CURRICULUM REVISION PROJECT

2012

TEACHER GUIDE FOR STRENGTH OF MATERIALS (17304)

THIRD SEMESTER MECHANICAL ENGINEERING GROUP

JUNE 2013

MAHARASHTRA STATE
BOARD OF TECHNICAL EDUCATION, Mumbai

I N D E X

1. APPROACH TO CURRICULUM DESIGN

1.1 Background:

MSBTE is introducing the revised curriculum 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.

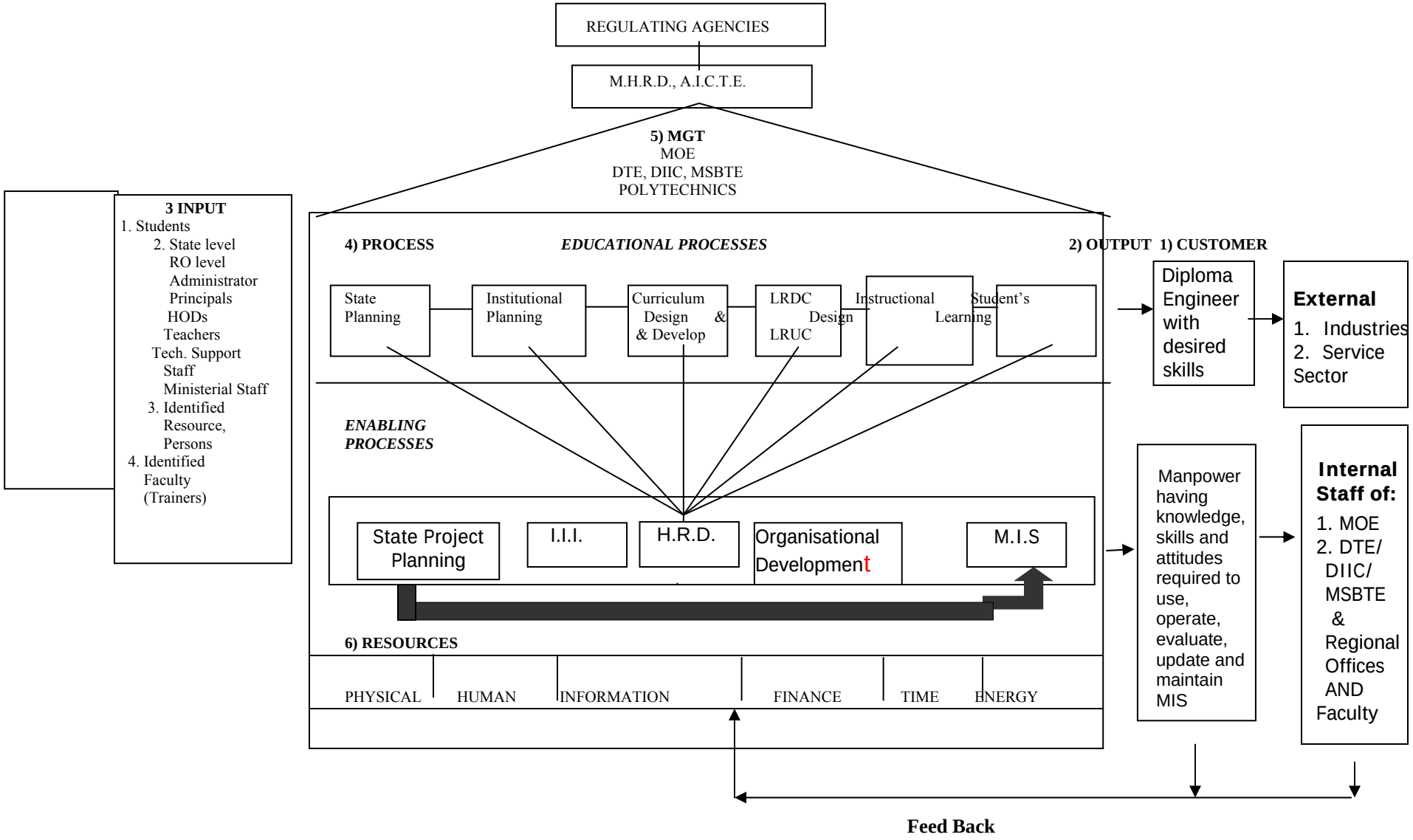


Fig 1 Systems Approach

1.4 Curriculum goals

1. To develop confidence in students by providing more exposure to industry experience and world of work at global level.
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.

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

1.5 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 Engineering 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 Engineering 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 either at the fifth and sixth semesters 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 Mechanical Engineering Group CADD, 3D Modelling, CNC Machines, Engine Maintenance (AUTO) are introduced as independent subjects.

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.

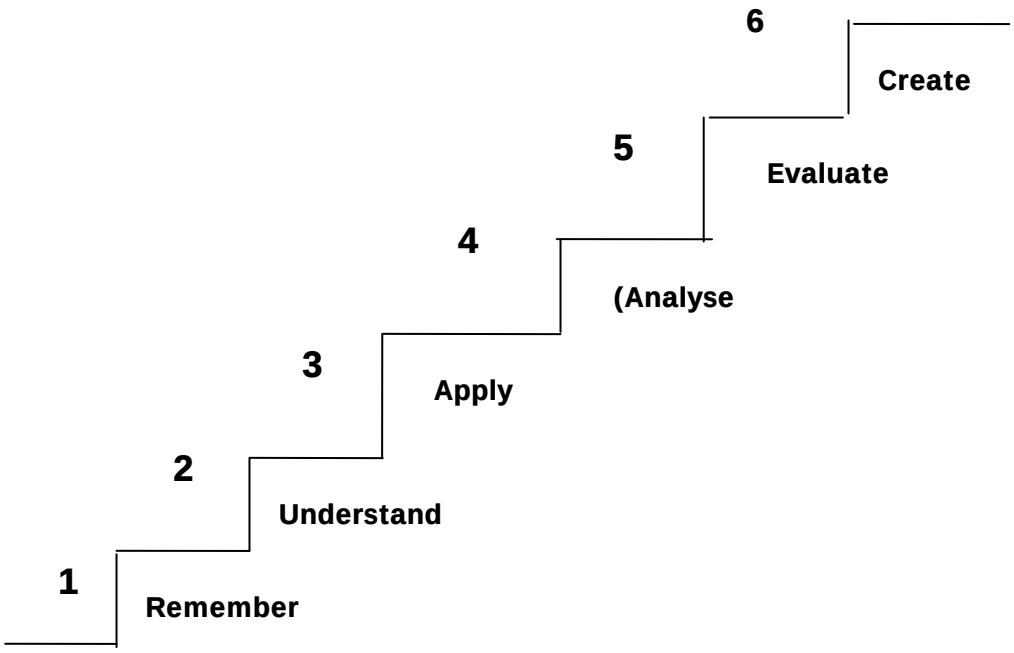
2.4 LEVELS OF LEARNING:

