MATERIAL SCIENCE AND METALLURGY (ME303PC)

COURSE PLANER

I. COURSE OVERVIEW:

Materials and metallurgical engineering is concerned with the generation and application of knowledge relating the composition, structure and processing of materials to their uses. The field encompasses the spectrum of materials that covers metals, ceramics, polymers, semiconductors, and combinations of materials or composites.

Materials engineering is an interdisciplinary field involving the properties of matter and its applications to various fields of science and engineering. The science investigates the relationship between structure of materials and their properties. New developments such as nano science and nanotechnology continue to propel materials science and engineering to the forefront of the studies (at many universities) around the world.

Metallurgical engineering is a broad field that studies the physical and chemical behavior of metallic elements, inter metallic compounds and their alloys. Extractive metallurgy involves extracting metal from ore. Chemical metallurgy deals with chemical properties of metals including uniting of different metals with one another to form alloys.

II. PREREQUISITE(S):

The knowledge of following subjects is essential to understand the subject:

1. Physics
2. Chemistry (bonding, metals and non metal).

III. COURSE OBJECTIVES:

The objectives of the course are to enable the student

- To understand the basic crystal structures, defects and mechanisms
- To be able to analyse the phase diagrams and interpret them
- To be able to understand various heat treatment process and change in micro structures
- To be able to understand cooling curves and final micro structure properties
- To be able to interpret various kinds of alloys and its properties

IV. COURSE OUTCOMES

Sl. NO	Description	Bloom's Taxonomy level
CO1	Application of knowledge relating the composition, structure and processing of materials to their uses. The field encompasses the spectrum of materials that covers metals, ceramics, polymers, semiconductors, and combinations of materials or composites.	**Knowledge, Understand,Apply(Level1, Level2,Level 3)**
CO2	Able to investigate the relationship between structure of materials and their properties. It also includes elements of applied physics and chemistry, as well as chemical, mechanical, civil and electrical engineering	**Understand,Apply(Level2,Level 3)**

CO3	Able to understand the new developments such as Nano-science and nanotechnology continue to propel materials science and engineering to the forefront of the studies (at many universities) around the world utilize fluid mechanics principles in design.	**Understand(Level2)**

V. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Level	Proficiency assessed by
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Assignments, Practicals, Midterm and University examination
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	Assignments, Practicals, Midterm and University examination
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	3	Assignments, Practicals, Midterm and University examination
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Assignments, Practicals, Midterm and University examination
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	2	Assignments, Practicals, Midterm and University examination
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	-	--
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	-	--
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	2	Practicals, Projects
PO9	**Individual and team work**: Function effectively as an		--

	individual, and as a member or leader in diverse teams, and in multidisciplinary settings.		
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.		---
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	-	---
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	2	Practicals,Mid term and University examination, Projects, Technical activites.

VI. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Level	Proficiency assessed by
PSO 1	The student will be able to apply the knowledge of Mathematics, Sciences and engineering fundamentals to formulate, analyze and provide solutions for the problems related to Mechanical engineering and communicate them effectively to the concerned.	2	Lectures, Assignments
PSO 2	Design mechanical systems in various fields such as machine elements, thermal, manufacturing, industrial and inter-disciplinary fields by using various engineering/technological tools to meet the mercurial needs of the industry and society at large.	2	Lectures, Assignments
PSO 3	The ability to grasp the latest development, methodologies of mechanical engineering and posses competent knowledge of design process, practical proficiencies, skills and knowledge of programme and developing ideas towards research.	2	Lectures, Assignments

VII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

CO's	Program Outcomes (PO's)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	2	2	--	--	2	--	--	--	2
CO2	2	2	3	2	2	--	--	2	--	--	--	2
CO3	3	3	3	2	2	--	--	2	- -	--	--	2
Average	**2**	**3**	**3**	**2**	**2**	--	--	**2**	- -	- -	--	**2**

Program Specific Outcomes (PSO's)

