NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR DEPARTMENT OF METALLURGICAL AND MATERIALS ENGINEERING

Revised Curriculum and Syllabi

Program Name Master of Technology in Metallurgy and Materials Technology (MT) Effective from the Academic Year: 2021-2022



Recommended by DPAC	: 04.08.2021
Recommended in PGAC	: 16.08.2021
Approved by the Senate	: 22.08.2021

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MAPPING		
PAPER CODE	PAPER NAME	
MT1001	Thermodynamics and Kinetics of Materials	9-10
MT1002	Advanced Physical Metallurgy	11-12
MT1003	Advanced Process Metallurgy	13-14
MT1051	Advanced Physical Metallurgy Laboratory	15-16
MT1052	Process Metallurgy Laboratory	17
MT2001	Principles and Techniques of Materials Characterisation	18-19
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	Laboratory	
MT2053	Minor Project with Seminar	22
MT3051	Dissertation-I	23
MT3052	Seminar – Non Project / Evaluation of Summer Training	24
MT4051	Dissertation – II / Industrial Project	25
MT4052	Project Seminar	26

MT9031	Advances in Production of Non-Ferrous Metals	27-28
MT9032	Advances in Agglomeration Processes	29-30
MT9033	Secondary Steel Making	31-32
MT9034	Surface Engineering	33-34
MT 9035	Materials Modelling and Simulation	35-36
MT9036	Advanced Welding Metallurgy	37-38
MT9037	Advanced Metal Forming Processes	39-40
MT9038	Mechanical Behaviour of Materials	41-42
MT9039	Composite Material and its Development	43-44
MT9040	Advanced Ceramic Materials	45
MT9041	Advanced Powder Metallurgy	46
MT9042	Nano-Materials and Nano-Technology	47
MT9043	Human Behavior and Management	48-49
MT9044	Electron Microscopy	50
MT9045	Strengthening Mechanisms of Materials	51-52
MT9046	Environmental Degradation of Materials	53-54
MT9047	Advanced Casting Processes	55-56
MT9048	Physical and Finite Difference Based Modelling Approaches in Metallurgy	57-58
MT9049	Plasma Technology for Metallurgical Applications	59-60
MT9050	Technology of Advanced Materials	61-62
MT9051	Severe Plastic Deformation	63-64
MT9052	Finite Element Method for Metallurgy and Materials	65-66
MT9053	Solidification Phenomena	67-68
MT9054	Environmental Management in Metallurgical Industries	69-70
MT9055	Corrosion Engineering	71-72

PROGRAM OBJECTIVES*

PO1: An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: An ability to handle techno-scientific challenges of the society.

*The POs have been prepared in accordance with the Self-Assessment Report (SAR) format of the National Board of Accreditation (NBA)

DEPARTMENT OF METALLURGICAL AND MATERIALS ENGINEERING

M. Tech in Metallurgy and Materials Technology (MT)

CURRICULUM

SEMESTER-I

Sl. No.	Subject Code	Subject	L - T - P	Credit
1	MT1001	Thermodynamics and Kinetics of Materials	3 - 0 - 0	3
2	MT1002	Advanced Physical Metallurgy	3 - 1 - 0	4
3	MT1003	Advanced Process Metallurgy	3 - 1 - 0	4
4	MT903X	Elective - I	3 - 0 - 0	3
5	MT903X	Elective - II	3 - 0 - 0	3
6	MT1051	Advanced Physical Metallurgy Laboratory	0 - 0 - 4	2
7	MT1052	Process Metallurgy Laboratory	0 - 0 - 4	2
	TOTAL			21

SEMESTER-II

Sl. No.	Subject Code	Name of the Subject	L - T - P	Credit
1	MT2001	Principles and Techniques of Materials	3 - 1 - 0	4
		Characterisation		
2	MT903X	Elective - III	3 - 0 - 0	3
3	MT903X	Elective - IV	3 - 0 - 0	3
4	MT903X	Elective - V	3 - 0 - 0	3
5	MT903X	Elective - VI	3 - 0 - 0	3
6	MT2051	Principles and Techniques of Materials	0 - 0 - 4	2
		Characterisation Laboratory		
8	MT2053	Minor Project with Seminar	0 - 0 - 6	3
		TOTAL	15-1-10	21

