

# **CURRICULUM REVISION PROJECT**

**2012**

**TEACHER GUIDE FOR  
MECHANICAL ENGINEERING MATERIAL  
(17303)  
THIRD SEMESTER MECHANICAL ENGINEERING  
GROUP**

**JUNE 2013**



**MAHARASHTRA STATE  
BOARD OF TECHNICAL EDUCATION, Mumbai**

## I N D E X

1.	Approach to Curriculum Design	3
2.	Objectives	8
3.	Content Analysis	14
4.	Curriculum	20
5.	Implementation Strategy_	26
6.	Mode of assessment	35
	• Sample Test Papers	36
	• Specification Table and Question Paper Profile	38
	• Sample Question Paper	40

# 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.

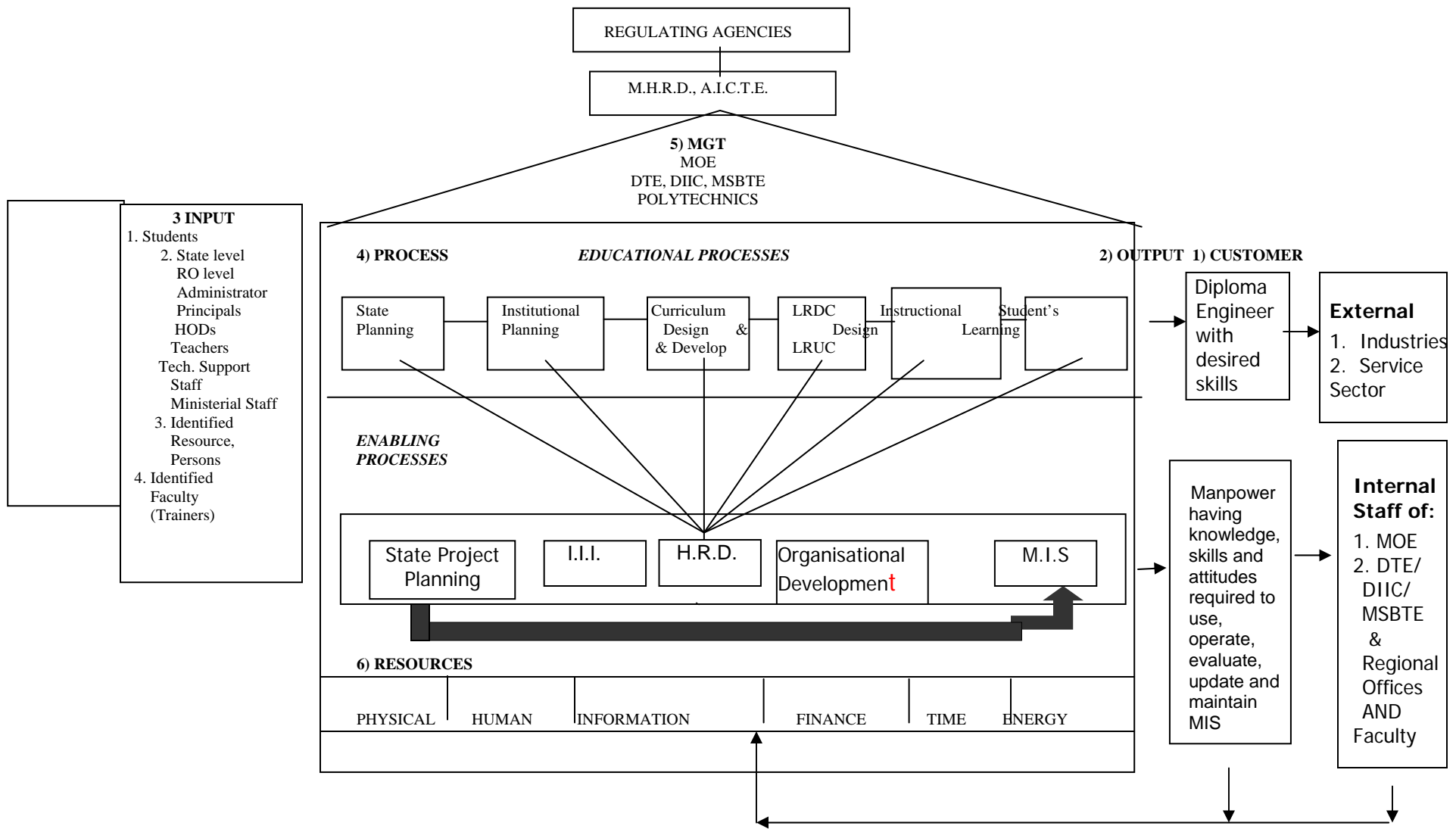
To fulfill the needs derived from systems approach following conceptual framework is considered:

## 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 and 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 broadened 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 viz. 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.