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	Understands fact, principles Interprets verbal material, Interprets charts, tables,	Convert, distinguish estimate, explain, extend, generalize,

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.	graphs. Translates verbal material to mathematical formula. Estimates consequences implied in data. Justifies methods & procedures.	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.

Importance of the subject is on two counts:

One the knowledge gained while studying the subject helps understand and develop further knowledge of the subject or understand and effectively learn the higher level subjects.

The other indicates how the knowledge gained can be used in the world of work to perform given tasks.

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

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

Objectives indicate what is achievable and hence gives direction ot 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 in Cognitive Domain knowledge is divided in four components Factual, Conceptual, Procedural and Metacognitive. Of this Factual, Conceptual and Procedural knowledge components are identified in the curriculum of the subject along with the applications. Learning structure gives broad idea of these components for a subject. It indicates the scope of the subject. Normally we first decide what we want to achieve by studying the subject, which forms the application component. Based on this we decide what procedures are required for these 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.

One has to be careful in allotting the hours required to teach the topics looking at the importance of the topic for development of the subject. There fore it is necessary to provide sufficient time to teach concepts and principles so that they are well understood by the students as they form the basis for development of the subject.

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 there should not be any study type experiment as it is nothing but repetition of what is taught in the theory class. 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 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 (I 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. Materials, Manufacturing Processes, Heat treatment processes, patterns, molding processes, casting processes, cutting tools, and machine tools .

2. **Abstract Concepts:** those which cannot be seen and touched and handled but can only be imagined e.g. working principle of casting, working principle of lathe including shear of metal. 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 Pattern**

Attributes:

1. Replica of component to cast
2. Suitable material for pattern to be selected depending upon complexity involed.
3. Selection of pattern depending upon its size, shape and orientation.
4. Pattern allowances
5. Colour coding of pattern

.

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

1. What is it?
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. Working principle of Lathe – Principle of working of lathe is that a material is removed from a rotating job by a single point cutting tool which past the workpiece.

2. Principle of heat treatment – The material is heated to certain desired temperature and is allowed to cool in different media so as to change mechanical properties

.

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. Casting used in automobiles, pumps, hardware etc.

2. Turned components like pins, shafts, flanges, etc.

3. Holes made in various engineering components or jobs

.

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 with engineering and technological

aspects of that procedure. We should not pre-suppose that the students understand them. We cannot afford to take these things for granted. We should try our best to show live demonstration / VDO clip if possible. (Some clips and animations are available on official website of NPTL)

For Example:

1. Sequential procedure of casting
2. Procedure of setting of single point cutting tool on tool post of lathe
3. Procedure to operate 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. Making of pattern from given material with the help of carpentry tools ,
2. Setting of a lathe to turn the given job
3. Confirmation of dimensions of the component with dimensions on the drawing.
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 or 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 : Mechanical Engineering Group

Course Code : ME/PG/PT/AE/MH/MI/FE/PS

Semester : Third

Subject Title : Strength of Materials

Subject Code : 17304

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
03	--	02	03	100	--	--	25@	125

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:

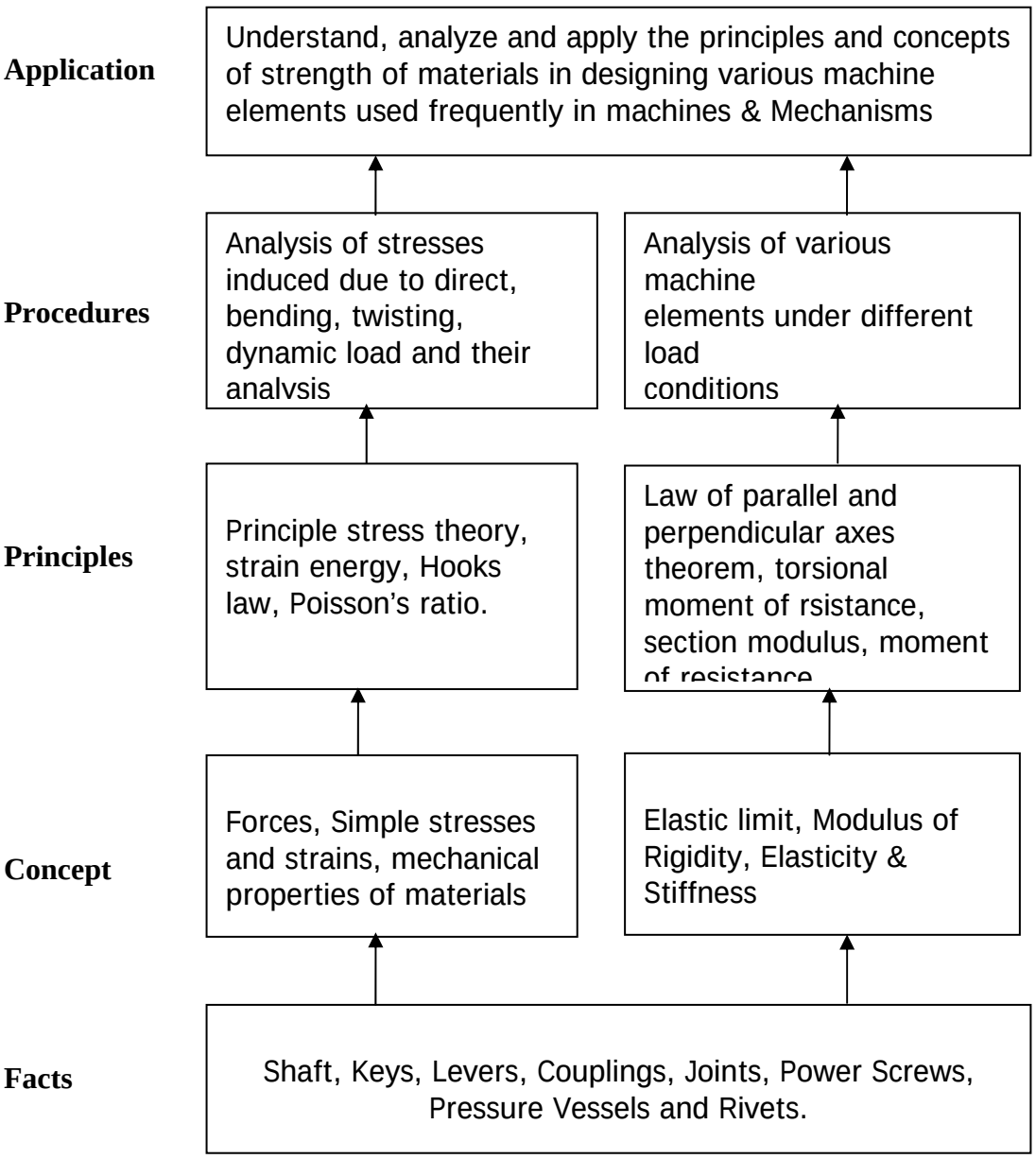
Strength of Material is a core technology subject. It aims at enabling the student to understand & analyze various types of loads, stresses & strains along with main causes of failure of machine parts. The subject is pre-requisite for understanding principles of machine design. Understanding mechanical properties of materials will help in selecting the suitable materials for various engineering applications.