SEMESTER-III

Sl. No.	Subject Code	Name of the Subject	L-T-P	Credit
1	MT9071	Audit Lectures/Workshop	0-0-2	0
2	MT3051	Dissertation-I	0-0-24	12
3	MT3052	Seminar – Non-Project / Evaluation of Summer Training	0-0-4	2
	TOTAL		0-0-30	14

SEMESTER-IV

Sl. No.	Subject Code	Name of the Subject	L-T-P	Credit
1	MT4051	Dissertation – II / Industrial Project	0-0-24	12
2	NT4052	Project Seminar	0-0-4	02
			0-0-28	14
		TOTAL	30-3-76	70

LIST OF ELECTIVE PAPERS

Sl. No.	Subject Code	Name of the Subject
1	MT9031	Advances in Production of Non-Ferrous Metals
2	MT9032	Advances in Agglomeration Processes
3	MT9033	Secondary Steel Making
4	MT9034	Surface Engineering
5	MT9035	Materials Modelling and Simulation
6	MT9036	Advanced Welding Metallurgy
7	MT9037	Advanced Metal Forming Processes
8	MT9038	Mechanical Behaviour of Materials
9	MT9039	Composite Material and its Development
10	MT9040	Advanced Ceramic Materials
11	MT9041	Advanced Powder Metallurgy
12	MT9042	Nano-Materials and Nano-Technology
13	MT9043	Human Behavior and Management
14	MT9044	Electron Microscopy
15	MT9045	Strengthening Mechanisms of Materials
16	MT9046	Environmental Degradation of Materials
17	MT9047	Advanced Casting Processes
18	MT9048	Physical and Finite Difference Based Modelling Approaches in Metallurgy
19	MT9049	Plasma Technology for Metallurgical Applications
20	MT9050	Technology of Advanced Materials
21	MT9051	Severe Plastic Deformation
22	MT9052	Finite Element Method for Metallurgy and Materials
23	MT9053	Solidification Phenomena
24	MT9054	Environmental Management in Metallurgical Industries
25	MT9055	Corrosion Engineering

LIST OF CORE PAPERS WITH THEIR DEVELOPERS' NAMES

Subject code	Name of the Subject	L - T - P	Credit	Name of the developer
MT1001	Thermodynamics and Kinetics of Materials	3 - 0 - 0	3	Dr. M. K. Mondal&Dr.S. Pramanik
MT1002	Advanced Physical Metallurgy	3 - 1 - 0	4	Prof. J. Maity
MT1003	Advanced Process Metallurgy	3 - 1 - 0	4	Dr. S. Pramanik& Dr. A. K. Mandal
MT2001	Techniques of Materials Characterization	3 - 1 - 0	4	Prof. J. Maity&Dr. B. K. Show

LIST OF ELECTIVE PAPERS WITH THEIR DEVELOPERS' NAMES

Subject Code	Name of the Subject	L-T-P	Credit	Name of the developer
MT9031	Advances in Production of Non- Ferrous Metals	3 - 0 - 0	3	Dr. A.K. Mandal

