints**	Explain by actually designing the different fasteners and welded joints for different applications.

Learning Resources:

Books:

Title: 1) Machine Design - RS Khurmi and Gupta - S. Chand publication
2) Machine Design - VB Bhandari - Tata McGraw Hill publication
3) Design Data Book - PSG - PSG College of Technology Coimbatore
4) Machine Design - U C Jindal - Pearson Education India

Teaching Aids:
1. Chalk Board
2. Power Point Presentation
3. Models and actual fasteners and welded components

PPTs: Teacher to develop the power point presentations for the topics

Websites :- www.slideshare.net to get the relevant power points

1	Stresses in Screwed fasteners, bolts of Uniform Strength,
2	Design of Bolted Joints subjected to eccentric loading**.**
3	Simple numerical on bolted joints
4	Welding, types of weld, symbols, throat thickness, size of weld.
5	Design of parallel and transverse fillet welds,
6	Axially loaded symmetrical section
7	Simple numerical on welded joints
8	Merits and demerits of screwed and welded joint
Topic VII	Name**: ANTIFRICTION BEARINGS** **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 more meaningful.** **e.g.**

	<table><tr><th>Knowledge Category</th><th>Example/s of category</th><th>Teaching methodology</th></tr><tr><td>FACT</td><td>Bearings</td><td>Explain by showing different available warn out bearings if any</td></tr><tr><td>CONCEPT</td><td>Terminology and Stresses in different Bearing</td><td>Explain different bearings and components by showing actual bearings or ppts</td></tr><tr><td>PRINCIPLE</td><td>Sliding contact and rolling contact bearing</td><td>Explain by comparing Sliding contact and rolling contact bearing by showing available warn out bearings if any</td></tr><tr><td>PROCEDURE</td><td>Identify the type of bearing</td><td>Explain by showing different types of bearing</td></tr><tr><td>APPLICATION</td><td>Selection of bearing</td><td>Explain selection of bearing using manufacturer's catalogue.</td></tr></table> Learning Resources: Books: Title: 1) Machine Design - RS Khurmi and Gupta - S. Chand publication 2) Machine Design - VB Bhandari - Tata McGraw Hill publication 3) Design Data Book - PSG - PSG College of Technology Coimbatore 4) Machine Design - U C Jindal - Pearson Education India Teaching Aids: 1. Chalk Board 2. Power Point Presentation 3. Actual warn out bearing PPTs: Teacher to develop the power point presentations for the topics Websites :- www.slideshare.net to get the relevant power points
1	Classification of Bearings – Sliding contact & rolling contact.
2	Terminology of Ball bearings – life load relationship
3	Basic static load rating and basic dynamic load rating, limiting speed.
4	Selection of ball bearings using manufacturer's catalogue.

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:

One assignment on each topic should be given after completion. The assignment should contain at least five theoretical and five numerical questions. The answers of the above questions should be discussed in the class. Discuss important point/ steps/ design methodology expected in the answer. Display the model answer on the notice board. Check the assignment in front of each students during practical

5.4

5.4.1 Laboratory Manuals: Purpose and Utility:

5.4.2 Strategies for Conduct of Practical:

1) Explain the objectives behind conducting any practical
2) Question the students related to the principles, concept or procedure during conduction of practical/ designing the component.
3)

Sr.No.	Time in Minutes	Activity of teacher	Activity of student
1	5	Explain the objective of design	Note down in their note book
2	10	Explain the design procedure for conduction of practical	Listen and note down points
3	15	Guide the student during designing the machine element.	Note down the design procedure
4	30	Observe & Guide the student for design calculation	Carry out design calculation
5	5	Discussion the obtained dimensions and clarify queries of the students	Correction of results (if any) on the basis of discussions and queries
6	45	Discuss the detailed and assembly drawing	Draw the detailed and assembly drawing of the component on drawing sheet

7	10	Checking manuals and taking attendance	Completion of practical for assessment

5.4.3 Preparation for conduct of practical

1) Ask the student to summarize the design procedure for particular design element given in the practical.

2) Ask the student to draw proportionate sketch of given element.

3) Ask the student to start designing the given element.

4) Help the students during design calculations.

5) Discuss the obtained dimensions of the given element for safer design.

6) Ask the students to draw the detailed and assembly drawing as per obtained dimension on half imperial sheet using suitable scale.

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 1

Roll No.				

