

DEPARTMENT OF PRODUCTION TECHNOLOGY

MADRAS INSTITUTE OF TECHNOLOGY CAMPUS

ANNA UNIVERSITY :: CHENNAI – 600 044.

COURSE PLAN

COURSE DETAILS:

Degree	B.E.		
Programme Name	Production Engineering		
Course Code & Title	PR5402 ENGINEERING MATERIALS		
Credits	3	Session	January 2024 – April 2024
Course Type	Theory/ Theory with Lab/ Lab	Section	
Name of the Faculty	Dr.S.Sathish Assistant Professor, Department of Production Technology MIT, Anna University, Chennai – 600044.		

COURSE CONTENT:

Syllabus: (Approved Syllabus as per Regulation 2019)

COURSE OBJECTIVES:

The objective of this course is

- ☐ To impart knowledge on the various microstructural features of metallic materials.
- ☐ To illustrate the role of heat treatment on microstructure and properties.
- ☐ To desire the various non ferrous alloys and their applications.
- ☐ To introduce the concepts of mechanical behaviour of the materials.
- ☐ To describe the properties and applications of polymers and ceramics.

UNIT I MICROSTRUCTURAL DEVELOPMENT AND METALLOGRAPHY 9

Basics of Metallographic microscopy -sample preparation – resolution – contrast – Metallographic microscope - quantitative techniques - Homogenous and Heterogeneous nucleation - grain growth directional solidification- cast and weld microstructure- ingot and continuous casting - microstructures of Steels and Cast irons - spinodal decomposition - Pearlitic, bainitic and martensitic transformations - Effect of alloying elements on steel (Mn, Si, Cr, Ni, Mo, V, Ti and W) – Specification and Standards, Properties and application -stainless and tool steels – HSLA steels – TRIP steel- maraging steels – Gray, white, malleable, spheroidal / graphite, alloy cast irons

UNIT II HEAT TREATMENT AND KINETICS 9

Diffusion in solids - Fick's law - Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram CCR - Types and stages of annealing, stress relief, recrystallisation and spheroidizing – normalizing, Hardenability, Jominy end quench test - hardening and tempering of steel –Cryotreatment, Austempering, martempering – case hardening, carburizing, nitriding cyaniding, carbonitriding – Flame, Induction Laser and Electron beam and plasma phase hardening, Special and Duplex surface hardening processes.

UNIT III NON FERROUS METALS 9

Specification, Properties and application: Copper and Copper alloys, Brass, Bronze and Cupronickel – Aluminium alloys and Al-Cu –precipitation strengthening treatment – Bearing alloys, Alloys of Titanium, Zinc, Magnesium and Nickel –Intermetallics - Ni, Ti Aluminides – Refractory alloys- Superalloys- Shape memory alloys- high entropy alloys- Bulk Metallic glasses.

UNIT IV DEFORMATION AND FAILURE OF METALS 9

Elastic, anelastic and viscoelastic behaviour - Dislocation in FCC,BCC,HCP – stress field - interaction between dislocations -Strengthening mechanism- effect of temperature- deformation mechanism maps - cyclic loading - Types of Fracture – Fracture mechanics - fracture toughness ductile-brittle transition -

types of wear - corrosion - Basics of Scanning electron microscope (SEM)- Energy Dispersive Spectroscopy (EDS)- Failure analysis

UNIT V NON METALLIC MATERIALS 9

Polymers- Thermo, Thermoset Polymers, Co and mixed Polymers- Commodity Polymers, PE, PS,PVS PMMA, PC, PET, ABS- Engineering Polymers, PA, PPS, PI, PFE- Natural and Synthetic rubbers, Elastomers- Adhesives- Ceramics- Natural and Synthetic Ceramic- Feldspar, Corundum, Garnet- WC, TC,TiC, Si3N4,Al2O3, CBN, PCD, Uses of abrasives and cutting tools.