MT9032	Advances in Agglomeration Processes	3 - 0 - 0	3	Dr. S.Ghorai
MT9033	Secondary Steel Making	3 - 0 - 0	3	Dr. M. K.Mondal& Dr. S. Ghorai
MT9034	Surface Engineering	3 - 0- 0	3	Dr. D. Mandal
MT9035	Materials Modelling and Simulation	3 - 0 - 0	3	Dr. M. M. Ghosh
MT9036	Advanced Welding Metallurgy	3 - 0 - 0	3	Prof. K. S. Ghosh
MT9037	Advanced Metal Forming Processes	3 - 0 - 0	3	Dr. M. M. Ghosh
MT9038	Mechanical Behaviour of Materials	3 - 0 - 0	3	Dr. B. K. Show & Dr. S. Bera
MT9039	Composite Material and its Development	3 - 0 - 0	3	Prof. J. Maity& Dr. S. Bera
MT9040	Advanced Ceramic Materials	3 - 0 - 0	3	Dr. M. Mallik
MT9041	Advanced Powder Metallurgy	3 - 0 - 0	3	Dr. M. Mallik
MT9042	Nano-Materials and Nano- Technology	3 - 0 - 0	3	Dr. S. Bera
MT9043	Human Behavior and Management	3 - 0 - 0	3	Dr. S. Pramanik
MT9044	Electron Microscopy	3 - 0 - 0	3	Dr. S. Bera
MT9045	Strengthening Mechanisms of Materials	3 - 0 - 0	3	Dr. D. Mandal
MT9046	Environmental Degradation of Materials	3 - 0 - 0	3	Dr. S. Pramanik
MT9047	Advanced Casting Processes	3 - 0 - 0	3	Dr. D. Mandal & Dr. B. Maji
MT9048	Physical and Finite Difference Based Modelling Approaches in Metallurgy	3 - 0 - 0	3	Dr. M. K. Mondal
MT9049	Plasma Technology for Metallurgical Applications	3 - 0 - 0	3	Dr. A. K. Mandal
MT9050	Technology of Advanced Materials	3 - 0 - 0	3	Dr. D. Mandal & Dr. M. Mallik
MT9051	Severe Plastic Deformation	3 - 0 - 0	3	Dr. M. K. Mondal& Dr. D. Mandal
MT9052	Finite Element Method for Metallurgy and Materials	3 - 0 - 0	3	Dr. M. K. Mondal
MT9053	Solidification Phenomena	3 - 0 - 0	3	Dr. S. Pramanik& Dr. K. P Yagati
MT9054	Environmental Management in Metallurgical Industries	3 - 0 - 0	3	Dr. A. K. Mandal
MT9055	Corrosion Engineering	3 - 0 - 0	3	Prof. K. S. Ghosh

LIST OF LABORATORY & SESSIONAL PAPERS

SUBJECT CODE	SUBJECT	L-T-P	CREDIT
MT1051	Advanced Physical Metallurgy Laboratory	0 - 0 - 4	2
MT1052	Process Metallurgy Laboratory	0 - 0 - 4	2
MT2051	Principles and Techniques of Materials	0 - 0 - 4	2
	Characterization Laboratory		

LIST OF PROJECT/DISSERTATION/SEMINAR PAPERS

SUBJECT CODE	SUBJECT	L-T-P	CREDIT
MT2053	Minor Project with Seminar	0 - 0 -6	3
MT9071	Audit Lectures / Workshops	0 - 0 -0	0
MT3051	Dissertation - I	0 - 0 - 24	12
MT3052	Seminar-Non-Project / Evaluation of Summer Training	0 - 0 -4	2
MT4051	Dissertation – II / Industrial Project	0 - 0 - 24	12
MT4052	Project Seminar	0 - 0 -4	2