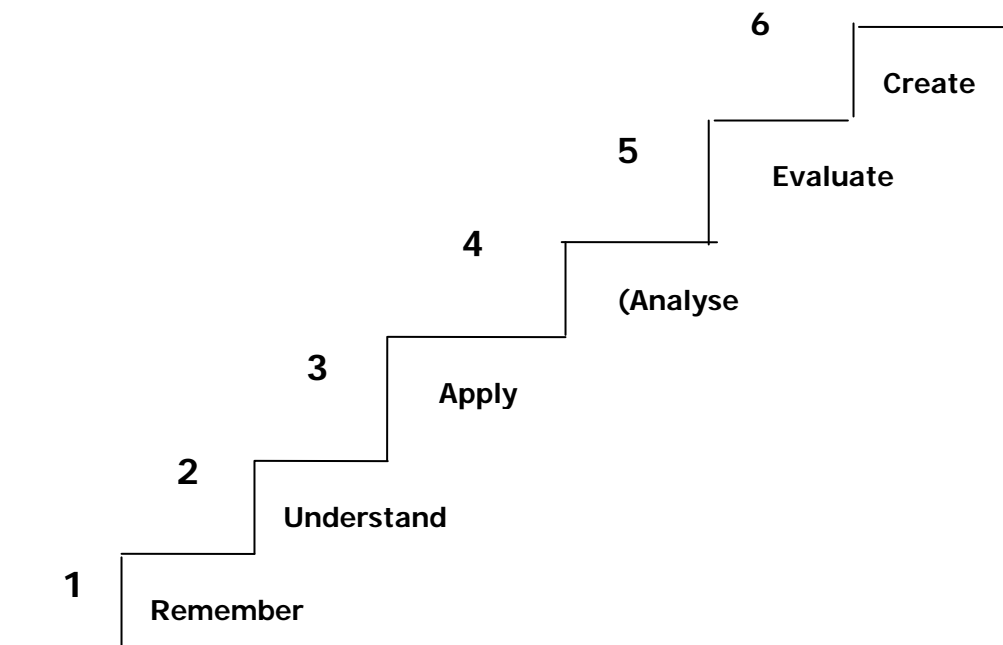
### **2.4 LEVELS OF LEARNING:**

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 and 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
<b>Remember</b> – 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
<b>Understand</b> – 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.
<b>Apply</b> – 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.
<b>Analyze</b> – 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 the 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 use 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 of 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 studying 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.

### **LEARNING RESOURCES**

#### **1. Books:**

List of recommended standard text and reference books:

<b>Sr.no</b>	<b>Author</b>	<b>Title</b>	<b>Publication</b>
1	O.P.Khanna	A Text Book of Material Science and Metallurgy	Dhanpat Rai and Sons
2	Shrinivasan	Engineering Material and Metallurgy	Tata Mc-Graw Hill
3	Dr.V.D.Kodgire	Material Science And Metallurgy	Everest Publishing House
4	Ramarao & Vyas	Engg.Metallurgy	Nit -Din Publications,Nagpur
5	Lawrence H. Van Vlack	Elements of Material Science and Engineering	Person Education
6	Sidney H. Avner	Introduction to Physical metallurgy	Tata Mc Graw Hill edition (2nd )

#### **CDs , PPT etc.:**

Learning Materials: Transparencies, CBT packages developed by NITTER Bhopal

**IS, BIS and International Codes:**

**Websites:**

[www.youtube.com](http://www.youtube.com)

[www.npkauto.com](http://www.npkauto.com)

### **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/MH/MI/PG/PT**

**Semester : Third**

**Subject Title : Mechanical Engineering Material Subject Code : 17303**

**Teaching and Examination Scheme:**

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
04	--	--	03	100	--	--	--	100

**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)**

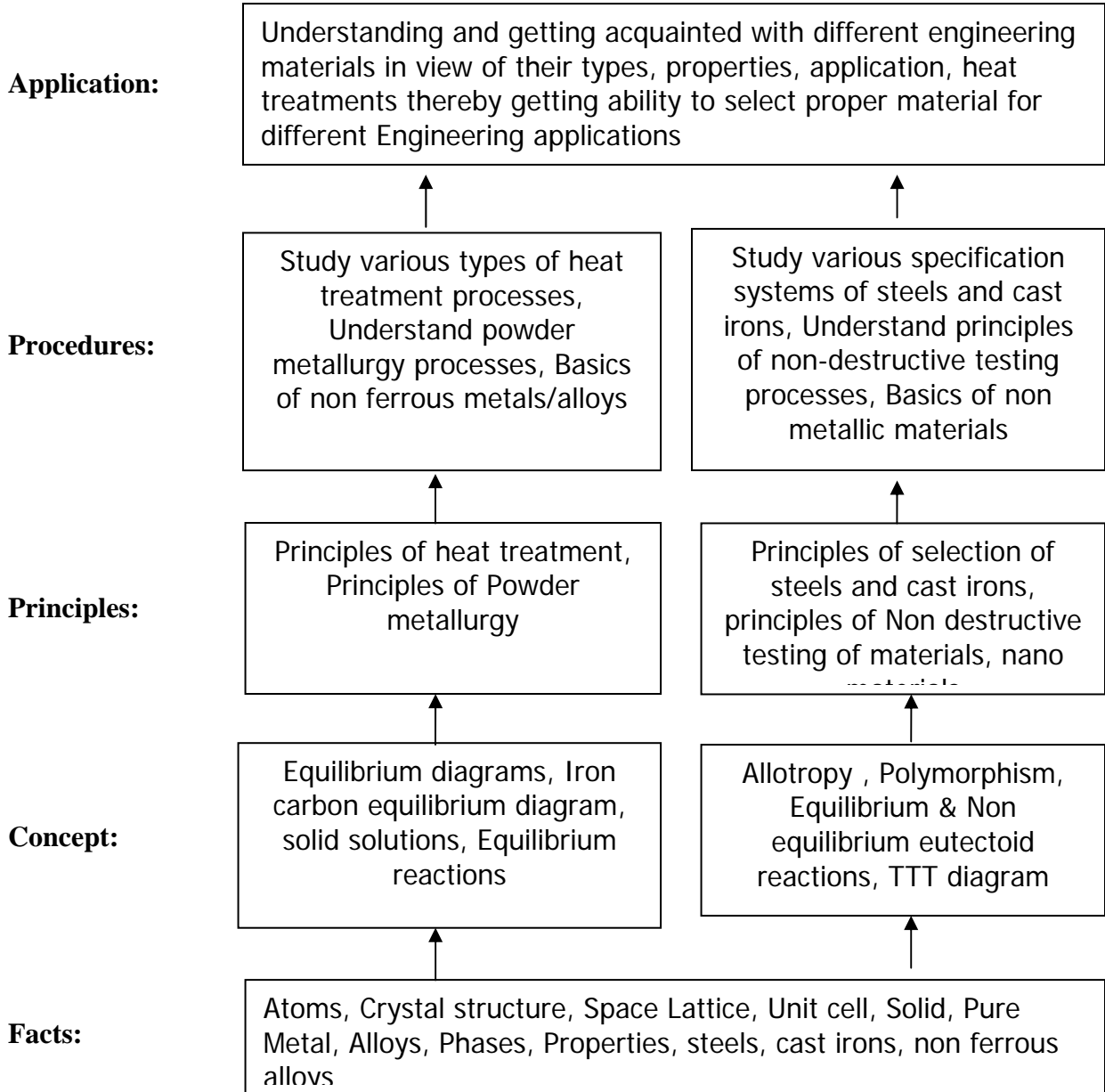
**Rationale:**

Practical field in engineering involves different materials with varied composition, properties with numerous applications. Diploma engineers should have a good knowledge of composition, properties, and applications of these materials. In order to inculcate the same, this subject is designed. Ferrous & Non ferrous metals and alloys find major applications. Amongst these, steels and cast iron are the main alloys with major applications in engineering practice. Sound knowledge about types, properties, composition and heat treatment of steels and cast irons is absolutely necessary to diploma engineers. He should be able to identify steels and cast irons by their specifications and be able to select them for proper applications. Materials like plastics polymers, are also finding importance in engineering application areas. Powder metallurgy process also finds application in manufacturing of special parts with typical properties. Non destructive testing methods are also extensively used in practice today. Diploma engineers should have basic knowledge of these areas.