CO's	PSO1	PSO2	PSO3
CO1	2	1	1
CO2	2	1	1
CO3	2	1	1
Average	2	1	1

VIII. SYLLABUS:

Unit – I	Crystal Structure: Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, inter facial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress
Unit – II	Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstrctural aspects of ledeburite, austenite, ferrite and cementite, cast iron
Unit – III	Heat treatment of Steel: Annealing, Normalising, Hardening, Tempering and Spheroidising, Isothermal transformation diagrams for Fe-C alloys and microstructures development.
Unit - IV	Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening
Unit - V	Alloying of steel, properties of stainless steel and tool steels, maraging steels- cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys (Brass, bronze and cupro-nickel)- Aluminium and Al-Cu – Mg alloys- Titanium alloys

SUGGESTED BOOKS/RESOURCES:

TEXT BOOKS:

1. V. Raghavan, “Material Science and Engineering’, Prentice Hall of India Private Limited, 1999.
2. W. D. Callister, 2006, “Materials Science and Engineering-An Introduction”, 6th Edition, Wiley India.

REFERENCES:

1. Kenneth G. Budinski and Michael K. Budinski, “Engineering Materials”, Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.
2. U. C. Jindal, “Engineering Materials and Metallurgy”, Pearson, 2011.

Additional Reading:

NPTEL WEB COURSE:

http://nptel.ac.in/courses/113105024/
http://nptel.ac.in/courses/113105024/1
http://nptel.ac.in/courses/113105024/2
http://nptel.ac.in/courses/113105024/3
http://nptel.ac.in/courses/113105024/4
http://nptel.ac.in/courses/113105024/5

NPTEL Video Course:

https://www.youtube.com/channel/UC9sKRSg8Kn5axYdORJUnqFw

https://www.youtube.com/watch?v=PVnftOMxl6w&list=PLbMVogVj5nJQbjE_u2KZhUmCypfLunjG4
https://www.youtube.com/watch?v=FrhvKcjKdPo&index=5&list=PLbMVogVj5nJQbjE_u2KZhUmCypfLunjG4

GATE SYLLABUS:

Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers, structure of surfaces and interfaces, nano-crystalline and amorphous structures; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, cast iron and aluminium alloys; surface treatments; recovery, recrystallization and grain growth; structure and properties of industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of optical, scanning and transmission electron microscopy; industrial ceramics, polymers and composites; introduction to electronic basis of thermal, optical, electrical and magnetic properties of materials; introduction to electronic and opto-electronic materials.

IX: COURSE PLAN

Lecture No.	Unit	Topics to be covered	Contents to be Covered	Link for PPT	Link for PDF	Course Learning Outcomes	Teaching Methodology	References
1	1	**Unit 1 -** Introduction Crystal Structure	Basics	https://drive.google.com/drive/folders/1yb0rLS-8KZYnUNj_AWs0Q9pQSOWM0iuo?usp=sharing	https://drive.google.com/drive/folders/1hNT5TPaexsmuQ2cB3sX2EbFN1tfJWpZa?usp=sharing	Understand	Chalk & Talk/ PPT	T1,R1
2		Unit cells, Metallic crystal structures,	Understand arrangement			Understand	Chalk & Talk/ PPT	T1,R1
3		Ceramics. Imperfection in solids	Analyse arrangement			Understand	Chalk & Talk/ PPT	T1,R1
4		Point, line, interfacial and volume defects	Basic knowledge of ceramics			Understand	Chalk & Talk/ PPT	T1,R1
5		dislocation strengthening mechanisms	To be able to understand defects			Understand	Chalk & Talk/ PPT	T1,R1
6		critically resolved shear stress.	To be able to understand defects			Understand	Chalk & Talk/ PPT	T1,R1
7		critically resolved shear stress.	Analyse mechanisms			Understand	Chalk & Talk/ PPT	T1,R1
8		Revision	Revise			Understand	Chalk & Talk/ PPT	T1,R1
9	2	**Unit 2 -** Alloys, substitutional, interstitial solid solutions	Basics of alloy formation			Understand	Chalk & Talk/ PPT	T1,R1
10		Alloys, substitutional,	Intro to phase			Understand	Chalk & Talk/ PPT	T1,R1

