



JAIPUR ENGINEERING COLLEGE
AND RESEARCH CENTRE

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

JECRC Campus ,Shri Ram ki Nangal, Via-Vatika ,Tonk Road, Jaipur

Department of Mechanical Engineering

Name of Subject: Material Science & Engineering (MSE)

Subject Code: 3ME4-06

Year: 2nd Year, IIIrd-Semester



JAIPUR ENGINEERING COLLEGE
AND RESEARCH CENTRE

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

JECRC Campus ,Shri Ram ki Nangal, Via-Vatika ,Tonk Road, Jaipur

Department of Mechanical Engineering

Vision and Mission of Institute:

Vision: To become a renowned center of outcome based learning, and work towards academic, professional, cultural and social enrichment of the lives of individuals and communities.

Mission:

M1: Focus on evaluation of learning outcomes and motivate students to inculcate research aptitude by project based learning.

M2: Identify, based on informed perception of Indian, regional and global needs, areas of focus and provide platform to gain knowledge and solutions.

M3: Offer opportunities for interaction between academia and industry.

M4: Develop human potential to its fullest extent so that intellectually capable and imaginatively gifted leaders can emerge in a range of professions.

Vision and Mission of Department:

Vision: The Mechanical Engineering Department strives to be recognized globally for outcome based technical knowledge and to produce quality human resource, who can manage the advance technologies and contribute to society.

Mission:

M1: To impart quality technical knowledge to the learners to make them globally competitive mechanical engineers.

M2: To provide the learners ethical guidelines along with excellent academic environment for a long productive career.

M3: To promote industry-institute relationship.



JAIPUR ENGINEERING COLLEGE
AND RESEARCH CENTRE

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

JECRC Campus ,Shri Ram ki Nangal, Via-Vatika ,Tonk Road, Jaipur

Department of Mechanical Engineering

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

PEO1: To equip graduates with a strong foundation in engineering sciences, with an emphasis on mechanical engineering principles, enabling them to analyze, design, and solve real-world engineering challenges.

PEO2: To prepare graduates with sound scientific and engineering fundamentals to innovate and deliver effective solutions addressing practical challenges in mechanical engineering

PEO3: To inculcate in graduates a professional and ethical attitude, effective communication and teamwork skills, a multidisciplinary approach, entrepreneurial mindset, and the ability to connect engineering solutions with societal and environmental concerns.

PEO4: To provide students with an academic environment that fosters excellence, leadership, adherence to ethical standards, and encourages self-motivated lifelong learning essential for a successful professional career in mechanical

PEO5: To prepare students to excel in industry and higher education by providing quality education grounded in strong technical knowledge and high moral values

Program Specific Outcomes (PSOs)

PSO1: Graduates will be able to design, analyze, and fabricate electric and hybrid vehicles using modern engineering tools and sustainable practices.

PSO2: Graduates will be able to apply design principles and computational techniques, including programming and data structures, to analyze and solve mechanical engineering problems.



JAIPUR ENGINEERING COLLEGE
AND RESEARCH CENTRE

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

JECRC Campus ,Shri Ram ki Nangal, Via-Vatika ,Tonk Road, Jaipur

Department of Mechanical Engineering

Program Outcomes (POs)

- PO1: Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
- PO2: Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
- PO3: Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
- PO4: Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
- PO5: Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
- PO6: The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
- PO7: Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
- PO8: Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
- PO9: Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
- PO10: Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
- PO11: Life-Long Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)



JAIPUR ENGINEERING COLLEGE
AND RESEARCH CENTRE

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

JECRC Campus ,Shri Ram ki Nangal, Via-Vatika ,Tonk Road, Jaipur

Department of Mechanical Engineering

SYLLABUS



RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

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

3ME4-06 : MATERIAL SCIENCE AND ENGINEERING

Credit: 3
3L+0T+0P

Max. Marks: 100 (IA:30, ETE:70)
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