General Objectives:

The Student will be able to:

1. Understand the fundamentals of solid mechanics.
2. Acquire elementary knowledge of stresses, strains & material properties.
3. Understand & analyze the basic principles involved in the behavior of machine parts under load in the context of designing it.
4. Understand & analyze the mechanical properties of the various materials.

Learning structure:



Theory

Topic and Contents	Hours	Marks
1. Mechanical Properties of Materials, Simple Stresses & Strains Specific Objectives. ➢ Acquire elementary knowledge of stresses, strains and material properties. ➢ Study and apply Euler's theory Contents 1.1 Mechanical properties and Concept of Simple stresses & strains. **8 marks**	10	16

• Elasticity, Plasticity, Plastic flow, Ductility, Malleability, Stiffness & Strength. • Types of loads, stresses- tensile, compressive, Shear, single & double shear, concept of plain strain –tensile ,compressive, direct shear strain, torsional shear strain, lateral strain, Hooke's law, • Poisson ratio common values for C.I.& M.S. Relation between stress-strain. Stress-strain diagram for tensile & brittle materials, important points on the stress- strain diagram, • Modulus of elasticity & modulus of rigidity, Volumetric Strain, Bulk modulus, relation between modulus of elasticity & modulus of rigidity. • Thermal stresses - Temperature stresses & strains of uniform section. 1.2 Composite section. **-- 4 Marks** ➢ Stress & strains in bars of stepped & uniformly varying sections subjected to axial load at ends only, composite sections having same length. 1.3 Buckling of long columns **-- 4 Marks** 'Euler's theory, Rankine's theory – equivalent length of the column for the cases below • Both ends hinged, One end fixed and other free, Both ends fixed, One end fixed and other end hinged. (simple numerical only)		
2. Principal stresses and planes. Specific Objectives. ➢ Acquire elementary knowledge of hoop stresses & principal stresses. Contents 2.1 Concept of Principal stresses and Principal planes. Stresses on an oblique section of a body subjected to Direct stresses on one plane. • Direct stresses on mutually perpendicular planes. • Direct and Shear stress on one plane. • Direct and Shear stress on mutually • Perpendicular plane (No derivations). • Mohr's circle method for finding principle stresses and planes (only simple numericals). 2.2 Thin Cylindrical shell • Stresses in thin closed cylindrical vessels subjected to internal pressure, Hoop stress, Radial & Axial Stress.(Simple numericals only)	05	08
3. Bending Moment & Shear Force Specific Objectives. ➢ Understand & analyse the basic principles involved in the behaviour of machine parts under load in the context of designing it Contents 3.1 Concept & definition of Shear force & bending moment • Relation between rate of loading, shear force & bending moment. • Shear force & bending moment diagrams for cantilevers, simply supported beam & over hanging beam subjected to point loads &	08	16

uniformly distributed load. Location of point of contra flexure		
4. Moment of Inertia Specific Objectives. ➢ Determine Area Moment of Inertia of regular and composite sections. Contents • 4.1 Concept & definition of Moment of inertia, Parallel & perpendicular axes theorem. • (No derivation) • Moment of inertia of solid sections-square, rectangular, circular, semicircular, Triangular Hollow sections- square, rectangular & circular cross sections only. • Moment of Inertia of angle section, Channel section, Tee- section, I - section about centroidal axis & any other axis parallel to centroidal axis. • Polar moment of inertia.	06	16
5. Bending Stresses Specific Objectives. ➢ Acquire and apply knowledge of bending stresses & shear stresses Contents 5.1 Theory of simple bending, • Assumptions in the theory of bending, moment of resistance, section modulus, neutral axis. Stress distribution diagram for Cantilever & simply supported beam. Equation of bending (Simple numericals based on formula) 5.2 Concept of direct & transverse shear stress. . Transverse Shear stress equation (No derivation). Shear stress distribution diagrams Average shear stress & Maximum shear stress for rectangular & circular section	06	12
6. Direct and Bending Stresses Specific Objectives. ➢ Acquire and apply knowledge of bending stresses and direct stresses. Contents 6.1 Concept of Axial load, eccentric load, direct stresses, bending stresses, maximum & minimum stresses. Stress distribution diagram. -- 4 marks Problems on the above concepts for strut, machine parts such as offset links, C-clamp, Bench vice, Drilling machine frame etc. -- 8 marks Condition for no tension in the section, core of section -- 4 marks	07	16
7. Torsion 16 Marks Specific Objectives. ➢ Understand and apply the concept of pure torsion and stresses due to Power Transmission Contents 7.1 Concept of Pure Torsion, • Assumptions in theory of pure Torsion, Torsion equation for solid and hollow circular shafts, stress distribution across solid circular shaft.(No	06	16

derivation) • Power transmitted by a shaft. **--10 marks** 7.2 Comparison between Solid and Hollow Shafts subjected to pure torsion (no problem on composite and non homogeneous shaft) **-- 6 marks**		
Total	**48**	**100**

Practicals:
Skills to be developed:

Intellectual Skills:-

1. Identify different stresses in machine parts.
2. Interpret the test results.
3. Test different metals & compare experimental results.
4. Calculate the shear force & bending moment.