		interstitial solid solutions	diagrams	https://drive.google.com/drive/folders/1yb0rLS-8KZYnUNj_AWs0Q9pQSOWM0iuo?usp=sharing				
11		Phase diagrams: Interpretation of binary phase diagrams	Should be able to identify based on diagrams		https://drive.google.com/drive/folders/1hNT5TPaexsmuQ2cB3sX2EbFN1tfJWpZa?usp=sharing	Understand	Chalk & Talk/ PPT	T1,R1
12		Microstructure development;	How micro structure works and looks			Explain	Chalk & Talk/ PPT	T1,R1
13		Eutectic, Peritectic	How this phase is formed and its properties			Understand	Chalk & Talk/ PPT	T1,T2
14		Peritectoid Reaction	How this phase is formed and its properties			Understand	Chalk & Talk/ PPT	**T1,T2, R1**
15		Monotectic reactions	How this phase is formed and its properties			Understand	Chalk & Talk/ PPT	**T1,T2, R1**
16		Iron Iron-carbide phase diagram	Should be able to draw and interpret them			Understand	Chalk & Talk/ PPT	**T1,T2, R1**
17		microstructural aspects of ledeburite	Should be able to analyse them			Understand	Chalk & Talk/ PPT	**T1,T2, R1**
18		Austenite, Ferrite Cementite, Cast iron	Should be able to analyse them			Understand	Chalk & Talk/ PPT	**T1,T2, R1**
19		Revision	Revise			Understand	Chalk & Talk/ PPT	**T1,T2, R1**
20	3	**Unit 3 -** Heat treatment of Steel:	Able to know how it works and what changes it make	https://drive.google.com/drive/folders/1yb0rLS-8KZYnUNj_AWs0Q9	https://drive.google.com/drive/folders/1hNT5TPaexsmuQ2cB3sX2EbFN1tfJWpZa?usp=sharing	Understand	Chalk & Talk/ PPT	**T1,T2, R1**
21		Annealing, Normalising,	Definition, Process, Formation			Explain	Chalk & Talk/ PPT	**T1,T2, R1**
22		Hardening, Tempering	Definition, Process,			Explain	Chalk & Talk/ PPT	**T1,T2, R1**

			Formation	pQSOWM0iuo?usp=sharing				
23		Spheroidising	Definition, Process, Formation			Explain	Chalk & Talk/ PPT	**T1,T2 , R1**
24		Isothermal transformation diagrams for Fe-C alloys	Definition, Process, Formation			Understand	Chalk & Talk/ PPT	**T1,T2 , R1**
25		Isothermal transformation diagrams for Fe-C alloys	Definition, Process, Formation			Explain	Chalk & Talk/ PPT	**T1,T2 , R1**
26		microstructures development.	Definition, Process, Formation			Understand	Chalk & Talk/ PPT	**T1,T2 , R1**
27		Revision				Application	Chalk & Talk/ PPT	**T1,T2 , R1**
28		**Unit 4 -** Continuous cooling curves	How curves are formed and how they change properties			Application	Chalk & Talk/ PPT	**T1,T2 , R1**
29		interpretation of final microstructures	To be able to interpret them			Application	Chalk & Talk/ PPT	**T1,T2 , R1**
30	4	properties-austempering	Able to know how it works and what changes it make	https://drive.google.com/drive/folders/1yb0rLS-8KZYnUNj_AWs0Q9pQSOWM0iuo?usp=sharing	https://drive.google.com/drive/folders/1hNT5TPaexsmuQ2cB3sX2EbFN1tfJWpZa?usp=sharing	Application	Chalk & Talk/ PPT	**T1,T2 , R1**
31		Martempering	Able to know how it works and what changes it make			Application	Chalk & Talk/ PPT	**T1,T2 , R1**
32		case hardening, carburizing,Nitriding	Able to know how it works and what changes it make			Understand	Chalk & Talk/ PPT	**T1,T2 , R1**