Office of Dean Academic Affairs
Rajasthan Technical University, Kota



JAIPUR ENGINEERING COLLEGE
AND RESEARCH CENTRE

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

JECRC Campus ,Shri Ram ki Nangal, Via-Vatika ,Tonk Road, Jaipur

Department of Mechanical Engineering



RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

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

	Classification of steels and cast iron constitution and properties. BIS standards. Engineering Ceramics – Properties and applications of Al ₂ O ₃ , SiC, Si ₃ N ₄ , PSZ etc. Fiber and particulate reinforced composites and resin plastics. Introduction to Nano materials- Nano structured materials. Nano clusters & Nano crystals.	3
	TOTAL	39



JAIPUR ENGINEERING COLLEGE
AND RESEARCH CENTRE

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

JECRC Campus ,Shri Ram ki Nangal, Via-Vatika ,Tonk Road, Jaipur

Department of Mechanical Engineering

REFERENCE BOOKS (MSE)

Text Book		
1	Materials Science and Engineering: An Introduction, William D. Callister Jr. & David G. Rethwisch, 10th Edition, Wiley India	2018
Reference Books		
1	Materials Science and Engineering: A First Course, V. Raghavan, 6th Edition, PHI Learning	2022
2	Material Science and Metallurgy, O.P. Khanna, 18th Revised Edition, Dhanpat Rai Publications	2014
3	Engineering Physical Metallurgy and Heat Treatment, Y. Lakhtin, Reprint Edition, CBS Publishers (Indian Reprint)	2005
4	The Science and Engineering of Materials, Donald R. Askeland & Wendelin J. Wright, 7th Edition, Cengage Learning	2016
5	Introduction to Physical Metallurgy, Sidney H. Avner, 2nd Edition (Reprint Edition), McGraw-Hill Education (India)	2017



JAIPUR ENGINEERING COLLEGE
AND RESEARCH CENTRE

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

JECRC Campus ,Shri Ram ki Nangal, Via-Vatika ,Tonk Road, Jaipur

Department of Mechanical Engineering

COURSE OUTCOME

Subject: Materials Science and Engineering

Code: 3ME4-06

COURSE OUTCOMES

CO1.Classify engineering materials and explain their structure-property relationships.

CO2.Analyze mechanical, thermal, and electrical properties of materials.

CO3.Evaluate the effects of heat treatment and processing on material behavior.

CO4.Apply knowledge of phase diagrams and microstructures in materials design.

CO5.Investigate failure mechanisms like fatigue, corrosion, and creep in materials.

CO6.Propose novel materials or composites for advanced engineering applications.

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	1	1	1	1	1	1	2	2	3
CO2	3	3	2	1	1	1	1	1	1	1	2	2	3
CO3	3	3	3	2	2	1	1	1	1	1	3	2	3
CO4	3	3	3	3	3	1	1	1	1	1	3	3	3
CO5	3	3	3	3	3	1	1	1	1	1	3	2	3
CO6	3	3	3	2	2	2	1	1	1	1	3	2	3



JAIPUR ENGINEERING COLLEGE
AND RESEARCH CENTRE

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

JECRC Campus ,Shri Ram ki Nangal, Via-Vatika ,Tonk Road, Jaipur

Department of Mechanical Engineering

Course Plan

Name of the Course : **Material Science Engineering**

Code of the course : **3ME4-06**

Name of Faculty : **Mr. Yogesh Dubey**

Course Outcome

CO1.Classify engineering materials and explain their structure-property relationships.

CO2.Analyze mechanical, thermal, and electrical properties of materials.

CO3.Evaluate the effects of heat treatment and processing on material behavior.

CO4.Apply knowledge of phase diagrams and microstructures in materials design.

CO5.Investigate failure mechanisms like fatigue, corrosion, and creep in materials.

CO6.Propose novel materials or composites for advanced engineering applications.