**General Objectives:** Students will be able to

- Understands about basics of engineering materials as regards classification, structure and properties.
- Understand basics of structure - property relationships of heat treatments.
- Analyze various types of steels and cast irons along with their specifications.
- Understand about types, composition and field of application of various non ferrous metals and alloys & non metallic materials
- Understand about types, composition and field of application of various Non metallic materials.
- Understand about basic process of powder metallurgy and applications.
- Understand about various Nondestructive testing methods and their applications.

**Learning Structure:**



**Theory Content:**

Topic and Contents	Hours	Marks
<p><b>1. Engineering Materials - Structure and Properties</b></p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> <li>➤ List basic types and crystal structure of materials</li> <li>➤ Compare properties of material</li> <li>➤ Define steel and cast iron</li> </ul> <p>Contents:</p> <p>1.1 Introduction, Classification of materials as amorphous and crystalline , ferrous and non ferrous, Crystal structure Properties of metals Physical Properties, Mechanical Properties, unit cell and space lattice, Concept of packing efficiency</p> <p>1.2 Introduction to steels and Cast irons as alloys of iron and carbon.</p>	06	10
<p><b>2. Equilibrium Diagrams</b></p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> <li>➤ Define pure metal, alloy, solid solutions</li> <li>➤ Learn different equilibrium Diagrams</li> <li>➤ Draw Iron carbon phase equilibrium diagram, locate fields of steels and cast iron on diagram</li> </ul> <p>Contents:</p> <p><b>2.1 Definitions <span style="float: right;">8 marks</span></b></p> <ul style="list-style-type: none"> <li>➤ Definitions of phase, pure metal, alloy and solid solutions. <ul style="list-style-type: none"> <li>• Types of solid solutions -substitutional and interstitial.</li> <li>• Solid solubility</li> </ul> </li> <li>➤ Solidification of pure metal and Alloys: <ul style="list-style-type: none"> <li>• Cooling curves equilibrium diagrams for isomorphous, Eutectic, Eutectoid systems.</li> </ul> </li> </ul> <p><b>2.2 Iron Carbon Equilibrium diagram <span style="float: right;">8 marks</span></b></p> <ul style="list-style-type: none"> <li>• Study of various phases</li> <li>• Critical temperatures &amp; significance</li> <li>• Reactions on Iron carbon equilibrium diagram</li> <li>• Introduction of steels and cast irons</li> <li>• Classification of steels on various basis as low , medium, high carbon steels, Hypo, Hyper eutectoid steels</li> </ul>	06	16
<p><b>3. Heat Treatment Of Steels</b></p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> <li>➤ Represent various heat treatment processes on TTT diagram</li> <li>➤ Suggest different heat treatment processes</li> <li>➤ Compare surface heat treatment processes for different steels</li> </ul> <p>Contents: <span style="float: right;"><b>-----16 Marks</b></span></p> <p>3.1 Transformation in steel on heating under equilibrium conditions</p> <ul style="list-style-type: none"> <li>• Transformation of pearlite to austenite</li> <li>• Transformation of Austenite to Pearlite</li> </ul>	14	24

<ul style="list-style-type: none"> <li>• T T T diagrams/isothermal diagram for plain carbon and alloy steels</li> </ul> <p>3.1.1 Annealing:</p> <ul style="list-style-type: none"> <li>• Purposes of annealing, Annealing temperature range</li> <li>• Types of annealing like conventional / full annealing, isothermal annealing, spheroidizing annealing, Process Annealing</li> </ul> <p>3.1.2 Normalizing:</p> <ul style="list-style-type: none"> <li>• Purposes of Normalizing, Temperature range,</li> <li>• Broad applications of Normalizing</li> </ul> <p>3.1.3 Hardening:</p> <ul style="list-style-type: none"> <li>• Purposes of hardening, Hardening temperature range</li> <li>• Conventional hardening process, Structure of martensite and properties</li> <li>• quenching mediums, hardening defects.</li> </ul> <p>3.1.4 Tempering:</p> <ul style="list-style-type: none"> <li>• Purpose of tempering</li> <li>• Variations of properties of hardened steel with tempering temperatures</li> <li>• Types of tempering as low, medium and high temperature tempering.</li> <li>• Martempering, Austempering and patenting processes</li> </ul> <p>3.2 Surface Heat Treatment <span style="float: right;"><b>..... 8 Marks</b></span></p> <ul style="list-style-type: none"> <li>• Need of Surface heat treatment,</li> <li>• Types of Surface heat treatments like Surface hardening and case hardening.</li> <li>• Surface hardening methods like Flame Hardening , Induction Hardening</li> <li>• Case hardening methods like Carburizing, Nitriding, Cyaniding.</li> </ul>		
<p><b>4. Steels and Cast Irons:</b></p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> <li>➤ List different types of steels and cast irons</li> <li>➤ Know manufacturing processes of steels &amp; cast irons</li> <li>➤ Refer to specifications systems of steels and cast irons</li> <li>➤ Suggest suitable steels/ cast irons in specifications for particular applications.</li> </ul> <p>Contents:</p> <p>4.1 Broad Classification of steels, Plain carbon steels</p> <ul style="list-style-type: none"> <li>• Definition, Types &amp; Properties</li> <li>• Compositions and applications of low, medium and high carbon steels.</li> </ul> <p>4.2 Alloy Steels:</p> <ul style="list-style-type: none"> <li>• Definition &amp; Effects of alloying elements on properties of alloy steels.</li> <li>• Tool steels: Cold work tool steels, Hot work tool steels, High speed steels(HSS), HCHC and OHNS</li> <li>• Stainless Steels</li> </ul>	12	20