Course Code	Title of the course	Program Core		s Engineeri mber of cor	-		Credi
	The of the course	0				T-4-1	Clear
Cour		(PCR) / Electives (PEL)	Lecture	Tutorial (T)	Practical	Total	
N 611001			(L)	(T)	(P)	Hours	2
MT1001	Thermodynamics and Kinetics of Materials	PCR	3	0	0	3	3
Pre-requisites		Course Assessme	ent methods	(Continuou	s (CT) and e	end assessi	nent
1		(EA))		× ·	~ /		
NIL		CT+EA					
Course	On completion	of the course the le	earner shal	l be able to):		
Outcomes	 thermod CO2: In multi-state CO3: A 	nderstand the c ynamics and kinet Identify and solve eps reactions. analyze and solve gical systems.	tics of Engine reaction 1	ineering M kinetics an	laterials. d mechanis		gle an
Covered	Solutions – ch activity determ Heterogeneous predominant ar composition di external and int	t capacity, entro lemical potential, ination properties systems-equilibri ea diagrams, Evol agrams solidus-li ernal interfaces, so Point imperfec	Raoult H s of differ um consta lution of P quidus lin plid electro	Henry's la rent soluti unts. Ellin Phase diagnes, Interfa lytes; Effe	w Gibbs-D ons, quasion gham-Rich ramsphase aces-energy act of high p	Ouhem ec chemical ardson d rule free- c: segrega pressure c -elementa	theory iagram energy ation
	transfer in Me concentration of Effect of conce activation energy in series, shrink layer diffusion a	s, heterogeneous a tallurgical kinetic on reaction kinetic entration (order of gy. Kinetics of sol- ing core model, C as rate controlling	cs rate exp cs effect of f a reactio id-fluid rea themical re	pression. I of tempera n), signifi action: Def action as r	Effect of 7 ature (Arrh cance and finition of v rate controll	Femperation enius Eq determination various re ing step,	ure an uation ation of sistance Produce
	layer definition	, Heat transfer as and significance of ss transfer coeffic Kinetics	of heat and	l mass trar rrelations	nsfer coeffic	cient. The	oundar coretica transfe
	layer definition models for ma coefficients. [10]	and significance of stansfer coefficients	of heat and cients. Con of	l mass trar rrelations liq	nsfer coeffic for heat an uid-liquid	cient. The nd mass r	oundar coretica transfe eaction
	layer definition models for ma coefficients. [10] Solid state pl	and significance of ss transfer coeffic Kinetics nase changes-clas	of heat and cients. Con of	l mass trar rrelations liq	nsfer coeffic for heat an uid-liquid	cient. The nd mass r owth pr	oundar coretica transfe eaction

	heterogeneous Nucleation kinetics, kinetics of growth, kinetics of alloy solidification. [4]					
	Kinetics of solid-state phase transformation-scope and classification kinetics of homogeneous and heterogeneous nucleation, interface growth velocity, kinetics of special transformations (Widmanstatten, massive, polymorphic, coarsening, recrystallization, age hardening) kinetics of invariant and moving boundry transformation, kinetics of phase transition in polymers, glass, ceramics. [4]					
	Overall transformation Kinetics-Johnson-Mehl and Avram's model, kinetics of					
	non-random nucleation, kinetics of diffusion controlled isothermal and non-					
	isothermal analysis.[4]					
Text Books,	Text Books:					
and/or reference	1. Introduction to Metallurgical Thermodynamics – David R. Gaskell.					
material	 Textbook of Materials and Metallurgical Thermodynamics- A. Ghosh Problems in Metallurgical Thermodynamics and Kinetics-G.S. Upadhyay and R. K. Dube. 					
	4. Problems in Applied Thermodynamics- C. Bodsworth and A.S. Appleton.					
	5. Kinetics of Metallurgical Reactions – H. S. Ray					
	6. Metallurgical Thermochemistry-O. Kubaschewski, E.LL. Evans and C.B.					
	Alcock. Reference Books:					
	1. Physical Chemistry of Metals-Lawrence S, Darken and Robert W. Gurry;					
	 2. Thermodynamics of Solids-Richard A. Swalin. 					
	 Stoichiometric and Thermodynamics of Metallurgical Processes- Y.K.Rao. 					
	4. Chemical Kinetics-Keith J. Laidler.					
	5. Metallurgical Thermodynamics- R. H. Tupkary.					

	CO1	CO2	CO3
PO1	\checkmark	\checkmark	\checkmark
PO2	✓	\checkmark	\checkmark
PO3	✓	\checkmark	\checkmark
PO4	-		✓