Unit No.	Topic	Lec.	CO	Specific Objectives	Expected Outcomes	Primary Reference (William D. Callister Jr. & David G. Rethwisch, Materials Science and Engineering: An Introduction, 10th Edition, Wiley.)	
Intr o	Introduction to Material science engineering	1	CO1	Understand the basics and importance of materials science.	Understand the basic concept of material science engineering	Ch.1	1-20
1	Crystal structure	2	CO1	Learn the arrangement of atoms in crystalline materials.	understand the concept of crystal structure	Ch.3	55-70
	Crystal parameters	3	CO1	Understand the unit cell and its parameters.	understand the concept of crystal structure	Ch.3	71-82
	crystallographic	4	CO1	Learn the basic concepts of crystallography.	Understand the crystallographic planes	Ch.3	83-92



JAIPUR ENGINEERING COLLEGE
AND RESEARCH CENTRE

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

JECRC Campus ,Shri Ram ki Nangal, Via-Vatika ,Tonk Road, Jaipur

Department of Mechanical Engineering

	planes and directions, miller indices	5	CO1	Identify crystal planes and directions using Miller indices.	Understand the types of crystal planes and miller indices	Ch.3	93-105
	Crystal imperfections	6	CO1	Understand different types of crystal defects.	Understand crystal imperfections	Ch.4	106-125
	Crystal Dislocation	7	CO1	Learn the concept and types of dislocations.	Identify the types of crystal imperfection	Ch.4	126-140
	Crystal Dislocation (Continue)	8	CO2	Explain the effect of dislocations on material properties.	Identify the types of dislocation .	Ch.4	141-150
2	strain hardening	9	CO2	Understand the mechanism of strain hardening.	understand the concept of strain hardening .	Ch.7	171-180
	strain hardening (Continue)	10	CO2	Explain the effects of strain hardening on strength.	understand the principle of cold/hot working .	Ch.7	181-190
	cold/hot working	11	CO2	Compare cold working and hot working processes.	understand the principle of cold/hot working .	Ch.7	191-205
	Content beyond syllabus-1: Know different methods for materials selection	12	CO2	Learn the basic methods for selecting engineering materials.	Understands the various methods for selection of materials.	Ch.22	720-730
	Classification of Engineering Materials	13	CO2	Classify different engineering materials.	Classify various type of engineering materials	Ch.1	20-30
	Classification of Engineering Materials (Continue)	14	CO2	Compare the properties of engineering materials.	Classify various type of engineering materials	Ch.1	31-40
	General principles of phase	15	CO3	Understand the basics of phase transformations.	Understand the basic concept of phase	Ch.9	271-285



JAIPUR ENGINEERING COLLEGE
AND RESEARCH CENTRE

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

JECRC Campus ,Shri Ram ki Nangal, Via-Vatika ,Tonk Road, Jaipur

Department of Mechanical Engineering

	transformation				transformation		
	phase rule and equilibrium diagrams	16	CO3	Learn Gibbs phase rule and equilibrium diagrams.	Understand the basic concept of phase rules and phase diagram	Ch.9	286-300
3	phase rule and equilibrium diagrams (Continue)	17	CO3	Interpret simple equilibrium diagrams.	Understand the concept of phase rules and phase diagram	Ch.9	301-315
	phase rule and equilibrium diagrams (Continue)	18	CO3	Apply phase rule to engineering materials.	Understand the concept of phase rules and phase diagram	Ch.9	316-330
	Iron carbon equilibrium diagram	19	CO3	Understand the iron-carbon equilibrium diagram.	Understand the concept of iron carbon phase diagram .	Ch.10	331-350
	Iron carbon equilibrium diagram (Continue)	20	CO3	Explain phase changes in Fe-C alloys.	Understand the concept of iron carbon phase diagram .	Ch.10	351-370
	Full annealing	21	CO3	Learn the purpose and process of full annealing.	Understand the basic operation perform to improve mechanical properties	Ch.11	390-400
	Normalizing, Hardening and Tempering of steel	22	CO4	Compare different heat treatment processes of steel.	Understand the concept of annealing and hardening process.	Ch.11	401-420
	Types of fracture	23	CO4	Identify different types of material fracture.	Classify various type of fracture in materials	Ch.8	240-255
	Content beyond syllabus-2: Learn the various factors affecting/causing failures	24	CO4	Understand the common causes of material failure.	Understands various factors affecting failures.	Ch.8	256-270
4	Case hardening	25	CO4	Learn the objectives and	Understand the concept of case	Ch.11	421-430