33		cyaniding, carbo-nitriding, flame	Able to know how it works and what changes it make			Understand	Chalk & Talk/ PPT	**T1,T2 , R1**
34		induction hardening, vacuum Plasma hardening	Able to know how it works and what changes it make			Explain	Chalk & Talk/ PPT	**T1,T2 , R1**
35		Revision	Revise			Understand	Chalk & Talk/ PPT	**T1,T2 , R1**
36	5	**Unit 5 -** Alloying of steel, properties of stainless steel	Should be able to know how they are formed	https://drive.google.com/drive/folders/1yb0rLS-8KZYnUNj_AWs0Q9pQSOWM0iuo?usp=sharing	https://drive.google.com/drive/folders/1hNT5TPaexsmuQ2cB3sX2EbFN1tfJWpZa?usp=sharing	Application	Chalk & Talk/ PPT	**T1,T2 , R1**
37		tool steels, maraging steels	Able to determine the properties based on composition			Explain	Chalk & Talk/ PPT	**T1,T2 , R1**
38		Cast irons; grey, white	Able to determine the properties based on composition			Explain	Chalk & Talk/ PPT	**T1,T2 , R1**
39		malleable and spheroidal cast irons	Formation, Properties, Advantages			Explain	Chalk & Talk/ PPT	**T1,T2 , R1**
40		copper and copper alloy (Brass, bronze and cupro-nickel)	Formation, Properties, Advantages			Application	Chalk & Talk/ PPT	**T1,T2 , R1**
41		Aluminium and Al-Cu – Mg alloys	Formation, Properties, Advantages			Explain	Chalk & Talk/ PPT	**T1,T2 , R1**
42		Titanium alloys				APPLY	Chalk & Talk/ PPT	**T1,T2 , R1**

A) TEXT BOOKS:

1. V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited,1999.
2. W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition,Wiley India.

REFERENCES:

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2. U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011.

X. QUESTION BANK (JNTUH)

DESCRIPTIVE QUESTIONS:

Unit-I

SHORT ANSWER TYPE QUESTIONS

S.NO	QUESTION	BLOOMS TAXONOMY	COURSE OUTCOME
1	**Discuss** number of atoms, co-ordination number, and atomic packing factor for each unit cell.	**Understand**	**1**
2	Differentiate frenkel and schottky defect	understand	1
3	Classify the types of defects	understand	1
4	What is atomic packing Factor?	understand	1
5	**Explain** the influence of grain size on mechanical properties	understand	1
6	**Define** packing efficiency?	Remember	1
7	**Explain** the mechanism for formation of grain boundary	understand	1
8	**Define** intermediate phases?	Remember	1

LONG ANSWER TYPE QUESTIONS

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	**Prove** that FCC is closely packed than BCC by calculating atomic packing factor for both?	Evaluate	3
2	**Explain** the process of solidification of metals to form	understand	2

	polycrystalline structure.		
3	**Discuss** how the properties strength, ductility, and electrical conductivity are affected by these bonding?	understand	1
4	**Describe** solidification process for pure metal in terms of nucleation and grain growth of metals.	understand	1
5	**Explain** the method of plotting an equilibrium diagram and derive the lever rule as applied to equilibrium diagram.	understand	2
6	**Describe** Ionic bond, Covalent bond, Metallic bond.	understand	1
7	**Differentiate** substitutional and interstitial solid solutions with examples.	Analyse	2
8	**Explain ,** How does the bonding type influences the properties of crystals?	understand	1

Unit-II

SHORT ANSWER TYPE QUESTIONS

S.NO	QUESTIONS	BLOOMS TAXONOMY LEVEL	COURSE OUTCOME
1	**Discuss** Lever rule and explain its importance using eutectic system	Understand	1
2	**Discuss** phase rule and its importance.	Understand	1
3	**Discuss** binary alloy phase diagram.	Understand	1
4	**Discuss** non-equilibrium cooling and interstitial compounds.	Understand	1
5	**Define** eutectoid and peritectoid reactions.	Remember	1
6	**Explain** electron compounds.	Understand	1
7	**Define** inter-metallic compounds?	Remember	2