17610

Institute Name:
Course Name: **MECHANICAL ENGINEERING GROUP** Course Code: ME/PG/PT
Semester : SIXTH
Subject**: DESIGN OF MACHINE ELEMENTS**
Marks: **25** Time: **1 hour 15 min**

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 **3 x 3= 9 Marks**

a) State any six design consideration in designing the machine element.
b) Define Fatigue, Factor of Safety and Creep.
c) List steps in designing Bell crank lever.
d) Classify rigid coupling. State any one application of each.

Q2. Attempt any ONE **1 x 8= 8 Marks**

a) Draw neat sketch showing all details of cotter joint. State strength equations for each component with suitable failure cross sectional area.
b) Describe the importance of aesthetic considerations in design related to shape, size, color and surface finish.

Q3. Attempt any ONE **1 x 8= 8 Marks**

a) A line shaft is driven by means of a motor placed vertically below it. The pulley on the line shaft is 1.5 meter in diameter and has belt tension 5.4 KN and 1.8 KN on the right side and slack side of belt respectively. Both these tension may be assumed to be vertical. If the pulley be overhang from the shaft, the distance of the centre line of the pulley from the center line of the bearing being 400mm. Find the diameter of shaft, assuming maximum allowable shear stress of 42MPa.
b) Design a CI protective type flange coupling to transmit 15KW at 900 rpm from an electric motor to a compressor. Assume shear stress for shaft, bolt and key materials = 40MPa, Crushing stress for bolt and key = 80MPa and shear stress for CI material = 8MPa. Assume suitable data if required.

Sample Test Paper 2

Roll No.				

17610

Institute Name:
Course Name: **MECHANICAL ENGINEERING GROUP** Course Code: ME/PG/PT
Semester : SIXTH
Subject**: DESIGN OF MACHINE ELEMENTS**
Marks: **25** Time: **1 hour 15 min**

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 **3 x 3= 9 Marks**

a) State the strength equations when two rectangular plates are joint by double transverse weld and single longitudinal weld.
b) State the meaning of following terms related to helical spring.(i) Spring Index (ii) Spring Rate (iii) Solid length
c) State various stresses induced in screw fasteners.
d) Classify bearing in details .

Q2. Attempt any ONE **1 x 8= 8 Marks**

a) (i) Why square threads are preferred over V- thread for power transmission ?
(ii) Describe self locking property of threads. State its importance.
b) Design a helical spring for a spring loaded safety valve for the following conditions.
Operating pressure P_1 = N/mm^2,Maximum pressure when the valve is blow off freely P_2 = 1.075N/mm^2, Maximum lift of the valve when pressure is 1.075N/mm^2 =δ =6mm, diameter of valve seat D_v = 100mm, f_s max = 400 N/mm^2, G = 86 x 10^6 N/mm^2, Spring index C =5.5.
Show the obtained dimensions on proportionate sketch.

Q3. Attempt any ONE **1 x 8= 8 Marks**

c) (i) State the application of following bearings. Deep groove ball bearing, Taper roller bearing, Thrust roller bearing and Needle roller bearing. (4M)
(ii) A plate 75 mm wide and 12.5mm thick is joined with another plate by single transverse and double parallel fillet weld. The maximum tensile and shear stress are 75MPa and 56MPa respectively. Find the length of each parallel fillet weld, if the joint is subjected to pull of 90KN. (4M)
b) (i) State the formula for Walh's correction factor and its importance in design of spring. (2M)
(ii) A toggle jack is used to lift a load of 5 KN. The jack is operated by means of a 400mm long lever. The eight symmetrical links are 125mm in length. Design the screw and nut

if permissible tensile stress is limited to 20N/mm2. take co-efficient as 0.15. Assume pitch of the thread as 6mm. (6M)

