MECHANICAL

DEPARTMENT

2023-24

MSE

PREPARED BY

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Techno India NJR Institute of Technology

Course File

Material Science and Engineering (3ME4- 06)

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SYLLABUS

2nd Year - III Semester: B.Tech. (Mechanical Engineering)

3ME4-06 : MATERIAL SCIENCE AND ENGINEERING

Credit: 3 **Max. Marks: 150 (IA:30, ETE:120)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	CONTENTS	Hours
1	Crystal structure – BCC, FCC and HCP, unit cell, crystallographic planes and directions, miller indices. Crystal imperfections, point, line, surface and volume defects.	4
	Frank Reed source of dislocation, Elastic & plastic modes of deformation, Bauschinger's effect, slip & twinning, strain hardening, cold/hot working recovery, re-crystallization and grain growth.	4
2	Classification of Engineering Materials: Solidification of metals and of some typical alloys, mechanism of crystallization (I) nuclear formation (ii) crystal growth, general principles of phase transformation in alloys, phase rule and equilibrium diagrams, equilibrium diagram of binary system having complete mutual solubility in liquid state and limited solubility in solid state, binary isomorphous alloy system, Hume-Rothery rule , binary system with limited solid solubility of terminal phase and in which solubility decreases with temperature and also alloy with a peritectic transformation, equilibrium diagram of a system whose components are subject to allotropic change.	5
	Iron carbon equilibrium diagram, phase transformation in the iron carbon diagram, eutectic, peritectic, eutectoid and peritectoid reactions and microstructures.	3
3	Isothermal transformation diagrams –cooling curves superimposed on Isothermal Transformation diagram, critical cooling rate. (i) Formation of Austenite from Pearlite (ii) Transformation of Austenite into Pearlite.	4
	Full annealing, stress relief, spheroidizing – normalizing, hardening and tempering of steel. Hardenability, Jominey end quench test – Austempering, martempering. Case hardening, carburising, nitriding, cyaniding, carbonitriding. Flame and Induction hardening.	4
4	Non-Metallic Materials- Polymers – types of polymer, commodity and engineering polymers – Properties and applications of PE, PP, PS, PVC, PMMA, PET, PC, PA, ABS, PI, PAI, PPO,PPS, PEEK, PTFE Polymers. Urea and Phenol formaldehydes.	4
	Constitution of alloys: Solid solutions - substitutional and interstitial. Ferrous and Non Ferrous Metals- Effect of alloying additions on steel (Mn, Si, Cr, Mo, V, Ti & W) - stainless and tool steels – HSLA steel.	4
5	Mechanical Properties and Testing: Types of fracture, testing of materials under tension, compression and shear loads – hardness tests (Brinell, Vickers and Rockwell) Impact test Izod and charpy, fatigue and creep test.	4

	Classification of steels and cast iron constitution and properties. BIS standards. Engineering Ceramics – Properties and applications of Al2O3, SiC, Si3N4, PSZ etc. Fiber and particulate reinforced composites and resin plastics. Introduction to Nano materials- Nano structured materials. Nano clusters & Nano crystals.	3
	TOTAL	**39**

Course Overview:

Students will learn the basics of Material Science and Engineering from this 39 hours course. This course is dedicated to the application of materials and textures onto 3D objects in blender. The course guides you first through all the features of the easy to use blender render engine which is blenders internal renderer used for previewing objects in different materials before exporting to external game engines. We will also cover UV unwrapping different objects and how to use the features of the UV editor. After this the course moves onto the cycles render engine, covering in detail how to use the node tree and how to simplify your workflow and how to use nodes to create realistic materials for your scenes.

Course Outcomes:

CO. NO.	Cognitive Level	Course Outcome
1	Synthesis	Student will be able to apply core concepts in Materials Science to solve engineering problems.
2	Synthesis	Student will be able to interpret about material fundamental and material processing.
3	Synthesis	Students will be able to distinguish the defects in crystal and its effect on crystal properties.
4	Synthesis	Students will be able to figure out the different mechanical properties of material by studying different destructive and non-destructive testing.
5	Synthesis	Students will be able to understand articulate and utilize corrosion prevention strategies and estimate corrosion behavior of materials and components .