LONG ANSWER TYPE QUESTIONS

S.No.	Question	Blooms Taxonomy Level	Course Outcome
1	**Explain** the importance of equilibrium diagrams in the development of new alloys.	Understand	2
2	**Draw** Cu-Ni phase diagram and indicate the phases, temperatures and compositions.	Apply	2
3	**Draw** equilibrium diagram for eutectic type of system and discuss its important features.	Apply	2
4	**Explain** the importance of equilibrium diagrams in the development of new alloys.	Understand	2
5	**Explain** with sketch isomorphous system and discuss the equilibrium cooling of any one alloy from the above diagram.	Understand	2
6	**Explain** importance of lever rule.	Understand	1
7	**Define** peritectic, eutectoid and eutectic reactions.	Remember	1
8	**Explain** how is the cored structure formed? How it can be	Understand	1

	eliminated.		
9	**Explain** eutectic and peritectic reactions with a diagram? Also explain TTT curve	Remember	1

Unit-III

SHORT ANSWER TYPE QUESTIONS

S.No.	Question	Blooms Taxonomy Level	Course Outcome
1	**Explain** method of plotting isothermal transformation or TTT diagram.	Understand	1
2	**Explain** annealing heat treatmen	Understand	2
3	**Discuss** Normalizing heat treatment.	Understand	2
4	**Describe** austenite tempering process.	Understand	1
5	**Describe** martensite tempering process.	Understand	1
6	**Classify various heat treatment process**	**Understand**	**2**
7	**Define** alpha ferrite, austenite, cementite, delta ferrite.	Remember	2
8	**Explain** the phase reactions in iron-iron carbide phase diagram.	Understand	2

LONG ANSWER TYPE QUESTIONS

S.No.	Question	Blooms Taxonomy Level	Course Outcome
1	Recommend a heat treatment process to improve the machinability of high carbon steel. **Explain** the process and indicate the micro structures desired.	Understand	3
2	**What** is tempering process and **Explain** micro structures developed during various tempering stages.	Understand	1
3	**Describe** structural changes that take place when plain carbon steels: 0.8 % C, 0.4% C and 1.2 % C are cooled from austenite region to room temperature.	Understand	2
4	**Draw** TTT diagram for a eutectoid steel and indicate transformation products.	Apply	1
5	**Discuss** types of stainless steels and applications.	Understand	1
6	**Explain** Jominy end quench test used for determining the hardenability of steels.	Understand	2
7	Name the allotropic forms of iron and **Explain** lattice structure of each.	Understand	1
8	**Define** alpha ferrite, austenite, cementite, delta ferrite.	Remember	1
9	**Explain** the phase reactions in iron-iron carbide phase diagram.	Understand	1
10	**Explain** effect of small quantities of S, P, Mn, and Si upon properties of steel.	Understand	1

11	**Distinguish** between hypo eutectoid and hyper eutectoid steels	Analyse	1
12	**Explain** the process and indicate the micro structures desired.	Understand	1

Unit-IV

SHORT ANSWER TYPE QUESTIONS

S.No.	Question	Blooms Taxonomy Level	Course Outcome
1	Explain Austempering	Understand	1
2	Explain Martempering	Understand	1
3	Explain Case Hardening	Understand	1
4	Explain Carburizing	Understand	1
5	Explain Nitriding	Understand	1

LONG ANSWER TYPE QUESTIONS

S.No.	Question	Blooms Taxonomy Level	Course Outcome
1	**Explain** equilibrium cooling?	Understand	1
2	**Explain** cooling of Bi- Cd eutectic type I system.	Understand	1
3	**Explain** cooling of Pb- Sn eutectic type II system.	Understand	1
4	Classify various heat treatment process	Understand	1
5	Explain Carbo Nitriding, Cyaniding	Understand	1
6	Explain Flame and Induction Hardening	Understand	1
7	Explain Vaccum and Plasma Hardening	Understand	1

Unit-V

SHORT ANSWER TYPE QUESTION

S.No.	Question	Blooms Taxonomy Level	Course Outcome
1	**Discuss** heat treatable and non-heat treatable Aluminium alloys.	Understand	2
2	**Explain** Ni-resist cast iron.	Understand	2
3	**Discuss** Ni-hard cast iron.	Understand	2
4	**Explain** precipitation hardening.	Understand	2
5	**Explain** importance of copper for engineering applications.	Understand	2
6	**Define** cast irons?	remember	1
7	**Define** white cast iron and explain its uses.	remember	1
8	**Define** grey cast iron and its uses.	remember	1
9	**Define** malleable cast iron and its uses	remember	1