TOTAL = 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students are expected to

- Identify the microstructural features of ferrous materials.
- Relate the heat treatment, microstructure and properties.
- Understand the properties and uses of non ferrous alloys.
- Correlate the mechanical behaviour with the mechanisms of strengthening.
- Suggest suitable polymer and ceramic for a given application.

TEXTBOOKS:

1. Balasubramanian.R, Callister's 'Materials Science and Engineering', 7th Edition, Wiley India Pvt. Limited, 2010.
2. Kenneth G.Budinski and Michael K.Budinski , "Engineering Materials", 9th Indian Reprint, Prentice-Hall of India Private Limited, 2011.

REFERENCES:

1. Callisers's Jr. W.D, Rethuish, D.G, Materials Science and Engineering, 9th Edition, Wiley, 2014.
2. Donald R. Askeland, Pradeep P. Fulay and Wendelin J. Wright, "The Science and Engineering of Materials", 7 th Edition, Cengage Learning, Inc. 2017.
3. Raghavan V., "Materials Science and Engg: A first Course", 6th Edition, Prentice Hall of India Pvt Ltd., 5th edition, 2004.
4. Sidney H. Avner, "Introduction to Physical Metallurgy", McGraw Hill Book Company, 2ndEdition, 2008.
5. Yang Leng, "Materials Characterization: Introduction to Microscopic and Spectroscopic Methods", John Wiley and Sons, 2ndedition, 2013.

COURSE ALIGNED PROGRAMME OUTCOMES (PO) & PROGRAMME SPECIFIC OUTCOMES (PSO)

PO	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply knowledge of mathematics, basic science and engineering science.
2	Problem analysis	Identify, formulate and solve engineering problems.
3	Design/development of solutions	Design a system or process to improve its performance, satisfying its constraints.
4	Conduct investigations of complex problems	Conduct experiments & collect, analyze and interpret the data.
5	Modern tool usage	Apply various tools and techniques to improve the efficiency of the system.
6	The Engineer and society	Conduct selves to uphold the professional and social obligations.
7	Environment and sustainability	Design the system with environment consciousness and sustainable development.
8	Ethics	Interacting industry, business and society in a professional and ethical manner.
9	Individual and team work	Function in a multidisciplinary team.
10	Communication	Proficiency in oral and written Communication.
11	Project management and finance	Implement cost effective and improved system.
12	Life-long learning	Continue professional development and learning as a life-long activity.

PSO	Graduates demonstrate
1	Graduates shall capable to design and develop robot and automation system by applying fundamentals of mechanics of materials and machines, thermal, mechatronics and production engineering.
2	Graduates shall capable to opt appropriate sensor technologies, control systems, electrical and electronic circuits, drives and actuators for the Robotics and automation applications in various field.
3	Graduates shall demonstrate competency on multidisciplinary integration in developing robot and automation system with intelligence.