Course Outcome Mapping with Program Outcome:

Material Science Engineering Year of study: 2020-21												
Course Outcome	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	0	2	2	1	0	0	1	1	0	1
CO2	1	1	1	2	1	1	0	0	1	1	0	1
CO3	2	1	1	1	0	0	0	0	1	0	0	0
C04	3	1	1	1	1	0	0	0	0	1	0	0
C05	3	2	3	2	2	0	0	0	0	1	0	1
Average	2.33	1.33	1.50	1.67	1.33	0.33	0.00	0.00	0.50	0.83	0.00	0.67

Course coverage module wise:

Lecture No.	Unit	Topic
1	**1**	**CRYSTAL STRUCTURE:** BCC, FCC and HCP,
2	1	Student should be able to understand unit cell, crystallographic planes and directions,
3	1	Student should be able to understand miller indices
4	1	Student should be able to understand Crystal imperfections, point, line, surface and volume defects.
5	1	Student should be able to understand Frank Reed source of dislocation, Elastic & plastic modes of deformation
6	**1**	Student should be able to understand Bauschinger's effect, slip & twinning
7	1	Student should be able to understand strain hardening, cold/hot working recovery,
8	1	Student should be able to understand re-crystallization and grain growth.
9	**2**	**CLASSIFICATION OF ENGINEERING MATERIALS:** Student should be able to understand solidification of metals and of some typical alloys, mechanism of crystallization (I) nuclear formation (ii) crystal growth,
10	2	Student should be able to understand general principles of phase transformation in alloys, phase rule and equilibrium diagrams,

11	2	equilibrium diagram of binary system having complete mutual solubility in liquid state and limited solubility in solid state, binary isomorphous alloy system,
12	2	Student should be able to understand Hume- Rothery rule , binary system with limited solid solubility of terminal phase and in which solubility decreases with temperature
13	2	Student should be able to understand alloy with a peritectic transformation, equilibrium diagram of a system whose components are subject to allotropic change.
14	2	Student should be able to understand Iron carbon equilibrium diagram,
15	2	Student should be able to understand phase transformation in the iron carbon diagram,
16	2	Student should be able to understand Eutectic, peritectic, eutectoid and peritectoid reactions and microstructures.
17	**3**	**TRANSFORMATION DIAGRAMS**: Student should be able to understand Isothermal transformation diagrams
18	3	Student should be able to understand cooling curves superimposed on Isothermal Transformation diagram, critical cooling rate.
19	3	Student should be able to understand Formation of Austenite from Pearlite.
20	3	Student should be able to understand Transformation of Austenite into Pearlite.
21	3	Student should be able to understand full annealing, stress relief, spheroidizing
22	3	Student should be able to understand normalizing, hardening and tempering of steel.
23	3	Student should be able to understand hardenability, jominey end quench test – Austempering, martempering.
24	3	Student should be able to understand Case hardening, carburising, nitriding, cyaniding, carbonitriding. Flame and Induction hardening.
25	**4**	**POLYMERS:** Student should be able to understand Non-Metallic Materials- Polymers – types of polymer
26	4	Student should be able to understand commodity and engineering polymers
27	4	Student should be able to understand properties and applications of PE, PP, PS, PVC,

		PMMA, PET, PC, PA, ABS, PI
28	4	Student should be able to understand properties and applications of PAI, PPO,PPS, PEEK, PTFE Polymers. Urea and Phenol formaldehydes.
29	4	Student should be able to understand constitution of alloys
30	4	Student should be able to understand solid solutions - substitutional and interstitial.
31	4	Student should be able to understand Ferrous and Non Ferrous Metals- Effect of alloying additions on steel (Mn, Si, Cr, Mo, V, Ti & W)
32	4	Student should be able to understand stainless and tool steels – HSLA steel.
33	**5**	**MECHANICAL PROPERTIES & TESTING**
34	5	Student should be able to understand types of fracture, testing of materials under tension,
35	5	Student should be able to understand compression and shear loads – hardness tests (Brinell, Vickers and Rockwell)
36	5	Student should be able to understand Impact test Izod and charpy, fatigue and creep test.
37	5	Student should be able to understand classification of steels and cast iron constitution and properties. BIS standards.
38	5	Student should be able to understand Engineering Ceramics – Properties and applications of Al2O3, SiC, Si3N4, PSZ etc. Fiber and particulate reinforced composites and resin plastics.
39	5	Student should be able to understand Introduction to Nano materials- Nano structured materials. Nano clusters & Nano crystals.

TEXT/REFERENCE BOOKS

- MATERIAL SCIENCE AND ENGINEERING AN INTRODUCTION, WILLIAM D.CALLISTER, JOHN WILEY AND SONS.
- PRINCIPLES OF MATERIAL SCIENCE AND ENGINEERING, WILLIAM F.SMITH, TATA MCGRAW-HILL PUBLICATIONS.