	_	nent of Metallurgical		-	-		
Course	Title of the course	Program Core		mber of con		T	Credit
Code		(PCR) /	Lecture	Tutorial		Total	
		Electives (PEL)	(L)	(T)	(P)	Hours	
MT	Advanced	PEL	3	1	0	4	4
1002	Physical						
	Metallurgy						
Pre-requisi	tes	Course Assessmen (EA))	nt methods (Continuous	s (CT) and er	nd assessm	nent
NIL		CT+EA					
Course	On completion	of the course the le	arner shall	be able to	:		
Outcomes	• CO1:	Understand the d	concept of	f bonding	and evo	lution o	f three
		onal solid.	oneept o	containg	, und evo	1441011 0	1 11100
		Conceive phase t	ransforma	tion in a	ualitative	and aua	ntitative
		cal) terms.	lansionna	uon ni q	uantative	and qua	
	•	,	action of m	hasa trans	formation		
		inderstand the appli	-			. • 1	
T		inderstand detailed					
Topics Covered	e e	c, covalent and m					
Covered		ng; Free-energy con	-	-	-		•
		ystems: binary pha	-	-		grams m	view of
	ternary two-pha	ise, three-phase and	i ioui-pilas	e equinori	a.[0]		
	parameter; sol athermal transfe displacive transfe reconstructive a ferrite, idiomor	lritic and equiaxe id state phase tran ormation; Buerger's sformation; paraequ and displacive trans phic ferrite, massiv bainite and marten	sformation s classifica uilibrium s sformation re ferrite, p	is: thermal tion: recon tate, conce s in steel:	lly activated astructive tra- ept of invar evolution o	l transfor ansforma iant plane f allotrior	rmation, tion and e strain; morphic
	matrix, concept strain energy, a activation energy heterogeneous heterogeneous temperature de nucleation rate growth rate; Jo	tment to solid sta of fluctuation, emi- free energy changer rgy for critical nucleation, expre- nucleation rate; of pendence of nucle ; effect of prior co- hnson-Mehl equat nsformation (TTT)	bryo, volui e for form embryo f essions of effect of eation rate cold worki ion- overa	ne free end ation of a formation; homoger strain ene train ene time de ng on nue	ergy change in embryo, homogene neous nucl- ergy on sh pendence o cleation rat	e, surface critical d eous nuc eation ra ape of d of heterog e, express , origin d	energy, embryo, eleation, ate and embryo, geneous
	different heat	solid state phase tr treatment proces and CCT diagram	sses: anne	ealing, no	ormalizing,	hardeni	ng and

	elements on TTT/CCT diagram; Precipitation hardening (age hardening): PTT diagram, age hardening behaviour of aluminium alloys and aluminium metal matrix composites. [10]
	Structure-property correlation: Material deformation under load with regard to crystal structure and inherent crystal defects; role of dislocation; strengthening mechanism; Hall-Petch effect; Quantum confinement effect; strength, ductility, toughness, fatigue and creep properties in relation to material structure. [10]
Text Books,	Text Books:
and/or reference	 Physical Metallurgy Principles, R.E.Reed-Hill and R. Abbaschian, 3rd ed, PWS-Kent Publishing, 1992.
material	2. The Theory of Transformations in Metals and Alloys- J.W. Christian, Pergamon Press, 1965.
	 Phase transformations in metals and alloys- D.A. Potter and K.E. Easterling, CRC Press,1992.
	4. T.H. Courtney, Mechanical Behavior of Materials, McGraw-Hill, 2nd Ed., 2000.
	5. Physical Metallurgy Principles, R.E. Reed-Hill and R. Abbaschian, 3rd ed, PWS-Kent Publishing, 1992.
	6. The Structure and properties of Materials (I – IV) – R.M. Rose, L. A. Shepard and J. Wulff, Wiley, 1966
	7. Materials Science and Engineering: An Introduction - William D. CallisterJr. and David G. Rethwisch, Wiley 2018
	Reference Books:
	1. Heat treatment of metals- B. Zakharov, CBS publishing, 1998.
	2. Principles of the heat treatment of plain carbon and low alloy steels- C.R. Brooks, ASM International, 1996.
	3. <i>Heat Treatment</i> : Principles and Techniques- T. V. <i>Rajan</i> , C. P. Sharma and A. <i>Sharma</i> , PHI Learning Pvt. Ltd., 2012.