COURSE TENTATIVE SCHEDULE / PLAN

Week	Date	Hrs	Unit	Topics	Mode of Delivery	Text / Ref.
UNIT I - MICROSTRUCTURAL DEVELOPMENT AND METALLOGRAPHY						
6	06.02.2024	1	1	Basics of Metallographic microscopy -sample preparation – resolution – contrast – Metallographic microscope	PPT	T1
	06.02.2024	2	1	Quantitative techniques - Homogenous and Heterogeneous nucleation - grain growth directional solidification	PPT	T1
	09.02.2024	8	1	Cast and weld microstructure- ingot and continuous casting	PPT	T1
7	13.02.2024	1	1	Microstructures of Steels and Cast irons - spinodal decomposition	PPT	T1
	13.02.2024	2	1	Pearlitic, bainitic and martensitic transformations -	PPT & Quiz	T1
	16.02.2024	8	1	Effect of alloying elements on steel (Mn, Si, Cr, Ni, Mo, V, Ti and W) – Specification and Standards, Properties and application	PPT & Quiz	T1
8	20.02.2024	1	1	Stainless and tool steels – HSLA steels	PPT	T1
	20.02.2024	2	1	TRIP steel- maraging steels	PPT	T1
	23.02.2024	8	1	Gray, white, malleable, spheroidal / graphite, alloy cast irons	PPT	T1
UNIT II - HEAT TREATMENT AND KINETICS						
9	27.02.2024	1	2	Diffusion in solids - Fick's law - Isothermal transformation diagrams	PPT Flipped class	T1
	27.02.2024	2	2	Cooling curves superimposed on I.T. diagram CCR	PPT	T1
	01.03.2024	8	2	Types and stages of annealing, stress relief, recrystallisation and spheroidizing	PPT	T1
10	05.03.2024	1	2	Normalizing, Hardenability, Jominy end quench test	PPT	T1
	05.03.2024	2	2	Hardening and tempering of steel, Cryotreatment	PPT	T1
	08.03.2024	8	2	Austempering, martempering, case hardening	PPT	T1
11	12.03.2024	1	2	Carburizing, nitriding cyaniding, carbonitriding	PPT	T1
	12.03.2024	2	2	Flame, Induction Laser and Electron beam	PPT	T1
	15.03.2024	8	2	Plasma phase hardening, Special and Duplex surface hardening processes.	PPT	T1

UNIT III - NON FERROUS METALS

12	19.03.2024	1	3	Specification, Properties and application: Copper and Copper alloys, Brass	PPT	T1
	19.03.2024	2	3	Bronze and Cupronickel	PPT	T1
	22.03.2024	8	3	Aluminium alloys and Al-Cu –precipitation strengthening treatment	PPT	T1
13	26.03.2024	1	3	Bearing alloys, Alloys of Titanium, Zinc	PPT	T1
	26.03.2024	2	3	Magnesium and Nickel	PPT	T1
	29.03.2024	8	3	Intermetallics - Ni, Ti Aluminides	PPT	T1
14	02.04.2024	1	3	Refractory alloys	PPT	T1
	02.04.2024	2	3	Superalloys- Shape memory alloys	PPT	T1
	05.04.2024	8	3	High entropy alloys- Bulk Metallic glasses	PPT	T1

UNIT IV - DEFORMATION AND FAILURE OF METALS

15	09.04.2024	1	4	Elastic, anelastic and viscoelastic behaviour	PPT	T1
	09.04.2024	2	4	Dislocation in FCC,BCC,HCP	PPT	T1
	12.04.2024	8	4	Stress field - interaction between dislocations	PPT	T1
16	16.04.2024	1	4	Strengthening mechanism- effect of temperature	PPT	T1
	16.04.2024	2	4	Deformation mechanism maps - cyclic loading	PPT	T1
	19.04.2024	8	4	Types of Fracture – Fracture mechanics - fracture toughness	PPT & Cross word puzzle	T1
17	23.04.2024	1	4	Ductile-brittle transition - types of wear - corrosion	PPT	T1
	23.04.2024	2	4	Basics of Scanning electron microscope (SEM)-	PPT	T1
	26.04.2024	8	4	Energy Dispersive Spectroscopy (EDS)- Failure analysis	PPT	T1

UNIT V - NON METALLIC MATERIALS

18	30.04.2024	1	5	Polymers- Thermo, Thermoset Polymers	PPT	T1
	30.04.2024	2	5	Co and mixed Polymers- Commodity Polymers	PPT	T1
	03.05.2024	8	5	PE, PS,PVS PMMA	PPT	T1
19	07.05.2024	1	5	PC, PET, ABS- Engineering Polymers	PPT	T1
	07.05.2024	2	5	PA, PPS, PI, PFE	PPT	T1
	10.05.2024	8	5	Natural and Synthetic rubbers, Elastomers-Adhesives	PPT	T1
20	14.05.2024	1	5	Ceramics- Natural and Synthetic Ceramic-Feldspar, Corundum	PPT	T1