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**

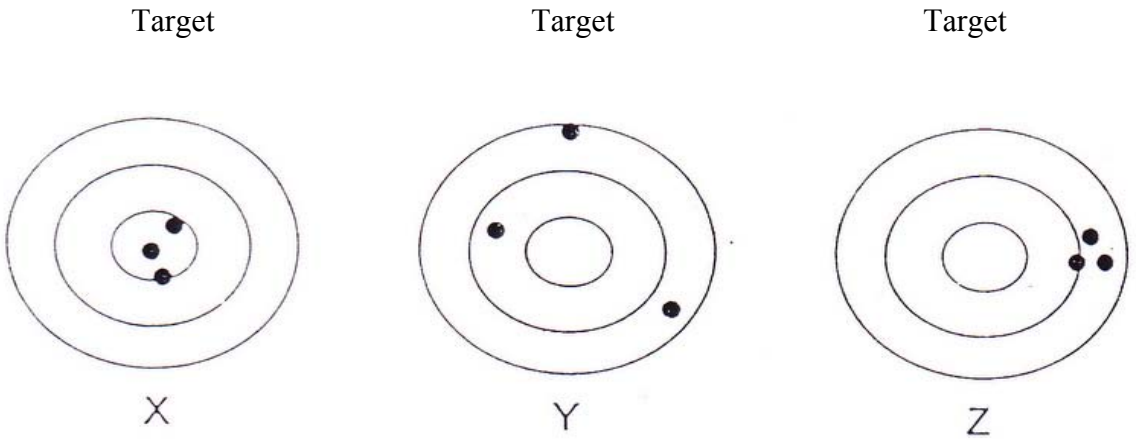
This relates to consistency with which examiners examine and mark the answer scripts/books. If marks assigned to answers are greatly influenced by the examiner's state of mind at that moment, no one will keep faith in the assigned marks, and reliability of marking is adversely affected.

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"



Reliable & Valid Shooting | Unreliable & Invalid Shooting | Reliable but invalid 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.

6.3.3 Sample Question Paper:

Exam Seat No.									

17610

Maharashtra State Board of Technical Education

Course Name: **MECHANICAL ENGINEERING GROUP** Course Code: ME/PG/PT

Semester: **SIXTH**

Title of the Subject: **DESIGN OF MACHINE ELEMENT** Subject Code: 17610

Marks: 100 Time: 4 Hours

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(a). Attempt any THREE. **12 Marks**

i) What is stress concentration? State its significance in machine design. (1U4)
ii) Write the design procedure for turn buckle.(2R4)
iii) Draw neat sketch showing all details of protective type flange coupling. (3A4)
iv) Define Pitch and Lead of screw thread.(4R4)

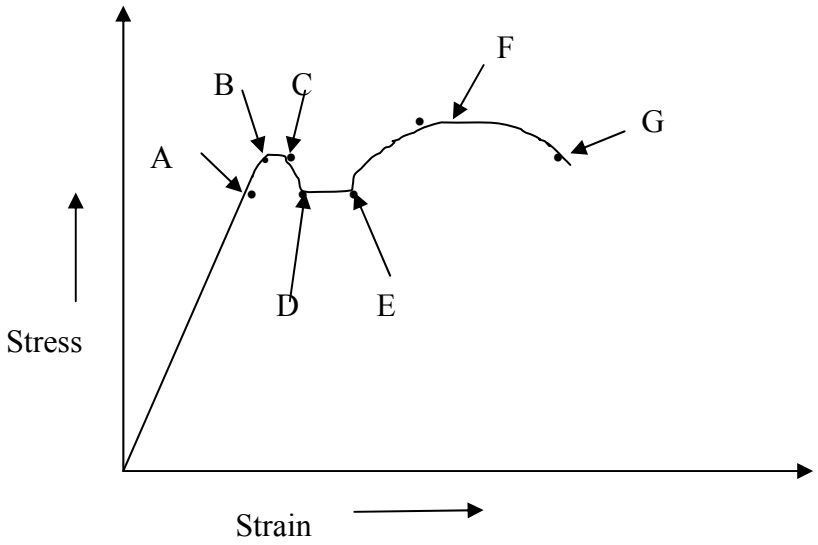
Q1(b). Attempt any ONE. **6 Marks**

i) State and describe in brief any six ergonomics consideration in design of machine elements.(1R6)
ii) Determine the diameter of hollow shaft having inside diameter 0.6 times outside diameter. The shaft is driven by a 900mm diameter overhang pulley placed vertically. The weight of pulley is 600N. The overhang is 250mm. the tension in the tight and slack sides are 2900N and 1000N respectively. Assume fs=85N/mm2.(3A6)

Q2. Attempt any TWO. **16 Marks**

a) Differentiate Key and Cotter (any four points). Also explain why taper is provided on cotter? Give recommended values of taper.(2U8)
b) Compare the weight and strength of hollow shaft of same external diameter as that of solid shaft. The inside diameter of the hollow shaft being half the external diameter. Both the shafts have same material and length.(3U8)

c) (i) Figure shows stress strain diagram for material. Redraw and identify the type of material and name the meaning of points A to G.(1A4)



(ii) State any two applications of cotter joint and Knuckle joint.(2A4)