<ul style="list-style-type: none"> <li>• Spring Steels</li> </ul> <p>4.3 Cast Irons: Classification of cast irons and applications. Types of cast irons as white, gray, nodular, malleable</p> <p>4.4 Specifications of steels and cast Irons:</p> <ul style="list-style-type: none"> <li>• Bureau Of Indian Standards BIS, AISI / SAE , British Standard B.S. specifications of steels &amp; their equivalent Specifications of cast irons</li> <li>• Selection of appropriate steels and cast irons for engineering applications like Shafts, axles, Nuts, bolts, Levers, crank shafts, camshafts, Shear blades, agricultural equipments, House hold utensils, machine tool beds, car bodies.</li> </ul>		
<p><b>5. Non ferrous Metals and Alloys</b></p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> <li>➤ Select various non ferrous metals/alloys in view of their composition, properties for applications</li> </ul> <p>Contents:</p> <p>5.1 Chemical compositions, properties and applications of Copper alloys - brasses, bronzes</p> <p>5.2 Aluminium alloys --Y-alloy, Hindalium, duralium with their composition and applications. Bearing materials like white metals (Sn based), aluminium bronzes. Porous self lubricating bearings.</p>	08	10
<p><b>6. Non Metallic Materials</b></p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> <li>➤ Select non metallic materials in view of their composition, properties and applications</li> </ul> <p>Contents:</p> <p>6.1 Polymeric Materials</p> <ul style="list-style-type: none"> <li>• Polymers- types, characteristics,</li> <li>• Properties and uses of Thermoplastics, Thermosetting Plastics &amp; Rubbers.</li> </ul> <p>6.2 Thermoplastic and Thermosetting Plastic materials</p> <ul style="list-style-type: none"> <li>• Characteristics and uses of ABS, Acrylics. Nylons and Vinyls,</li> <li>• Epoxides, Melamines &amp; Bakelites</li> </ul> <p>6.3 Rubbers :</p> <p>Neoprene, Butadiene, Buna &amp; Silicons – Properties &amp; applications.</p> <p>6.4 Other Engineering Materials of importance -Properties and applications– Ceramics, glasses, Glass Wool. Introduction to Composite Materials like, Laminated &amp; Fibre reinforced materials Nano materials – nature, properties and applications</p>	08	12
<p><b>7. Powder Metallurgy &amp; Nondestructive Testing</b></p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> <li>➤ Know concepts of powder metallurgy process with their applications</li> <li>➤ Compare Different Non destructive testing processes</li> </ul>	10	08

<p>Contents:</p> <p>7.1 Powder Metallurgy :</p> <ul style="list-style-type: none"> <li>• Advantages, limitations and applications of Powder Metallurgy for engineering products.</li> <li>• Brief Description of Process of Powder Metallurgy – Powder making, blending, compacting, sintering, infiltration &amp; impregnation.</li> <li>• Applications of Powder metallurgy for tungsten carbide tip tools &amp; porous bearing.</li> </ul> <p>7.2 Non destructive Testing:</p> <ul style="list-style-type: none"> <li>• Importance of Non-destructive testing, Difference between Destructive and Nondestructive testing.</li> <li>• Nondestructive testing methods - Radiography (X-Ray &amp; Gamma Ray), Ultrasonic crack detection, Dye penetrant test, Magnaflux test – Comparison &amp; applications</li> </ul>		
<b>Total</b>	<b>64</b>	<b>100</b>

### Learning Resources:

#### 1. Books:

Sr. No.	Title	Author	Edition	Publisher
01	A Text Book of Material Science and Metallurgy	O. P. Khanna	2005	Dhanpat Rai and Sons
02	Engineering Material and Metallurgy	Shrinivasan	1st	Tata Mc-Graw Hill
03	Material Science And Metallurgy	Dr. V.D. Kodgire	--	Everest Publishing House
04	Engg. Metallurgy	Ramarao & Vyas	1995	Nit -Din Publications,Nagpur
05	Elements of Material Science and Engineering	Lawrence H. Van Vlack	2012	Person Education
06	Introduction to Physical metallurgy	Sidney H. Avner	2006	Tata Mc Graw Hill edition (2nd )
07	Material Science & Engg. Materials	Smith	--	--
08	Physical Metallurgy	Yu Lakhtin	--	Mir Publication

2. CD's PPTs, Video clips on basics of steels, Iron Carbon Diagram, Heat Treatments, Manufacturing of steels, Powder Metallurgy and Non destructive testing

3. Charts, Models, Transparencies on basics of steels, Iron Carbon Diagram, Heat Treatments, Manufacturing of steels, Powder Metallurgy and Non destructive testing

4. Specifications of steels-standards

- a) Bureau Of Indian Standards (BIS) Specifications of steels
- b) British Specifications (B.S.) of steels
- c) American Iron & Steel Institute (AISI) / Society of Automotive Engineers (SAE) specifications of steels
- d) Mahindra Ugine Steel Company (MUSCO) steel book

5. Web sites of following companies for reference

- Mukand Iron Ltd
- Jindal steels
- Tata steels
- Rajuri steels
- Roopam steels
- TISCO
- Kalika steels

**5. IMPLEMENTATION STRATEGY:**

**Guideline for effective teaching:-**

- 1) Teacher should read carefully teaching scheme, rationale and objectives of the subject.
- 2) Prepare lesson plan.
- 3) Prepare own notes.
- 4) Prepare for lecture, carry charts in class room.
- 5) Use PPTs, videos and transparencies to explain concepts.
- 6) Develop more interaction with students by asking questions.