	14.05.2024	2	5	Garnet- WC, TC, TiC, Si3N4	PPT	T1
	17.05.2024	8	5	Al2O3, CBN, PCD, Uses of abrasives and cutting tools	PPT	T1

COURSE DELIVERY/INSTRUCTIONAL METHODOLOGIES:

<input checked="" type="checkbox"/> Chalk & Talk	<input checked="" type="checkbox"/> Stud. Assignments	<input checked="" type="checkbox"/> Web Resources
<input checked="" type="checkbox"/> LCD/Smart boards	<input checked="" type="checkbox"/> Stud. Seminars	<input type="checkbox"/> Add-On Courses

COURSE ASSESSMENT METHODOLOGIES-DIRECT

<input checked="" type="checkbox"/> University (End Semester) Examination	<input checked="" type="checkbox"/> Internal Assessment Tests		
<input checked="" type="checkbox"/> Assignments	<input type="checkbox"/> Laboratory Practices	<input type="checkbox"/> Mini/Major Projects	<input type="checkbox"/> Stud. Seminars
<input type="checkbox"/> Viva Voce	<input type="checkbox"/> Certifications	<input type="checkbox"/> Add-On Courses	<input type="checkbox"/> Others

COURSE ASSESSMENT METHODS

S.N.	Mode of Assessment	Date	Duration	% Weight
1	Internal Assessment Tests 1		1½ hr	20 %
2	Internal Assessment Tests 2		1½ hr	20 %
3.	University Examination		3 hr	60 %
Additional marks may be given for Assignments / Group / Team Seminar Presentation)				

COURSE ASSESSMENT METHODOLOGIES-INDIRECT

<input checked="" type="checkbox"/> Assessment of CO (By Feedback, Once)	<input checked="" type="checkbox"/> Student Feedback On Faculty (Once)
<input type="checkbox"/> Assessment of Mini/Major projects by Ext. Experts	<input type="checkbox"/> Others

COURSE (EXTRA) ESSENTIAL READINGS:

1. NPTEL LINK
2. Refer Books

COURSE EXIT SURVEY (will be collected at end of the course)

The purpose of this survey is to find out from students about their learning experiences and their thoughts about the course.

COURSE OUTCOMES	STUDENTS RATING Low (1) /Medium(2)/ High(3)
CO1:	
CO2:	
CO3:	
CO4:	
CO5:	

PROGRAMME OUTCOMES	STUDENTS RATING Low (1) /Medium(2)/ High(3)
PO1	
PO2	
PO3	
PO4	
PO5	
PO6	
PO7	
PO8	
PO9	
PO10	
PO11	
PO12	
Average	

PROGRAMME SPECIFIC OUTCOMES	STUDENTS RATING Low (1) /Medium(2)/ High(3)
PSO1	
PSO2	
PSO3	

COURSE POLICY (Compensation Assessment)

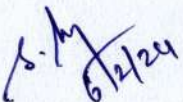
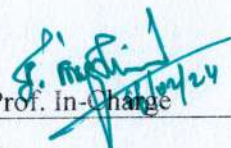
1. Attending all the assessment is mandatory for every student
2. Course policy will be followed as per the academic course regulation

COURSE ACADEMIC DISHONESTY AND PLAGIARISM

1. All rules and regulation prescribed by the ACOE, University Departments, are applicable in the Internal Assessment Tests and University (End Semester) Examinations. (https://acoe.annauniv.edu/download_forms/student_forms/Guidelines.pdf)
2. In general, possessing a mobile phone, carrying bits of paper with materials, talking to other students, copying from other students during Internal Assessment Tests and University (End Semester) Examinations will be treated as Malpractice and punishable as per the rules and regulations. The misuse of Assignment / Project / Seminar works from others is considered as academic dishonesty and will be treated with the rules and regulations of the University.

COURSE ADDITIONAL INFORMATION

Queries / clarifications / discussion (if required) may be e-mailed to / contact the course instructors during their Office Hours.

For Approval		
 Course Faculty	 Prof. In-Charge	HOD (PT)