Motor Skills:-

1. Use of instruments and equipments.
2. Sketching of standard specimen.
3. Prepare machines for tests.
4. Observe & compare behaviour of different materials during test.
5. Draw shear force & bending moment diagram for different types of loading on beams.

Practicals:

1. Know your laboratory to understand the difference Machines / their components and purpose.
2. Understand different components, their purpose and operations of "Universal Testing Machines" by conducting a trial on sample test specimen.
3. Understand different components, their purpose and operations of Extensometer by conducting a trial on sample test specimen.
4. Tension test on mild steel and aluminum specimen by using Universal Testing Machine (UTM) to calculate yield stress, ultimate stress, breaking stress, percentage elongation and moduli of Elasticity.
5. Compression test on cast iron specimen by using "Universal Testing Machine".
6. Determine the shear strength of mild steel bar in single and double shear by using "Universal Testing Machine"
7. Determine the Brinell hardness number of mild steel specimen and also its equivalent by the other method.

8. Izod or charpy test on M.S., copper, aluminum and brass specimen to calculate energy absorbed.
9. Conduct torsion test on mild steel bar and find breaking torsional shear strength and stiffness.
10. To calculate and draw the S. F. D. and B. M. D. for cantilever, simply supported and overhang beams.
11. To determine principal stresses and to locate principal planes for a given loading by analytical and graphical (Mohr's circle) methods.

Note - Use relevant IS codes for conducting the tests.

List of Assignments:

1. Problems on Shear force & bending moment diagram to be drawn on graph paper. (Minimum four)
2. Problems on principal plane and principal stresses by Mohr's circle method. (Minimum four)

Learning Resources:

1. Books:

Sr. No.	Title	Author	Edition	Publisher
01.	Strength of material	R.S.Khurmi	Reprint 2005	S.Chand Company Ltd. Delhi
02.	Fundamentals of Strength of Materials	Debabrata Nag & Abhijit Chanda	Reprint 2011	Wiley India
03.	Strength of Materials	S.S. Ratan	Second Edition 2008,Reprint 2011	Tata McGraw Hill New Delhi
04.	Strength of Materials	R. Subramanian	Second Edition 2010	Oxford University Press
05.	Strength of Material	S Ramamrutham & R. Narayanan	6^{th} Edition	Dhanpat Rai & Publication New Delhi
06.	Strength of Material	S. S. Bhavikatti	Third edition	Vikas publishing House Pvt. Ltd

2. ISO, IS, BS Codes:

I S:1982(PART –I),
I S:5242-1979,
I S:1500-1983,
I S:1598-1977,
I S:1757-1973,
I S:1717,
I S:800,

5. IMPLEMENTATION STRATEGY:

5.1 Planning of Lectures for a Semester with Content Detailing:

Topic I	Name**:-Mechanical Properties of Materials, Simple stresses & Strains** Facts:- Shaft, column, rivet, fixed and hinged end free end of column Concepts:- Forces, simple stresses and strains, mechanical properties of materials, elastic limit, modulus of rigidity, bulk modulus ,modulus of elasticity, Temperature stress and strain. Principles:- Hooks law, poisons ratio, Euler's theory, Rankin's theory Sample objectives for the sub-topic 1] Student should able to identify the shaft and column/ Hinged and free end of column. 2] Student shall define stress and strain, Hooks law Introduce student by bringing the sample of shaft. Bring the model of multi-storeyed building and show the column and its significance. Tell the effect of stress and strain. Show the distorted components due to stress & strain. Reference Material:- Books:- Title:-1) Strength of material by R.S.Khurmi, page 12-107, page795-820 2) Strength of material by S Ramamrutham & R. Narayanan, page 1-112,page 993-1046 Teaching Aids:- Chalk, Blackboard, OHP, LCD Projector PPT with Sample:- Websites:- http://en.wikipedia.org/wiki/mechanical
Lecture No.	Topic/ Subtopic to be covered
1	Elasticity, Plasticity, Plastic flow, Ductility, Malleability, Stiffness & Strength
2	Types of loads, stresses- tensile, compressive, Shear, single & double shear ,concept of plain strain –tensile ,compressive, direct shear strain, torsional shear strain, longitudinal strain, lateral strain.

3	Poisson ratio, common values for C.I.& M.S. Relation between stress- strain, Hooks law. Stress-strain diagram for tensile & brittle materials.
4	Modulus of elasticity & modulus of rigidity, Volumetric Strain, Bulk modulus, relation between E ,G& K.
5	Simple numerical on hooks law, poisons ratio and shear stress
6	Temperature stresses & strains of uniform section, Simple numerical.
7	Stress & strains in bars of stepped & uniformly varying sections subjected to axial load at ends only, Simple numerical
8	composite sections having same length.Simple numerical
9	Eulers theory ,equivalent length of the column or the cases, both end hinged, one end fixed other end free, both end fixed, , one end fixed other end hinged.
10	Simple numerical on Eulers theory ,Rankine theory
Topic 2	**Name:-Principal stresses and plain** Facts: Plain, Principal planes, Cylinder Concepts: -Direct stress, shear stress, normal stress , hoop stress. Principals:- Mohr's Circle. Sample objectives for the sub-topic 1] Student should able to identify Principal planes and principal stresses 2] Student shall define direct stress and shear stress. 3] Student should able to solve problem by Mohar's circle method. Introduce the student to different solids, its sections by Showing different cylindrical shell, cylindrical vessels. Reference Material:- Books:- Title:-1) Strength of material by R.S.Khurmi, page108-147,page742-754 2) Strength of material by S Ramamrutham & R. Narayanan,page 858-918,page956-976 Teaching Aids: - Chalk, Blackboard, OHP, LCD Projector PPT with Sample:- Websites: - http://en.wikipedia.org/wiki/mechanical
Lecture	Topic/ Subtopic to be covered