**5.1 PLANING OF LECTURES FOR A SEMESTER WITH CONTENT  
DETAILING:**

<b>Topic 1</b>	<p><b>Engineering Materials – Structure and Properties</b></p> <p><b>Facts:</b> Atoms, crystal structure, Space Lattice, Unit cell.</p> <p><b>Concept:</b> Diagrams, properties.</p> <p><b>Principle:</b> Principles of crystal structure and atoms.</p> <p><b>Here some sample (Specific) objectives for the topic is required for example</b></p> <p><b>1] Student should able to draw structure of an Atom.</b></p> <p><b>2[ Student should able to explain the properties of space lattice.</b></p> <p><b>Teacher should explain the structure through A/v aid or chart/ model available in laboratory and ask them to redraw the structure of Atom.</b></p> <p><b>Teacher should also explain the significance and importance of Atom and its stricture in future studies.</b></p>
----------------	---

	<p><b>Reference Material:</b></p> <p><b>Books:</b> A text book of material science and metallurgy by O.P.Khanna, Engineering Materials and Metallurgy by Shrinivasan</p> <p><b>Websites:</b> <a href="http://www.utk.edu">www.utk.edu</a></p>
<b>Lecture No.</b>	<b>Topic/ subtopic to be covered</b>
<b>1</b>	<p>Teacher may give the introduction of subject which include the importance of this subject in Mechanical Engineering.</p> <p>Materials, classification of materials.</p> <p>Teacher may explain the various applications of materials.</p>
<b>2</b>	<p>Explain the crystal structure, types of crystal structure as FCC, BCC, etc.</p> <p>Use the charts, transparencies or ppt for explaining crystal structure.</p>
<b>3</b>	<p>Various properties of metals.</p> <p>Teacher may explain the properties with giving proper examples.</p>
<b>4</b>	<p>Unit cell and space lattice.</p> <p>Concept of packing efficiency.</p>
<b>5</b>	<p>Introduction to steel.</p> <p>Short description includes composition and properties.</p>
<b>6</b>	<p>Introduction to Cast iron.</p> <p>Short description includes composition and properties.</p>
<b>Topic 2</b>	<p><b>Equilibrium Diagram</b></p> <p><b>Facts:</b> Phases, steel</p> <p><b>Concept:</b> Equilibrium diagram</p> <p><b>Principle:</b> Principles of phases.</p> <p><b>Here some sample (Specific) objectives for the topic is required for example</b></p> <p><b>1] Student should able to identify the different phases of steel</b></p> <p><b>2[Student should able to draw the equilibrium diagram and explain its significance.</b></p> <p><b>Teacher should explain the phase transformation diagram and ask students to draw/redraw to get sufficient practice.</b></p>

	<p><b>Teacher should also imbibe the properties of various stages of steel and explain its specific properties.</b></p> <p><b>Reference Material:</b></p> <p><b>Books:</b> A text book of material science and metallurgy by O.P.Khanna, Engineering Materials and Metallurgy by Shrinivasan Engineering Metallurgy by Ramarao &amp; Vyas</p> <p><b>Websites:</b> <a href="http://www.uwplatt.edu">www.uwplatt.edu</a> <a href="http://www.amazon.com">www.amazon.com</a> <a href="http://www.publiciastate.edu">www.publiciastate.edu</a></p>
<b>Lecture No.</b>	<b>Topic/ subtopic to be covered</b>
<b>1</b>	<p>With the help of ppt and videos explain definitions of phase, pure metal, alloy and solid solutions.</p> <ul style="list-style-type: none"> <li>• Types of solid solutions -substitutional and interstitial.</li> </ul>
<b>2</b>	<ul style="list-style-type: none"> <li>• Solid solubility</li> </ul> <p>Solidification of pure metal and Alloys: for example Ni-Cu alloys, Cu-Zn alloys etc.</p>
<b>3</b>	<ul style="list-style-type: none"> <li>• Cooling curves equilibrium diagrams for isomorphous, Eutectic, Eutectoid systems.</li> </ul>
<b>4</b>	<p>Explain how to draw Iron Carbon Equilibrium diagram.</p> <ul style="list-style-type: none"> <li>• Study of various phases</li> </ul>
<b>5</b>	<ul style="list-style-type: none"> <li>• Critical temperatures &amp; significance</li> <li>• Reactions on Iron carbon equilibrium diagram</li> </ul>
<b>6</b>	<ul style="list-style-type: none"> <li>• Introduction of steels and cast irons</li> <li>• Classification of steels on various basis as low , medium, high carbon steels, Hypo, Hyper eutectoid steels</li> </ul>
<b>Topic 3</b>	<p><b>Heat Treatment Of Steels</b></p> <p><b>Facts:</b> Steels, crystal structure, properties.</p> <p><b>Concept:</b> TTT diagram</p> <p><b>Principle:</b> Principles of heat treatment.</p> <p><b>Here some sample (Specific) objectives for the topic is required for example</b></p> <p><b>1] Student should able to draw and interpret the TTT diagram.</b></p>

	<p><b>2[Student should able to state the need and utility different types of Heat treatment</b></p> <p><b>Teacher should explain TTT diagram and various types of Heat treatments and its significance to the students.</b></p> <p><b>Teacher should brings heat treated item in class rooms like hammer chisel (carburization heat treated)</b></p> <p><b>Reference Material:</b></p> <p><b>Books:</b> A text book of material science and metallurgy by O.P.Khanna, Engineering Materials and Metallurgy by Shrinivasan Material Science and Metallurgy by Dr. V.D.Kodgire</p> <p><b>Websites:</b> <a href="http://www.uic.edu">www.uic.edu</a> <a href="http://www.journalamme.org">www.journalamme.org</a></p>
<b>Lecture No.</b>	<b>Topic/ subtopic to be covered</b>
<b>1</b>	Transformation in steel on heating under equilibrium conditions <ul style="list-style-type: none"> <li>• Transformation of pearlite to austenite</li> </ul>
<b>2</b>	<ul style="list-style-type: none"> <li>• Transformation of Austenite to Pearlite</li> </ul>
<b>3</b>	<ul style="list-style-type: none"> <li>• T T T diagrams/isothermal diagram for plain carbon and alloy steels</li> </ul>
<b>4</b>	Annealing: <ul style="list-style-type: none"> <li>• Purposes of annealing, Annealing temperature range</li> </ul>
<b>5</b>	<ul style="list-style-type: none"> <li>• Types of annealing like conventional / full annealing, isothermal annealing, spheroidizing annealing, Process Annealing</li> </ul>
<b>6</b>	Normalizing: <ul style="list-style-type: none"> <li>• Purposes of Normalizing, Temperature range,</li> <li>• Broad applications of Normalizing</li> </ul>
<b>7</b>	Hardening: <ul style="list-style-type: none"> <li>• Purposes of hardening, Hardening temperature range</li> <li>• Conventional hardening process</li> </ul>
<b>8</b>	Structure of martensite and properties <ul style="list-style-type: none"> <li>• quenching mediums, hardening defects.</li> </ul>