JAIPUR ENGINEERING COLLEGE
AND RESEARCH CENTRE

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

JECRC Campus ,Shri Ram ki Nangal, Via-Vatika ,Tonk Road, Jaipur

Department of Mechanical Engineering

				methods of case hardening.	hardening .		
	Carburising,	26	CO4	Understand the carburising process and its applications.	Understand the concept of carburising.	Ch.11	431-440
	Nitriding	27	CO4	Learn the nitriding process and its advantages.	Understand the concept of nitriding operation .	Ch.11	441-448
	Cyaniding and Carbonitriding	28	CO4	Compare cyaniding and carbonitriding processes.	Understand the concept of cynading and carbonitriding operation .	Ch.11	449-456
	Non-Metallic Materials	29	CO5	Understand the types and uses of non-metallic materials.	Classify various type of nonmetals materials	Ch.12	457-480
	Types of polymer	30	CO5	Classify different types of polymers.	Classify various type polymer .	Ch.15	535-550
	Properties and applications of polymers	31	CO5	Understand the properties and engineering applications of polymers.	Understand the basic properties and application of polymers.	Ch.15	551-565
	Properties and applications of polymers (Continue)	32	CO5	Compare various engineering polymers and their uses.	Understand the properties and application of polymers.	Ch.15	566-580
5	Properties and applications of polymers (Continue)	33	CO5	Select suitable polymers for engineering applications.	Understand the properties and application of polymers.	Ch.15	581-590
	Types of composites materials	34	CO5	Learn the classification of composite materials.	Classify various type composite material .	Ch.16	591-615
	Properties and applications of composite materials	35	CO6	Understand the properties and applications of composites.	Understand the concept alloys .	Ch.16	616-640
	Constitution of alloys	36	CO6	Learn the basic constitution of	Identify the effect of	Ch.10	340-360



JAIPUR ENGINEERING COLLEGE
AND RESEARCH CENTRE

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

JECRC Campus ,Shri Ram ki Nangal, Via-Vatika ,Tonk Road, Jaipur

Department of Mechanical Engineering

				engineering alloys.	alloying .		
	Effect of alloying	37	CO6	Understand the effects of alloying elements on metals.	Understand the basic mechanical properties	Ch.10	361-375
	Mechanical Properties and Testing	38	CO6	Learn the important mechanical properties of materials.	Understand the various mechanical testing perform under loads	Ch.6	140-160
	Mechanical Testing of engineering materials under loads	39	CO6	Understand the methods of mechanical testing under different loads.	Understand the various mechanical testing perform under loads	Ch.6	161-170
	RTU Previous question papers	40	CO1-CO6	Practice previous RTU questions for better examination preparation.	Understand the RTU question papers	-	-

Reference Books

1	Materials Science and Engineering: A First Course, V. Raghavan, 6th Edition, PHI Learning	2022
2	Material Science and Metallurgy, O.P. Khanna, 18th Revised Edition, Dhanpat Rai Publications	2014
3	Engineering Physical Metallurgy and Heat Treatment, Y. Lakhtin, Reprint Edition, CBS Publishers (Indian Reprint)	2005
4	The Science and Engineering of Materials, Donald R. Askeland & Wendelin J. Wright, 7th Edition, Cengage Learning	2016
5	Introduction to Physical Metallurgy, Sidney H. Avner, 2nd Edition (Reprint Edition), McGraw-Hill Education (India)	2017