LONG ANSWER TYPE QUESTION

S.No.	Question	Blooms Taxonomy	Course Outcom

		Level	e
1	**Draw** Aluminum-copper phase diagram and explain precipitation hardening	Apply	2
2	**Explain** alpha titanium alloys and their uses	Understand	2
3	**Discuss** importance of titanium alloys for strategic applications.	Understand	2
4	**Discuss** various types of brasses and their applications.	Understand	2
5	**Discuss** tin bronzes and important applications	Understand	2
6	What is nodular cast iron? **Explain** its uses.	Understand	2
7	**State** factors control the structure of cast iron?	remember	1
8	**Discuss** duraluminium and its applications.	Understand	2
9	**Draw** aluminium-copper phase diagram.	Apply	2
10	What is al clad? **Explain** its advantages	Knowledge	2
11	**Explain** alpha-beta titanium alloys and their uses	Understand	2
12	**Define** beta titanium alloys?	remember	1

XI. OBJECTIVE QUESTIONS

UNIT-1

1. The number of protons in an atom is known as
   (a) Atomic Weight (b) Atomic Mass (c) Atomic number (d) Mass number
2. The nature of atomic bond found in diamond is
   (a) Ionic (b) Covalent (c)Metallic (d)Vander Walls
3. Smallest volume of crystal which gives atomic arrangement is known as
   (a) Space Lattice (b)Crystal Structure (c)Atomic Structure (d)Unit Cell
4. Dislocations in materials are
   (a) Point defects (b)Line defects (c)Volume Defects (d)Surface defects
5. Line imperfection in a crystal is called
   (a) Schottky defect (b) Frenkel defect (c)Edge dislocation (d)surface defects
6. Effective atoms per unit cell in a BCC lattice system
   (a) 2 (b) 3 (c) 4 (d) 6
7. A primitive cell is a
   (a) Unit cell of a simple cubic crystal
   (b) Cell containing smallest group of atoms
   (c) Unit cell in which lattice points are only at its corners
   (d) Basic building block of a crystal
8. Alloying element that promote graphitization is
   (a) Chromium (b) Vanadium (c) Silicon (d) Cobalt
9. The Alloy system representing interstitial solid solutions is
   (a) Copper-Nickel (b) Iron-Carbon (c) Gold-Silver (d) Copper-Aluminum
10. The formation of solid solutions are governed by
   (a) Lever rule (b) Phase rule (c) Hume-Ruthery rule (d) Kelvin-Plancks rule
11. Physically homogeneous and distinct portion of a material system is called
   (a) Alloy (b) Phase (c) Structure (d) None of the above

UNIT-2

1. Equilibrium diagrams are constructed by using
   (a) Microstructures (b) Heat Treatment (c) Cooling Curves (d) Composition
2. Complete substitutional solid solubility is found in the following system
   (a) Iron-Carbon (b) Lead-tin (c) Copper-nickel (d)Cadmium-bismuth
3. The Gibbs phase rule can be represented by the equation
   (a) P+F=C+2 (b) P-F=C+2 (c) P-C=F+2 (d) P+C=F+2
4. At invariant reaction the degree of freedom is
   (a) 2 (b) 3 (c) 4 (d) 0
5. The reaction that takes place within the solid state is
   (a) Eutectic (b) Peritectic (c) Monotectic (d) Eutectoid
6. The relative amounts of the co-existing phases in an alloy system are obtained from
   (a) Phase rule (b) Lever rule (c)Bain Rule (d)None of the above
7. ______________ is composed of two or more chemical elements of which atleast one is a metal.
8. __________________ is an alloy in which the atoms of the solute are distributed in the solvent and has some structure as that of solvent.
9. The start of solidification temperature is called _____________ temperature and the end of solidification temperature is called _____________ temperature.
10. In ______________ reaction, a solid phase reacts with a second phase to produce a third solid phase on cooling.