No.	
1	Principal planes and principal stresses,stresses on oblique section of a body subjected to i) Direct stress on one plane ii) Direct stress on mutually perpendicular planes iii) direct and shear stress on one plane iv) Direct stress shear stress on mutually perpendicular plane (no proof of derivation)
2	Simple numerical on i) Direct stress on one plane ii) Direct stress on mutually perpendicular planes iii) direct and shear stress on one plane iv) Direct stress shear stress on mutually perpendicular plane.
3	Mohar's circle method on i) Direct stress on one plane ii) Direct stress on mutually perpendicular planes iii) direct and shear stress on one plane iv) Direct stress shear stress on mutually perpendicular plane.
4	Stresses in thin cylindrical vessels, hoop stress, and axial stress (no proof of derivation)
5	Simple numerical on thin cylindrical vessels, hoop stress, and axial stress.
Topic 3	**Name:- Bending Moment & Shear Force** Facts: Beam, simple support, hinged support, concentrated load ,uniformly distributed load(udl) Concepts: -force, shear force, bending moment, point of contraflexture Principals:- Law of moment, equilibrium equations Sample objectives for the sub-topic 1] Student should able to identify simple support, hinged support, concentrated load ,uniformly distributed load(udl) etc. 2] Student shall draw shear force and bending moment diagram. Introduce student to simple support/hinged support Reinforce the concept of SF/BM by solving example in class along with students and giving more assignments for complete understanding of SF and BM Reference Material:- Books:- Title: -1) Strength of material by R.S.Khurmi,page286-343 2) Strength of material by S Ramamrutham & R. Narayanan,page162-266

	Teaching Aids: - Chalk, Blackboard, OHP, LCD Projector PPT with Sample:- Websites: - http://en.wikipedia.org/wiki/mechanical
Lecture No.	Topic/ Subtopic to be covered
1	Concept & definition of Shear force & bending moment. Relation between rate of loading, shear force & bending moment.
2	Shear force & bending moment diagrams for cantilever subjected to concentrated load, udl
3	Shear force & bending moment diagrams for cantilever subjected to concentrated load and udl both.
4	Shear force & bending moment diagrams for simply supported beam subjected to concentrated load, udl .
5	Shear force & bending moment diagrams for simply supported beam subjected to concentrated load and udl both.
6	Shear force & bending moment diagrams for simply supported beam subjected to concentrated load and udl both.
7	Point of contraflexture, Shear force & bending moment diagrams for over hanging beam subjected to point loads , Uniformly distributed load.
8	Shear force & bending moment diagrams for over hanging beam subjected to point loads & Uniformly distributed load both.
Topic 4	Name**:-Moment of Inertia** Facts: Shaft, I- Section, Angle section, Channel section, U-Section ,T-Section Rectangular ,triangular section. Concepts: -Moment of Inertia , section modulas, Radius of gyration Principals:- Law of parallel and perpendicular axis theorem. Sample objectives for the sub-topic 1] Student should able to identify I- Section, Angle section, Channel section, U-Section ,T-Section Rectangular ,triangular section etc. 2] Student should able to find out M.I. of I- Section, Angle section, Channel section, U-Section ,T-Section Rectangular ,triangular section etc.

	Explain the need and significance of Moment of inertia of various symmetrical and non-symmetrical bodies. State importance of Radius of Gyration. Reference Material:- Books:- Title: -1) Strength of material by R.S.Khurmi,page184-207 2) Strength of material by S Ramamrutham & R. Narayanan,page140-161 Teaching Aids: - Chalk, Blackboard, OHP, LCD Projector PPT with Sample:- Websites: - http://en.wikipedia.org/wiki/mechanical
Lecture No.	Topic/ Subtopic to be covered
1	Concept & definition of Moment of inertia, radius of gyration, M.I. of rectangular, triangular and circular section and
2	M.I. of hallow rectangular and circular section, Parallel & perpendicular axes theorem. (No derivation)
3	Numerical on triangular section , rectangular section and circular section and hallow rectangular and circular section
4	M.I. of T-Section, M.I. of Inverted T-Section (numerical)
5	M.I. of I-Section Symmetrical and unsymmetrical section (numerical)
6	M.I. of channel – Section(numerical)
Topic 5	Name**:-Bending stresses** Facts: Rectangular and circular section Concepts: -Bending stress, shear stress, section modulus and neutral axis Principals:- Moment of resistance Sample objectives for the sub-topic 1] Student should able to understand Theory of simple bending, Assumptions in the theory of bending and Equation of bending stress etc. 2] Student should able to draw Shear stress distribution diagrams for rectangular, circular section, T-Section and I-Section etc. Introduce student to Rectangular and circular section

	Reinforce the concept of section modulus and neutral axis Reference Material:- Books:- Title: -1) Strength of material by R.S.Khurmi,page344-363,384-404 2) Strength of material by S Ramamrutham & R. Narayanan,page267-392 Teaching Aids: - Chalk, Blackboard, OHP, LCD Projector PPT with Sample:- Websites: - http://en.wikipedia.org/wiki/mechanical
Lecture No.	Topic/ Subtopic to be covered
1	Theory of simple bending, Assumptions in the theory of bending, moment of resistance, section modulus &neutral axis.
2	Equation of bending stress, Stress distribution diagram for Cantilever & simply supported beam. Simple numerical
3	Simple numerical on cantilever and simply supported beam subjected to concentrated load and udl
4	Concept of direct & transverse shear stress. Transverse Shear stress equation (No derivation). Average shear stress & Maximum shear stress for rectangular & circular section.
5	Shear stress distribution diagrams for rectangular (simple numerical)
6	Shear stress distribution diagrams for circular section (simple numerical) and Shear stress distribution diagrams for T-Section and I-Section(only concept,no numerical)
Topic 6	Name:- **Direct and Bending stresses** Facts: Rectangular and circular section Concepts: -Direct stress ,Bending stress, axial load, eccentric load, Principals:- Moment, section modulus Sample objectives for the sub-topic 1] Student should able to identify axial load, Eccentric load, direct stress, bending stress, maximum & minimum stresses. Stress distribution diagram for