Q.3. Attempt any FOUR . 16 Marks

a) Give the compositions of 1. 35 Mn 2Mo 45 Steel 2. 30 cr 13 and XT72W18Cr4V1.(1R4)
b) Design knuckle joint to transmit 150 KN, the design stress may be taken as 75MPa in tension, 60MPa in shear and 150MPa in compression. (2A4)
c) Prove that for square key, the permissible crushing stress is twice the permissible shear stress.(3R4)
d) Describe bolt of uniform strength with neat sketch.(6U4)
e) Design a rectangular key for shaft of 50mm diameter. The permissible stresses for key material are 40N/mm2 in shear and 70N/mm2 in crushing.(3A4)

Q4 (a). Attempt any THREE. 12 Marks

i) State aesthetic consideration in design of office table context to following points:- Shape, Size, Color and Surface finish.(1A4)
ii) State the formula for deflection of spring. State the meaning of each term.(5R4)
iii) State the effect of key way on the strength of shaft with suitable diagram. (3U4)
iv) State any four advantages and disadvantages of welded joints over riveted joint.(6R4)

Q4 (b) . Attempt any ONE. 6 Marks

i) State any six design considerations while designing the spur gear.(3R6)
ii) State any six factors to be considered while selecting higher factor of safety.(1U6)

Q 5. Attempt any TWO. 16 Marks

a) A screw jack carries a load of 80KN. Assume the coefficient of friction between screw and nut as 0.14 and pitch of screw as 8mm. neglect collar friction and collar action. The allowable stresses of screw material in tension and compression are 100N/mm2 and in shear is 60N/mm2. The material for the nut is phosphor-bronze for which the allowable stresses may be taken as 50N/mm2 in tension, 45N/mm2 in crushing and 40N/mm2 in shear. The bearing

pressure between nut and the screw is not to exceed 18N/mm2. design and draw the screw and nut of the screw jack. (4U8)

b) A rail wagon of mass 20 tones is moving with a velocity 2m/s. It is brought to rest by two buffers with spring of 300mm diameter. The maximum deflection of spring is 250mm. the allowable shear stress in the spring material is 600MPa. Design the spring for the buffers.(5U8)

c) i) State any four applications of Hydrostatic bearing and sliding contact bearing.(7A4)

ii) State the engineering applications of Acme thread profile and Buttress thread profile with neat sketch.(4A4)

Q 6. Attempt any FOUR. 16 Marks

a) State the merits and demerits of screwed joint over welded joints (any four each).(6U4)

b) Design a compression helical spring with ground ends prepared out of bronze for the valve, used in hydraulic circuit. The spring index is 12. Maximum load on the spring is 100 N. Safe shear stress is 100N/mm2. modulus of rigidity is 4x104 N/mm and the deflection under maximum load is 15mm. find out- (1) diameter of spring wire (2) diameter of spring coil (3) number of spring coils (4) stiffness of spring. (5A4)

c) A wall bracket shown in figure 1is fixed to a wall by means of four bolts, find the size of bolt. The permissible tensile stress for bolt material is 70 N/mm^2.(6A4)

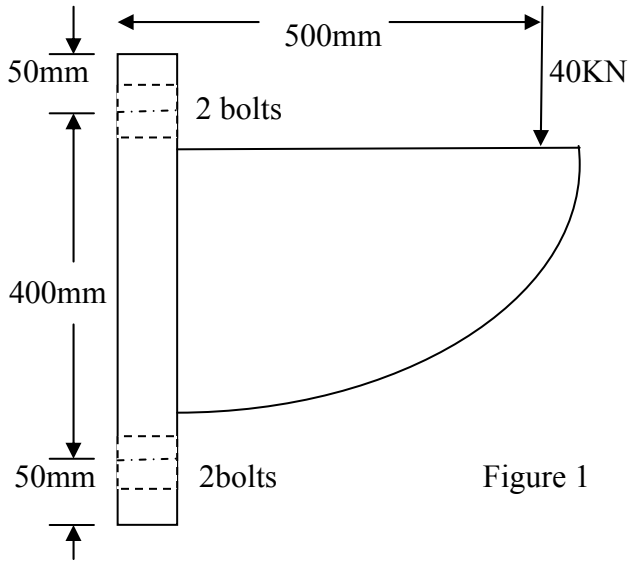


Figure 1

d) Compare Sliding contact bearing and Roller contact bearing on the basis of size, life, coefficient of friction and housing diameter.(7R4)

e) Write down the procedure for selection of bearing from manufacturers catalogue. (7U4)