9	Tempering: <ul style="list-style-type: none"> <li>• Purpose of tempering</li> <li>• Variations of properties of hardened steel with tempering temperatures</li> </ul>
10	<ul style="list-style-type: none"> <li>• Types of tempering as low, medium and high temperature tempering.</li> <li>• Martempering, Austempering and patenting processes</li> </ul>
11	Surface Heat Treatment <ul style="list-style-type: none"> <li>• Need of Surface heat treatment,</li> <li>• Types of Surface heat treatments</li> </ul>
12	Surface hardening <ul style="list-style-type: none"> <li>• Surface hardening methods like Flame Hardening</li> </ul>
13	Induction Hardening <ul style="list-style-type: none"> <li>• Case hardening methods like Carburizing, Nitriding, Cyaniding.</li> </ul>
14	
<b>Topic 4</b>	<p><b>Steels and Cast Irons</b></p> <p><b>Facts:</b> Steels and Cast Irons</p> <p><b>Concept:</b> Iron carbon equilibrium diagram</p> <p><b>Principle:</b> Principle of selection of steels and cast iron.</p> <p><b>Here some sample (Specific) objectives for the topic is required for example</b></p> <p><b>1] Student should able to identify different types of cast iron and explain its properties.</b></p> <p><b>2][Student should able to draw and interpret I-C diagram.</b></p> <p><b>Teacher should explain I-C diagram on PPTs or with the help of Large scale chart/ diagram and narrate importance of each stage of it. Teacher should tell student various application of different types of cast iron.</b></p> <p><b>Reference Material:</b></p> <p><b>Books:</b> Elements of material science and engineering by Lawrence H. Van lack, Engineering Materials and Metallurgy by Shrinivasan Material Science and Metallurgy by Dr. V.D.Kodgire</p> <p><b>Websites:</b> <a href="http://www.asminternational.org">www.asminternational.org</a> <a href="http://www.ksky.ne.jp">www.ksky.ne.jp</a></p>

Lecture No.	Topic/ subtopic to be covered
1	Broad Classification of steels, Plain carbon steels • Definition, Types & Properties
2	• Compositions and applications of low, medium and high carbon steels.
3	Alloy Steels: • Definition & Effects of alloying elements on properties of alloy steels.
4	• Tool steels: Cold work tool steels, Hot work tool steels, High speed steels(HSS)
5	HCHC and OHNS • Stainless Steels
6	• Spring Steels Cast Irons: Classification of cast irons and applications.
7	Types of cast irons as white, gray cast iron
8	Types of cast irons as nodular, malleable cast iron
9	Specifications of steels and cast Irons: • Bureau Of Indian Standards BIS
10	AISI / SAE , British Standard B.S. specifications of steels
11	Specifications of cast irons
12	• Selection of appropriate steels and cast irons for engineering applications like Shafts, axles, Nuts, bolts, Levers, crank shafts, camshafts, Shear blades, agricultural equipments, House hold utensils, machine tool beds, car bodies.
<b>Topic 5</b>	<b>Non Ferrous Metals and Alloys</b> <b>Facts:</b> Non ferrous alloys <b>Concept:</b> Allotropy <b>Principle:</b> Principle of non ferrous metals. <b>Here some sample (Specific) objectives for the topic is required for example</b> <b>1] Student should able to state different non ferrous alloys and its</b>

	<p><b>specific properties with applications.</b></p> <p><b>2[Student should able to state different properties of non-ferrou metals.</b></p> <p><b>Teacher should explain in classroom some sample of non ferrous alloys like bras material bronze material and ask them to write its properties and applications.</b></p> <p><b>Reference Material:</b></p> <p><b>Books:</b> A text book of material science and metallurgy by O.P.Khanna, Engineering Materials and Metallurgy by Shrinivasan Engineering Metallurgy by Ramarao &amp; Vyas</p> <p><b>Websites:</b> <a href="http://www.nature.com">www.nature.com</a> <a href="http://www.engineershandbook.com">www.engineershandbook.com</a></p>
<b>Lecture No.</b>	<b>Topic/ subtopic to be covered</b>
<b>1</b>	Chemical compositions, properties and applications of Copper alloys - brasses
<b>2</b>	Chemical compositions, properties and applications of Copper alloys – bronzes
<b>3</b>	Aluminium alloys --Y-alloy with their composition and applications.
<b>4</b>	Aluminium alloys - Hindalium with their composition and applications.
<b>5</b>	Aluminium alloys - duralium with their composition and applications.
<b>6</b>	Bearing materials like white metals (Sn based)
<b>7</b>	Bearing materials like aluminium bronzes.
<b>8</b>	Porous self lubricating bearings.
<b>Topic 6</b>	<p><b>Non Metallic Materials</b></p> <p><b>Facts:</b> Atom, properties</p> <p><b>Concept:</b> Non Metals</p> <p><b>Principle:</b> Principles of polymorphism and nano materials.</p>

	<p><b>Here some sample (Specific) objectives for the topic is required for example</b></p> <p><b>1] Student should able to state examples and properties non metals.</b></p> <p><b>2[Student should able to state commercial (practical) example of important materials like Nylon, Polycarbonate PET etc.</b></p> <p><b>Teacher should bring in classroom some sample of Nylon/ PET/Polycarbonate items nd explain its function and utility in day-to-day life.</b></p> <p><b>Reference Material:</b></p> <p><b>Books:</b> A text book of material science and metallurgy by O.P.Khanna, Engineering Metallurgy by Ramarao &amp; Vyas</p> <p><b>Websites:</b> <a href="http://www.uotechnology.edu">www.uotechnology.edu</a> <a href="http://www.asminternational.org">www.asminternational.org</a></p>
<b>Lecture No.</b>	<b>Topic/ subtopic to be covered</b>
<b>1</b>	Polymeric Materials • Polymers- types, characteristics,
<b>2</b>	Properties and uses of Thermoplastics, Thermosetting Plastics & Rubbers.
<b>3</b>	Characteristics and uses of ABS, Acrylics. Nylons and Vinyls,
<b>4</b>	Characteristics and uses of Epoxides, Melamines & Bakelites
<b>5</b>	Neoprene, Butadiene, Buna & Silicons – Properties & applications
<b>6</b>	Other Engineering Materials of importance -Properties and applications– Ceramics, glasses, Glass Wool.
<b>7</b>	Introduction to Composite Materials like, Laminated & Fibre reinforced materials
<b>8</b>	Nano materials – nature, properties and applications
<b>Topic 7</b>	<p><b>Powder Metallurgy &amp; Non-destructive testing</b></p> <p><b>Facts:</b> Atoms, solids</p> <p><b>Concept:</b> Metal powder</p>