	rectangular & circular section etc. 2] Student shall solve numerical on circular sections, Strut, Offset links, C-clamp, Bench vice etc. Introduce student to different pattern of loading Axial Load/ Eccentric Loading Rectangular and circular section Reinforce the concept by practising more problems. Reference Material:- Books:- Title: -1) Strength of material by R.S.Khurmi,page405-421 2) Strength of material by S Ramamrutham & R. Narayanan,page393-426 Teaching Aids: - Chalk, Blackboard, OHP, LCD Projector PPT with Sample:- Websites: - http://en.wikipedia.org/wiki/mechanical
Lecture No.	Topic/ Subtopic to be covered
1	Concept of Axial load, Eccentric load, direct stress, bending stress, maximum & minimum stresses
2	Stress distribution diagram for rectangular & circular section, simple numerical on rectangular sections
3	Simple numerical on circular sections
4	Numerical on Strut, Offset links
5	Numerical on C-clamp, Bench vice
6	Numerical on Drilling machine, No tension condition
7	Core section for rectangular & circular section.
Topic 7	Name:- **Torsion** Facts: shaft Concepts: - Stiffness Principals:- Torsional Moment, Power Transmission. Sample objectives for the sub-topic 1] Student should able to identify pure torsion, assumptions in theory of pure torsion, Torsional equation for solid & hollow shaft etc.

	2] Student shall solve numerical on solid & hollow circular shaft etc. Introduce student to the concept of torsion by giving suitable examples in practical field. Acquaint them to Torsional moment and State the effect of torsional moment on power transmission of shaft Reference Material:- Books:- Title: -1) Strength of material by R.S.Khurmi,page653-678 2) Strength of material by S Ramamrutham & R. Narayanan,page754-857 Teaching Aids: - Chalk, Blackboard, OHP, LCD Projector PPT with Sample:- Websites: - http://en.wikipedia.org/wiki/mechanical
Lecture No.	Topic/ Subtopic to be covered
1	Concept of pure torsion, assumptions in theory of pure torsion, Torsional equation for solid & hollow shaft(No proof of derivation), Stress distribution across a solid circular shaft.
2	Numerical on solid & hollow circular shaft.
3	Equation of power transmitted by a shaft, Average torque, maximum torque, numerical.
4	Numerical to select the diameter of the shaft.
5	Comparison between solid & hollow shaft subjected to pure torsion, simple numerical (No numerical on composites & non-homogeneous shaft)
6	Simple numerical.

5.2 Planning and Conduct of Test:

- Question paper shall be as per the MSBTE norms.
- The schedule of the test and portion shall be declared in advance.
- First test should be based on at least 50% of the curriculum covered and second test should be based on remaining curriculum.
- Class test should conduct as per schedule given by board.

5.3 Details about conduct of assignments:

- Assignments at the end of every topic should be given to the students.
- The nature of the questions for the assignments should be as per the specification table and question paper profile.
- Numerical whenever necessary should be given as assignments.
- Students may be asked to solve the test paper as an assignment.
- Question should be on remember, understand and apply level.

5.4 Strategies for Conduct of Practical:

1) A batch of max.20 nos. of students shall be divided in four subgroups so that each subgroup will contain 5 students. Four different tasks may be given to the students at a time with one task to each group. In rotation, all the groups should complete the practical's split into different tasks.

2) Explain the objective of the practical to the students. Explain the use of measuring instruments, procedure to be followed method of sample calculations, plotting of graphs, precautions to be taken, hand tools to be used etc, before the commencement of the practical.

3) A separate 40 pages note book shall be used for practical session. It will contain observation tables, sample calculations, rough sketches etc.

4) Each group will work for one dismantling/assembly task and they will do the drawing / sketching of the same.

5) Subject teachers shall check the tasks performed for each group separately and sign it.

6) If any student remains absent, teacher shall conduct repeat turn for such students and record of such repeat turns shall be maintained by the laboratory assistant.

7) At the end of the experiment, on the same day subject teacher shall explain how to enter the data from rough note book to Lab manual or in Journal.

8) Teacher shall explain the prior concepts, new concepts and learning structure to the students before starting of the experiments.

9) Teacher shall schedule the experiments date wise and display the same in advance.

10) The continuous assessment i.e. weekly checking shall be done as per CIAAN Norms.

11) If available various VCDs, DVDs may be shown to students during practical hours.

5.4.1 Approach for design of Manual:

Lab Manuals provided by M.S.B.T.E. should be used. If the lab manual for the subject is not available, then Journals should be prepared by the students.

5.4.2 Suggestions for effective conduct of practical and assessment:

A batch of Max. 20 nos. of students shall be divided in four subgroups so that each subgroup will contain 5 students. Four different jobs may be given to the students at a time with one job to each group. In rotation, all the groups should complete all the jobs.

Decide objective of the experiment. Standardize the procedure of Practical.

5.4.3 Preparation for conduct of practical

- Standard and calibrated equipments shall be used In the laboratory.
- Regular maintenance such as cleaning, oiling of equipments shall be done.
- While performing the experiments highest safety standards shall be followed.
- Students should preferably use shoes and Workshop apron at the time of practical.
- Maintain a log book of the instruments/equipments/test rigs etc. used for the practical.
- Use of computer graphics demos is recommended. Many such demos can be shown for the web site www.howstuffworks.com

6. Mode of assessment:

6.1 Class Test:

It is proposed that there will be two tests each of 25 Marks. The tests will be conducted as per the MSBTE Schedule

1. Guidelines for Setting Class Test Question Paper:

- The Class Test shall be of 25 Marks each.
- There will be three questions in the test paper. The distribution of marks for Q. no. 1to3 should be 9(5questions of 3Marks each, solve any3), 8 (3questions of

4Marks each, solve any 2), 8 (3questions of 4 Marks each, solve any 2) respectively.

- Question paper of class test should be set as per sample paper given. It is assume that seven weeks are completed up to first class test and teacher should completed 50% syllabus. In the second class test remaining 50% syllabus should cover.
- Internal options should be provided.

6.1.2 Sample Test Papers:

Sample Test Paper 1

Roll No.				