Course Level Problems (Test Items):

CO.NO.	Problem description
1	A. Describe and illustrate the edge and screw type dislocation. What types of strain field surrounds both types of dislocations. B. Describe the structure of grain boundary. C. What is slip, explain the slip systems present in B.C.C., F.C.C., and H.C.P. crystal systems. D. What is re-crystallization temperature, what are the factor which effect re-crystallization temperature. E. Distinguish between following- I. Slip and twin mechanism II. Elastic and plastic deformation III. Hot and cold working
2	A. Distinguish between homogeneous and heterogeneous nucleation for solidification of a pure metal. B. Draw an equilibrium diagram of a binary system with limited solid solubility in solid state and in which solubility decreases with decrease in temperature, also explain it briefly. C. Draw neat labelled iron-carbide equilibrium diagram also explain invariant reactions occur in this diagram. D. State Peritectic and Peritectoid reactions.
3	A. Draw an isothermal transformation diagram for plain carbon eutectoid steel and indicate various decomposition products on it. B. What is hardening process also explain the factors which affect hardenability of steel. C. Difference hardness and hardenability. D. Explain time temperature transformation (TTT) curve and critical cooling rate. E. Differentiate between the following- 1. Austempering and martempering 2. Carburizing and nitriding

	3. Annealing and normalising
4	A. What are plasticizers. Why they are used in polymeric materials,and what types of plasticizers are used in PVC. B. Explain some of the methods which are generally used for strengthening of thermoplastics. C. What are the effect of alloying element also discuss the effect of alloying SI, CR, NI, AL, MO in steel. D. What are constituents, properties and engineering applications of PVC, PMMA, ABS, PTFE and PA.
5	A. Explain tensile test, specifying standard specimen which is used for test. B. What are different types of fractures also explain Griffith's theory of brittle fracture. C. Explain various properties and application of Nanostructure materials. D. Differentiate various kind of hardness test. E. Explain BIS standard for classification of low and high alloy steels. F. Explain Brinell and Rockwell hardness test.

Assessment Methodology:

1. Practical exam in lab where they have to write readings of MST LAB.
2. Assignments one from each unit.
3. Midterm subjective paper where they have to write numericals.
4. Final paper at the end of the semester subjective.

Teaching and Learning resources unit-wise:

Unit-1

A. Crystal structure

Video Tutorials: https://youtu.be/CtHzWpcJcCA

Theory concepts: https://www.slideshare.net/SachinHariprasad/crystal-structures-40047329

Sample Quiz:
https://www.wisdomjobs.com/e-university/material-science-interview-questions.html

Unit-2

A. Classification of engineering materials

Video Tutorials: https://youtu.be/CEecToazteE

Theory concepts:
https://www.slideshare.net/akashambaliya/classification-of-engineering-materials-engineering-requirements-of-materials

Sample Quiz: https://www.examveda.com/mcq-question-on-mechanical-engineering/

B. Iron carbon equilibrium diagram

Video Tutorials: https://youtu.be/LQVHQ0YL0R0

Theory concepts: https://www.engineersgallery.com/iron-carbon-equilibrium-diagram/

Sample Quiz: https://www.objectivebooks.com/p/mechanical-engineering-mcq.html

Unit-3

A. Isothermal transformation diagram

Video Tutorials: https://youtu.be/Ca6xZO8WOnU

Theory concepts: https://en.wikipedia.org/wiki/Isothermal_transformation_diagram

Sample Quiz: https://www.wisdomjobs.com/e-university/material-science-interview-questions.html

B. Full annealing

Video Tutorials: https://youtu.be/1XdSqXawoRE

Theory concepts: https://www.mecholic.com/2018/10/annealing-process.html

Sample Quiz: https://www.careerride.com/Engineering-questions-answers.aspx

Unit-4

A. Non-metallic materials

Video Tutorials: https://youtu.be/dLexokEbVP4

Theory concepts:
https://www.sciencedirect.com/topics/materials-science/nonmetallic-material

Sample Quiz:
https://www.wisdomjobs.com/e-university/material-science-interview-questions.html

B. Constitution of alloys

Video Tutorials: https://youtu.be/YvuZxbgtAiM

Theory concepts:
https://www.brainkart.com/article/Constitution-of-Alloys-and-Phase-Diagrams_6354/

Sample Quiz: https://www.objectivebooks.com/p/mechanical-engineering-mcq.html

Unit-5

A. Mechanical properties and testing

Video Tutorials: https://youtu.be/cQJK0SEBMhA

Theory concepts: https://www.arcjournals.org/pdfs/ijmsme/v6-i2/3.pdf

Sample Quiz: https://www.wisdomjobs.com/e-university/material-science-interview-questions.html

B. Engineering ceramics

Video Tutorials: https://youtu.be/oav0xi0OvaY

Theory concepts: http://mse.gatech.edu/research-area/ceramics

Sample Quiz: https://www.objectivebooks.com/p/mechanical-engineering-mcq.html

Previous Year Question Papers:

3E1632

Roll No. _____ [Total No. of Pages : 3]

3E1632

B. Tech. III Semester (Main/Back) Examination-2014

Mechanical Engg.