	<p><b>Principle:</b> Principle of powder metallurgy and non destructive testing.</p> <p><b>Here some sample (Specific) objectives for the topic is required for example</b></p> <p>1] Student should able to state importance and utility of powder metallurgy process</p> <p>2] Student should able to identify the materials prepared by powder metallurgy process and state its field applications.</p> <p>3] Student should able to explain different non-destructive methods of testing and suggest specific non-destructive method for a specific material.</p> <p>Teacher should bring in classroom some sample of item made out of powder metallurgy process like Porous bearings and state its specific functions and application in engineering industries.</p> <p><b>Reference Material:</b></p> <p><b>Books:</b> A text book of material science and metallurgy by O.P.Khanna, Engineering Materials and Metallurgy by Shrinivasan Engineering Metallurgy by Ramarao &amp; Vyas</p> <p><b>Websites:</b> <a href="http://www.nature.com">www.nature.com</a> <a href="http://www.engineershandbook.com">www.engineershandbook.com</a></p>
Lecture No.	Topic/ subtopic to be covered
1	Powder Metallurgy : <ul style="list-style-type: none"> <li>• Advantages, limitations and applications of Powder Metallurgy for engineering products.</li> </ul>
2	Brief Description of Process of Powder Metallurgy – Powder making
3	Brief Description of Process of Powder Metallurgy – blending, compacting
4	Brief Description of Process of Powder Metallurgy – sintering, infiltration & impregnation
5	Applications of Powder metallurgy for tungsten carbide tip tools & porous bearing.
6	Non destructive Testing: <ul style="list-style-type: none"> <li>• Importance of Non-destructive testing</li> </ul>

<b>7</b>	Difference between Destructive and Nondestructive testing.
<b>8</b>	Nondestructive testing methods - Radiography (X-Ray & Gamma Ray)
<b>9</b>	Nondestructive testing methods - Ultrasonic crack detection, Dye penetrant test
<b>10</b>	Magnaflux test – Comparison & applications

**5.2 Planning and conduct of test:**

- a) The time table 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% - 50% of syllabus and second test should cover remaining syllabus.
- d) Format for question paper should be as per the sample question paper supplied by MSBTE.

## **6. Mode of assessment:**

### 6.1 Class Test:

- Discuss the class test question paper and its model answer in the class.
- Display the model answers of class test question paper on notice board.
- Assessment of the test papers shall be done by highlighting the mistakes.
- Test papers should be shown to students.
- Teacher shall give the feedback to students about their performance.
- Tests marks should be displayed on the notice board.
- Test marks should be entered in the test mark register.

#### 6.1.1 Guidelines for Setting Class Test Question Paper:

- The questions in the test paper shall be strictly as per the Dr. Bloom's revised taxonomy, described earlier.
- Sample class test paper given in this guideline should be refer before setting question paper.
- The question paper must have minimum three levels (remember, understand and analyse/ apply) of cognitive domain proposed by Dr. Bloom.
- There should be three questions with Q. 1 of 9 Marks, Q. 2 and Q. 3 of 8 marks each.
- Q. 1 will have 4 bits of 3 marks each and student will have to attempt any three
- Q.2 and Q.3 will have either 3 Bits of 4 marks each and students will attempt ant two

6.1.2 Sample Test Papers:

**Sample Test Paper - 1**

<b>Roll No.</b>				
-----------------	--	--	--	--

**17303**

**Course Name : Mechanical Engineering and Production Technology**

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

**Semester : Third**

**Subject Title : Mechanical Engineering Material**

**Subject Code : 17303**

**Marks: 25**

**Time: 1 hour**

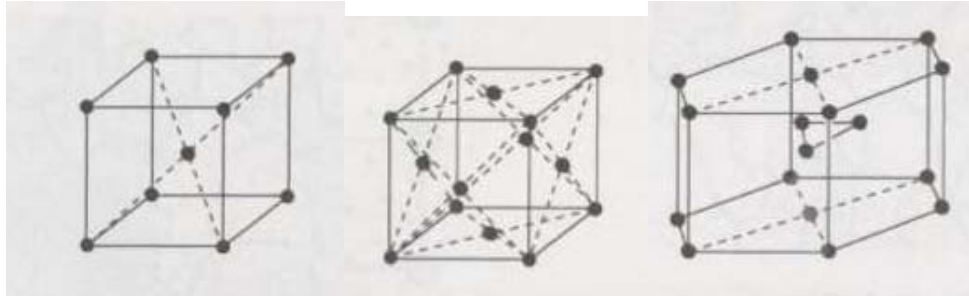
**Instructions:**

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

**Q1. Attempt any three of the following**

**3\*3=9 Marks**

- a) Define : Malleability, Hardenability and Creep.
- b) Explain is substitutional solid solution.
- c) Give composition of steels.
- d) Redraw and label the following diagrams.



**Q2. Attempt any two of the following.**

**4\*2=8 Marks**

- a) State the need of Surface heat treatment. Define Case hardening.
- b) Explain Eutectic and Eutectoid system.
- c) State the purpose of Normalizing and their applications.

**Q3. Attempt any two of the following.**

**4\*2=8 Marks**

- a) Draw the cooling curve equilibrium diagram for isomorphous system.
- b) Define tempering? Give its purposes.
- c) State purposes and applications of normalizing.