UNIT-3

1. Eutectoid steel contains
   (a) 0.8% carbon (b) 1.7-4.3%C (c) More than 4.3%C (d) Less than 0.8%carbon
2. Which of the following process is used for surface hardening
   (a) Tempering (b) Nitriding (c) Normalizing (d) Hardening
3. Machine tool guide ways are usually hardened by
   (a) Vacuum hardening (b) Martempering (c) Induction hardening (d) Flame Hardening
4. Which of the following generally decreases in the steel after quench-hardening
   (i) Brittleness (ii) Percentage Elongation (iii) Impact strength
   (a) 1 and 2 Only (b) 2 and 3 Only (c) 1 and 3 Only (d) 1, 2 and 3 Only
5. Induction hardening is basically a
   (a)Carburizing process (b) Surface hardening process
   (c) Core hardening process (d) None of the above
6. When a steel is heated in a furnace and then cooled in air at ordinary temperature, the process is one of
   (a) Annealing (b) Hardening (c) Normalizing (d) Tempering
7. Which one of the following structure is predominant in normalized steel
   (a) Troostile (b) Bainite (c) Sorbite (d) Martensite
8. Hardness of steel greatly improves with
   (a) Annealing (b) Cyaniding (c) Normalizing (d) Tempering
9. _______________ is the process of heating below lower critical point and cooling in air.
10. Austempering is the process of changing _____________ into _____________ at lower temperature (300°C).

UNIT -4

1. 1. The percentage of phosphorus in phosphor bronze is
   (a) 0.1 (b) 1 (c) 11.1 (d) 98
2. Invar is used for measuring tapes primarily due to its
   (a) Non magnetic properties (b) High nickel content
   (c)Low coefficient of thermal expansion (d) Hardenability
3. Alloy of copper and Zinc is known as
   (a) Brass (b) Bronze (c) Monel Metal (d) Gunmetal
4. Alloy of copper and tin is known as
   (a) Brass (b) Bronze (c) Monel Metal (d)Admiralty Brass
5. Alloy of nickel and copper is called
   (a) Brass (b) Bronze (c) Monel metal (d) Admiralty brass
6. Alloy mostly used in air craft is
   (a) Gun metal (b) Muntz metal (c) Duralumin (d) Babbit
7. Machining properties of steel are improved by adding ____________________.
8. An engineer's hammer is made of _______________ steel.
9. Tensile strength of steel can be safely increased by adding carbon upto ______ %.
10. Presence of sulphur makes steel brittle. Its effect can be reduced by adding __________.

UNIT -5

1. 1. Clay based ceramics are used for
   (a) Aero Craft Parts (b) Magnets (c) Floor-tiles (d) None of the above
2. Ceramic used for lining of metallurgical furnaces are
   (a) Abrasives (b) Glasses (c) Silicates (d) Refractory's
3. Alumina is a
   (a) Non ferrous metal (b) Ferrous metals (c) Ceramic Material (d) Composite Material
4. Glass ceramic is a
   (a) Amorphous solid (b) Crystalline solid (c) Partly crystalline (d) None of the above
5. Parts of uniform cross section in continuous lengths are manufactured by
   (a) Fibres (b) Wires (c) Whisker (d) Particular
6. Parts of uniform cross section in continuous lengths are manufactured by
   (a) Transfer molding (b) Hand Lay-up (c) Pultrusion (d) Vacuum bag molding
7. The composite composed of ceramic particles in a metal matrix is called
   (a) Cermets (b) Laminates (c) Fibre composites (d) None of the above
8. Orthosilicates have the melting point temperature of ________________.
9. A special glass "pyrex" is manufactured by using ________________.
10. The combination of ceramics and metal is known as ________________.

ii) GATE QUESTIONS:

1. The "Jominy test" is used to find
   (a) Young's modulus (b) hardenability(c) yield strength (d) thermal conductivity

2. The process of reheating the martensitic steel to reduce its brittleness without any significant loss in its hardness is
   (a) normalising (b) annealing (c) quenching (d)tempering
3. During normalizing process of steel, the specimen is heated
   (a) between the upper and lower critical temperature and cooled in still air
   (b) above the upper critical temperature and cooled in furnace
   (c) above the upper critical temperature and cooled in still air
   (d) between the upper and lower critical temperature and cooled in furnace
4. The material property which depends only on the basic crystal structure is
   a) fatigue strength (b) work hardening (c) fracture strength (d) elastic constant
5. The effective number of lattice points in the unit cell of simple cubic, body centered cubic, and face centered cubic space lattices, respectively, are
   (a) 1, 2, 2 (b) 1, 2, 4 (c) 2, 3, 4 (d) 2, 4, 4
6. If a particular Fe-C alloy contains less than 0.83% carbon, it is called
   (a) High speed steel (b) hypo eutectoid steel (c) hyper eutectoid steel (d) cast iron
7. The main purpose of spheroidising treatment is to improve
   (a) hardenability of low carbon steels (b) machinability of low carbon steels
   (c) hardenability of high carbon steels (d) machinability of high carbon steels

8. Liquid + solid (1) on cooling converting into solid (2) reaction is known as:
   (a) Eutectoid reaction (b) Eutectic reaction
   (c) Peritectic reaction (d) Peritectoid reaction
9. Structure of common glass is
   (a) Amorphous (b) Partially crystalline (c) Fully crystalline (d) None of these

10. Solid material chemical bonds are
   (a) Ionic, molecular and fusion (b) Covalent, fusion and fission
   (c) Ionic, covalent and molecular (d) Fission, molecular and ionic

iii) <u>IES QUESTIONS:</u>

1. The process of impregnation in powder metallurgy technique is best described by which of the following?
   (a) After sintering operation of powder metallurgy, rapid cooling is performed to avoid thermal stresses
   (b) Low melting point metal is filled in the pores of a sintered powder metallurgy product
   (c) Liquid oil or grease is filled in the pores of a sintered powder metallurgy product
   (d) During sintering operation of powder metallurgy, rapid heating is performed to avoid sudden high internal pressure due to volatilization of lubricant.
2. Cast iron possessing which one of the following metallographic structures is best suited for damping capacity in engineering applications?
   (a) Excess cementite (c) Carbon in temper form
   (b) Silicon carbide in flake structure (d) Spheroidal form of graphite

3. Eutectoid reaction occurring at 727 °C with 0.77%C is
   (a) austenite ferrite + pearlite (c) austenite ferrite + cementite
   (b) austenite ferrite + martensite (d) austenite martensite + bainite
4. Jominy end-quench test is carried out to determine
   (a) recrystallization temperature of steel (c) hardness of steel
   (b) glass transition temperature of a material (d) hardenability of steel
5. Edge dislocation is a:
   (a) Point imperfection (c) Line imperfection
   (b) Surface imperfection (d)Volume imperfection
6. Which of the following phase of steel is NOT present in Iron-Carbon phase diagram?
   (a) Ferrite (b) Cementite (c)Austenite (d) Martensite
7. Sialon ceramic is used as:
   (a)Cutting tool material (c) Creep resistant
   (b)Furnace linens (d) High strength
8. Line imperfection in a crystal is called
   (a)Miller defect (c) Frankel defect
   (b)Schottky defect (d) Edge dislocation
9. Addition of which one of the following elements, shifts the lower critical temperature line in iron–iron carbide diagram towards the higher side?
   (a)Chromium (b) Nickel (c) Molybdenum (d) Aluminum
10. Spheroidal or nodular graphite iron is designed as SG 500/7. Here '500' and 7 stand for
    (a)Proof stress in and elongation in % 2 N/ mm
    (b) Tensile strength in and impact strength in N–m 2 N/ mm
    (b)Tensile strength in and elongation in % 2 N/ mm
    (c)Tensile strength in and elongation in % 2 kg.mm
11. When steel containing less than 0.85% carbon is cooled slowly below the lower critical point, it contains
    (a)Ferrite mainly (c) Pearlite mainly
    (b)Ferrite and pearlite (d) Pearlite and cementite

XII. WEBSITES:

1. https://mse.stanford.edu/
2. www.iitk.ac.in/msp/
3. www.mse.seas.upenn.edu/about-mse/mse-defined.php
4. http://www.msm.cam.ac.uk/
5. http://www.mse.berkeley.edu/
6. http://www.mse.utoronto.ca/Page4.aspx

XIII. EXPERT DETAILS:

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