Subject Code **17304**

Institute Name:

Course Name: Mechanical Engineering Group

Course Code: ME/PG/PT/AE/MH/MI/EE

Semester: Third

Subject**: Strength of Materials**

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 of the following **9**

a) Explain hoop stress and strain. Write expressions for the same.

b) Find elongation of a rod tapering uniformly from 10.5cm to 5.5cm under the action of an axial force of 40KN.Length of the rod is 2m and $E=2x10^8$ KN/m^2.

c) A point in a strained material is subjected to two mutually perpendicular tensile stresses of 200MPa and 100MPa.Determine the intensities of normal ,shear stresses on a plane inclined at 30^0 with the axis of minor tensile stress.

d) For a certain material the modulus of elasticity is 189 MPa. If poisons ratio =0.35.Calculate the values of modulus of rigidity and bulk modulus.

e) A simply supported beam 6 m long is carrying a uniformly distributed load of 5KN/m over a length of 3 m from the right end. Draw the S.F. and B.M. diagrams for the beam.

Q2. Attempt any TWO of the following **8**

a) Define moment of inertia. Calculate the radius of gyration for a hallow circular lamina having 250 mm external diameter and 100 mm internal diameter.

b) Explain the behavior of mild steel bar under axial tension, Draw its stress strain graph.

c) A simply supported beam of 6 m span carries two point loads of 20 KN each at 2m and 4 m from the left hand support. It also carries udl of 30KN/m between two point loads. Draw SFD and BMD.

Q3. Attempt any TWO of the following **8**

a) A steel bar of 30 mm diameter is heated to 80^0c and then clamped at the ends. It is then allowed to cool down to30^0c.During cooling; only 1mm contraction was allowed. Calculate the temperature stress developed and reactions at the clamps.

Take length of the bar as 10 m, $\alpha = 12x10^{-8}/\ ^0$c,E=200GPa.

b) An element in a strained body is subjected to a compressive stress of 200 MPa and a clockwise shear stress of 50 MPa on the same plane. Calculate the values of normal and shear stresses on the plane inclined at 35^0 with the compressive stress.

c) Draw SFD and BMD for a cantilever of 3 m length loaded with a point load of 2 KN at the center and a udl of 0.8 KN/m over the right half of 1.5 m.

Sample Test Paper 2

Roll No.				

17304

Institute Name:

Course Name: Mechanical Engineering Group

Course Code: ME/PG/PT/AE/MH/MI/EE

Semester: Third

Subject**: Strength of Materials**

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 of the following **9**

a) State any four assumption made in theory of simple bending.

b) Calculate M.I. of a hallow rectangle about an axis passing through bottom side. The outer dimensions are 300mm and 450 mm and inner dimensions are 200 mmx350 mm.

c) A circular cross section of beam, 200 mm in diameter carries a shear force of 20 KN .Find the max. and average shear stress.

d) Calculate the suitable diameter of solid shaft to transmit 220 KW at 150 RPM, if permissible shear stress is 68 MPa.

e) State any four assumptions made in the theory of pure torsion.

Q2. Attempt any TWO of the following **8**

a) A T-section has the following details : Flange of 200 mm x 12 mm, web of 350 mm x 10 mm, overall depth 362 mm. Calculate its moment of inertia about its centroidal axis.

b) Find the bending stress at 25 mm below the top edge of rectangular section 80 mm wide and 200 mm deep.If maximum bending moment is 4 KNm.

c) A short mild steel column of external diameter 200 mm and internal diameter 150 mm carries an eccentric load. Find the greatest eccentricity which the load can have without producing tension in the section of column.

Q3. Attempt any TWO of the following **8**

a) Find the maximum stress in a propeller shaft 400 mm external and 200 mm internal diameter, when subjected to a twisting moment of 4650N.m. If the modulus of rigidity is 82GPa, Calculate the twist in a length 20 times the diameter.

b) A rectangular column is 200 mm wide and 100 mm thick. It is subjected to a load of 180 KN at an eccentricity of 100 mm in the plane bisecting the thickness. Draw the combined stress distribution diagram showing their values.

c) A short masonry pillar is 500 mmx500 mm in section. At what eccentricity a point load 9500 KN be placed on one of the centroidal axis of the section so as to produce no tension in the section.

6.2.3 Sample Question Paper:

Exam Seat No.									

Subject Code 17304

Maharashtra State Board of Technical Education

Course Name: **Civil, Chemical, Mechanical and Electrical Engineering Group**

Course Code: **ME/PG/PT/AE/MH/MI/EE**

Semester: Third

Title of the Subject**: Strength of Materials**

Subject Code: 17304

Marks: 100 Time:3 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 SIX of the following **12**

a) Define plasticity and stiffness.

b) Draw Core section for rectangular column.

c) State expression for power transmitted by a shaft giving meaning of each term used.

d) Define poisons ratio and modulus of elasticity.

e) Calculate the polar M.I. of circular section having 40 mm diameter.

f) Define Radius of Gyration and write its formula.

g) What is principle stress and principle plain?

h) What is meant by direct stress?

i) Define hoop stress and state condition of thin cylindrical shell.

Q1. (B) Attempt any TWO of the following **8**

a) A load of 5KN is to be raised with the help of a steel wire. Find the minimum diameter of the steel wire, if the stress is not to exceed 100MPa.

b) A cantilever beam 2 meter long carries a udl of 1.5 KN/m over a length of 1.6 m from the free end. Draw shear force and bending moment diagram for the beam.

c) A steel wire of 5mm diameter is bend into a circular shape of 5 m radius. Determine the minimum bending stress induced in the wire. Take E=200GPa.

Q2. Attempt any FOUR of the following **16**

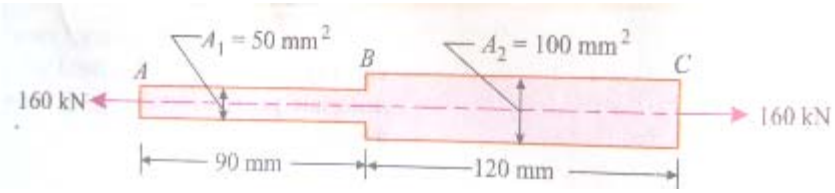
a) (i) Draw the sketch of stepped section showing axial load.