**Sample Test Paper - 2**

<b>Roll No.</b>				
-----------------	--	--	--	--

<b>17303</b>
--------------

**Course Name : Mechanical Engineering and Production Technology**

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

**Semester : Third**

**Subject Title : Mechanical Engineering Material**

**Subject Code : 17303**

**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. Preferably, write the answers in sequential order

**Q1. Attempt any three of the following**

**3\*3=9 Marks**

- a) Give classification of cast iron.
- b) State applications of Y-alloys.
- c) State properties of Rubber.
- d) Define is Non destructive testing.

**Q2. Attempt any two of the following.**

**4\*2=8 Marks**

- a) Write the 4 properties and 3 uses of copper.
- b) State the characteristics of Nylons and Vinyls.
- c) Describe in brief process of powder metallurgy .

**Q3. Attempt any two of the following.**

**4\*2=8 Marks**

- a) **State** different types of thermoplastics and state its characteristics.
- b) Give functions of porous self lubricating bearing and state its applications.
- c) Explain principle of radiographic testing? State its purpose.

### 6.2.3 Sample Question Paper:

<b>Exam Seat No.</b>									
----------------------	--	--	--	--	--	--	--	--	--

**17303**

**Maharashtra State Board of Technical Education, Mumbai**

**Course Name: Mechanical Engineering and Production Technology**

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

**Semester: THIRD**

**Title of the Subject: Mechanical Engineering Materials      Subject Code: 17303**

**Marks: 100**

**Time: 3 Hours**

**Instructions:**

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

**Q1(a). Attempt any six of the following.**

**2\*6=12 Marks**

- I) Write down the classification of materials.
- II) Define strength and creep.
- III) State types of solid solutions?
- IV) State the need heat treatment process.
- V) Write the composition of HSS.
- VI) Write down the chemical composition of gun metals.
- VII) Draw the cooling curve equilibrium diagram for Eutectoid system.
- VIII) State the applications of Flame hardening.

**Q1(b). Attempt any three of the following.**

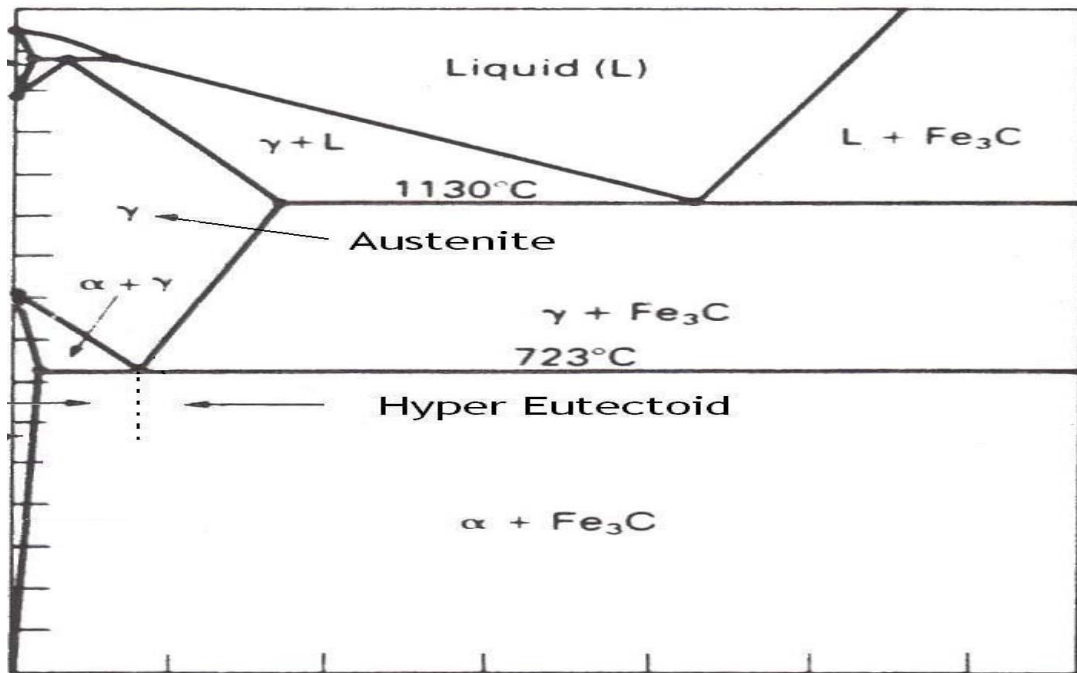
**4\*2=8 Marks**

- I) Classify Steels and cast iron.
- II) Compare austempering and martempering.
- III) State different types of stainless steels? Give one composition and application of each.

**Q2. Attempt any four of the following.**

**4\*4=16 Marks**

- a) Explain space lattice and unit cell.
- b) Redraw and label the following diagram.



- c) Define solid solutions? Give the examples of solid solution alloys.
- d) What are various micro constituents of iron and steel and explain in brief Austenite.
- e) Give the classification of Equilibrium diagram.

**Q3. Attempt any four of the following. 4\*4=16 Marks**

- a) Define hardening? State various factors affecting hardening.
- b) State advantages and limitations of normalizing.
- c) Explain principle of annealing and state its applications.
- d) Define induction hardening? What are its features?
- e) Draw TTT diagram for alloy steels.

**Q4. Attempt any four of the following. 4\*4=16 Marks**

- a) State the effects of alloying element on metal.
- b) State how Grey cast iron is produced?
- c) Write 4 applications of white cast iron and 4 applications of Nodular cast iron.
- d) Write IS designation of plain carbon steel and its composition and applications.
- e) State factors affecting the selection of following engineering applications
  - i. Bolt
  - ii. Crank shaft
  - iii. House hold utensils
  - iv. Car body

**Q5. Attempt any four of the following. 4\*4=16 Marks**

- a) Write chemical composition and application of copper alloys and brasses.
- b) Write down the properties of bearing materials.
- c) What are different types of bronzes? Write composition and uses of each.
- d) Differentiate between thermoplastics and thermosetting plastics.
- e) State the properties and applications of butadiene and buna.

**Q6. Attempt any four of the following.**

**4\*4=16 Marks**

- a) State the characteristics and uses of ABS.
- b) **Define** Nano Materials? Give its applications.
- c) State advantages and limitations of powder metallurgy?
- d) Describe in brief blending and sintering processes.
- e) Explain with neat sketch Radiography.