3ME2A Material Science and Engg.

(Common to 3AN2, 3PI2A and 3AE2A)

Time : 3 Hours **Maximum Marks : 80**

Min. Passing Marks : 24

Instructions to Candidates:

*Attempt any **five** questions, selecting **one** question from **each** unit. All questions carry **equal** marks. (Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly. Units of quantities used/calculated must be stated clearly.)*

Unit - I

1. a) What are crystal imperfections? **(4)**

   b) Differentiate edge dislocation and screw dislocation. **(4)**

   c) What are causes of crystal defects? **(4)**

   d) Differentiate elastic and plastic deformation. **(4)**

OR

1. a) Draw neat and labelled Iron - carbide equilibrium diagram. Explain invariant reactions occur in this diagram. **(10)**

   b) What is solid solution? **(3)**

   c) What is strengthing of metal? **(3)**

Unit - II

2. a) Explain the precipitation strengthing mechanism of aluminium alloys. **(8)**

   b) Discuss constitutents, properties and applications of various copper alloys. **(8)**

OR

2.	a)	Write a short note on HSLA steel.	(6)
	b)	Discuss effect of various alloying element on the properties of carbon steels.	(6)
	c)	Write a short note on spheroidal cast iron.	(4)

Unit - III

3.	a)	Differentiate hardness and hardenability.	(4)
	b)	Distinguish annealing and stress relief process.	(6)
	c)	Explain the following transformation:	
		i) Austenite to Bainite	
		ii) Austenite to pearlite.	(6)

OR

3.	a)	Discuss surface hardening.	(8)
	b)	What is TTT diagram?	(4)
	c)	Discuss Austeropering.	(4)

Unit - IV

4.	a)	Differentiate various kinds of hardness test.	(6)
	b)	What is significance of fatigue test?	(4)
	c)	Discuss the stress - strain curve for a ductile material.	(6)

OR

4.	a)	What are constituents, properties and engineering applications of PVC, PMMA, ABS, PTFE and PA?	(10)
	b)	Discuss impact test for the materials.	(6)

Unit - V

5. a) What are the engineering Ceramics? **(4)**

b) Discuss the properties and applications of Al_2O_3, Si_3N_4 and SiC. **(6)**

c) Define composite materials. **(2)**

d) Distinguish between fibre and particulate reinforced composite. **(4)**

OR

5. a) What are nano materials? **(4)**

b) Explain with energy level graph quantum well, quantum wire and quantum dots. **(8)**

c) Discuss various kind approaches for synthesis of nano materials. **(4)**

3E1632

Roll No. : 16CEBME715

Total Printed Pages : 3

3E1632

B. Tech. (Sem. III) (Mercy Back) Examination, December - 2017
Mechanical Engg.
3ME2A Material Science & Engg.

Time : 3 Hours

Maximum Marks : 80
Min. Passing Marks : 24

*Attempt any **five questions**, selecting **one question** from **each unit**. All Questions carry **equal** marks. Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly. Units of quantities used / calculated must be stated clearly.*

Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

1. Nil 2. Nil

UNIT - I

1 (a) With neat sketches, explain crystal lattice of BCC and FCC. **8**

(b) Explain with neat sketches, the various types of crystal imperfections. **8**

OR

1 (a) Explain slip and twinning mechanisms with neat sketches. **8**

(b) What is recovery, recrystallization and grain growth ? Draw suitable graph to explain. **8**

UNIT - II

2 (a) Distinguish between homogeneous and heterogeneous nucleation for solidification of a pure metal. 6

(b) Draw an equilibrium diagram of binary isomorphous alloy system, also explain it. 10

OR

2 Draw iron carbon equilibrium diagram and label the various phase, fields and temperature. Discuss in brief different reactions that take place in the system. 16

UNIT - III

3 Describe all the transformation which appear in TTT curve for steel. 16

OR

3 Explain briefly the following heat treatment operations :

(i) Annealing

(ii) Normalising

(iii) Hardening

(iv) Tempering.

4×4=16

UNIT - IV

4 (a) What are properties and engineering applications of PMMA, ABS, PVC, PA and PTFE ? 10

(b) Write a short note on urea and phenol formaldehyde. 6

OR

4 (a) Explain the effects of addition of Si, Cr, Mo, V and W alloying elements on the properties of steel. **10**

(b) Write short notes on :

(i) Stainless steel

(ii) Tool steel. **6**

UNIT - V

5 (a) Explain Rockwell hardness testing method with sketch. **8**

(b) Discuss Izod and Charpy impact test for the materials with sketch. **8**

OR

5 (a) Discuss the properties and applications of Al_2O_3, Si_3N_4, SiC and PSZ. **8**

(b) Explain various properties and applications of Nano structured materials. **8**