(ii) State the effective length for both end hinged column.

b) Write the assumptions made in the Euler's column theory.

c) Draw the stress strain curve for ductile material and explain the term ultimate stress.

d) An automobile component shown in fig no.1.is subjected to a tensile load of 160 KN. Determine the total elongation of the component, if its modulus of elasticity is 200GPa. Fig no.1.



e) The principle tensile stresses at a point across two perpendicular planes are 80 N/mm^2 and 40 N/mm^2. Find the normal and tangential stresses and its obliquity on a plane at 20^0 with the major principle plane.

f) A gas cylinder of internal diameter 40mm is 5mm thick. If the tensile stress in the material is not to exceed 30 MPa. Find the maximum pressure which can be allowed in the cylinder.

Q3. Attempt any FOUR of the following **16**

a) A simply supported beam of span 'L' is subjected to udl of 'w'/unit length. Draw S.F. diagram. and B.M. diagram.

b) A beam AB 10 m long has supports at its ends A and B .It carries a point load of 5KN at 3 meters from A and a point load of 5KN at 7 meters from A and a udl of 1KN per meter between the point loads. Draw S.F. Diagram and B.M. diagram for the beam.

c) A cantilever beam 1.5 meter long is carrying point loads 1000N each at a distance of 0.5 meter, 1.0 meter, and 1.5 meter from the fixed end. Draw S.F. diagram and B.M. diagram for the cantilever beam.

d) A simply supported right side overhanging beam supported at 4 meter and right side 1 meter overhang. A Loaded by udl 10 KN /m over entire span. Draw S.F. diagram and B.M. diagram.

e) A simply supported beam of 5 meter span subjected to a clockwise moment of 15 KN/m in a distance of 2 meter from the left end. Draw S.F. diagram and B.M. diagram.

f) Find M.I. of a square 100 mm size about their diagonal.

Q4. Attempt any FOUR of the following 16

a) Find M.I. about x-x axis of T-section having flange 150 mm x 50 mm and web 150 mm x 50 mm, overall depth 200 mm.

b) An I-section have the following dimensions Top flange 60 mm x 20 mm. bottom flange 100 mm x 20 mm, web 100 mm x 20 mm, overall depth 140 mm .Find the M.I. about y-y axis.

c) An angle section having dimensions 100 mm x 80 mm x 20 mm. Find M.I. about y-y axis, where 100 mm side is vertical.

d) An isosceles triangular section ABC has a base width 80 mm and height 60 mm. Determine the M.I. of the section about c.g. of the section and the base BC.

e) What is meant by moment of resistance and neutral axis?

f) Draw shear stress distribution diagram for circular section and define average shear stress.

Q5. Attempt any FOUR of the following 16

a) A rectangular beam 60 mm wide and 150 mm deep is simply supported over a span of 6 m. If the beam is subjected to central point load 12 KN, Find maximum bending stress induced in the beam section.

b) Calculate the limit of eccentricity for a circular section having diameter 50 mm.

c) A rectangular strut is 150 mm and 120 mm thick. It carries a load of 180 KN at an eccentricity of 10 mm in a plane bisecting the thickness. Find the maximum and minimum intensities of stress in the section.

d) A hallow circular column having external and internal diameters of 300 mm and 250 mm respectively carries a vertical load of 100 KN at the outer edge of the column. Calculate the maximum and minimum intensities of stress in the section.

e) A c-clamp as shown in fig.no 2 carries a load P=25 KN.The cross section of the clamp at x-x is rectangular, having width equal to twice the thickness.Assuming that the c-clamp is made of steel casing with allowable stress of 100N/ mm^2.Find its dimensions.

f) A M.S. link as shown in fig.no.3.by full lines, transmits a pull of 80 KN.Find the dimensions b and t if b=3t. Assume the permissible tensile stress as 70 MPa.

Fig no.2.

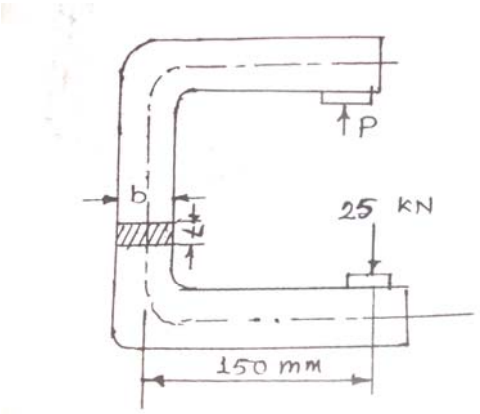
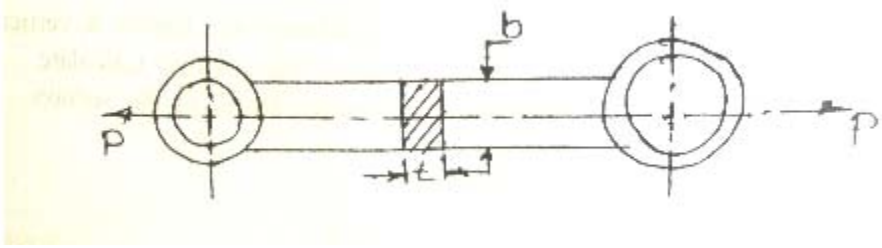


Fig no.3.



Q6. Attempt any FOUR of the following **16**

a) State the equation of torsion and write the notations used in it.

b) A solid circular shaft of 120 mm diameter is transmitting power of 120 KW at 150 rpm. Find the intensity of the shear stress induced in the shaft. Take Tmax =1.4 Tavg.

c) Find power transmitted by a shaft having 60 mm diameter rotating at120 rpm.If maximum permissible shear stress =80 MPa.

d) A steel shaft of solid circular section has to transmit 375 KW at 210 rpm. The maximum shear stress is not to exceed 50 MPa and the angle of twist must not be more than 1^0 in the length of 3m. Take G=80GPa.Determine diameter of the shaft.

e) A shaft of hallow circular cross section has outer diameter 120 mm, inner 90 mm It is subjected to a torsional moment of 18 KN/m. For this shaft compute shear stress at the outer surface.

f) (i) Define bending stress.

(ii)Define torque and state its S.I. unit.