	PO1	PO2	PO3	PO4
CO1	\checkmark	-	-	\checkmark
CO2	\checkmark	\checkmark	\checkmark	
CO3	-	\checkmark	-	\checkmark
CO4	\checkmark	\checkmark	\checkmark	-

Course	Title of the course	nent of Metallurgio Program Core		nber of cont			Credi			
Code	The of the course	(PCR) /	Lecture	Tutorial	Practical	Total	Cicui			
Code		(PEL)	(L)	(T)	(P)	Hours				
MT1003	Advance Process Metallurgy	PCR	3	1	0	4	4			
Pre-requisi		Course Assessn (EA))	Course Assessment methods (Continuous (CT) and end assessment (EA))							
NIL		CT+EA								
Course	On completion	of the course the	e learner sh	nall be able	to:					
Outcomes	CO2: A CO3: technol	Study the thermo Ability to solve p To obtain de logical principles industrial and la	roblems or etailed un used in ex	n Iron and S derstanding	Steel Extracti g of curre	on. nt metho	ds an			
Topics		ess overview c		metalluro	v including	nhysicoc	hemics			
Covered	_		-	-	y meruanig					
		principle and practice.								
		Basics and advanced technologies for mineral processing, including pyro, hydro,								
		electrometallurgy and associated impact on costs, pollution, energy, cycle time,								
	simplification.	simplification. [10]								
	Compelling ir	Compelling innovative measures in agglomeration, BF technology, BOF, EAF,								
	MBF, EOF and	MBF, EOF and other such routes involving DRI/HBI. [8]								
	Underlining p	Underlining principles of steel refining, physical chemistry, Continuous casting,								
	Near	net		sha	ipe		casting			
	[6]									
	Recent advar	nces in casting	practice	; Thixoca	sting, Semi	solid Pro	cessing			
	Rhiocasting.	c		, ,	U,		[4]			
	_	Recent advancements in extractive metallurgy of nonferrous metals like Al,Cu, Pb,								
		Zn, Ti, Mg etc. and their present status and application in India. [8]								
Text Books		. and then presen	it status and	a application	m m maia.		ĮU			
and/or reference material	 B.F. Ire Physica Iron and Fuels, I 	on making princi al chemistry of ir d steel making, t Furnaces And Re ion of Nonferrou	on & steel heory and fractories,-	manufactu practice – (- R. C. Gup	Ghosh and Cl ota (2016)	hatterjee (2	2012)			
	green Durgap 2. The Pro 3. Extract 4. Blast	oks: dings of internat & automated sta our, sept. 2015 oduction of alum ive Metallurgy o Furnace Ironma on, MitrenSukhra	eel plants- inium and f Copper-A king: Ana	A better alumina, V A. K. Biswa alysis, Con	tomorrow – fol. 20-Alfred as & W. G. D ntrol, and (- Steel teo I Richard I Davenport Optimizatio	ch/ NI' Burkin on- Ia			

	PO1	PO2	PO3	PO4
C01				-
CO2				-
CO3		-	-	

	Departr	nent of Metallurgical	& Material	s Engineeri	ng		
Course	Title of the course	Program Core		mber of con	<u> </u>		Credit
Code		(PCR) / Electives (PEL)	Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
MT 1051	Advanced Bhysical	PCR	0	0	4	4	2
1051	Physical Metallurgy Laboratory						
Pre-requis	· · · ·	Course Assessmen (EA))	nt methods ((Continuous	s (CT) and er	nd assessn	nent
NIL		CT+EA					
Course Outcomes	 CO1: U transfor morpho CO2: U phase tr CO3: U morpho CO4: U 	of the course the le Jnderstand the evo mation and diffusi- logical appearances Jnderstand the evo ansformation along Inderstand the evolu- logical appearances Jnderstand phase e to change in cher	olution of onal displa lution of j with morp ution of du s. evolution a	phases the acive phase phases three phological al-phase st and associa	rough reco e transform ough diffus appearances ructure in c ted structur	ation alo ionlessdi s. orrelatior cal variati	ng with splacive n to fon with
Topics Covered	reconstructive ph Part I: Investigat	An investigation hase transformation a ion of the microstruc ition of the microstru	nd diffusion ture of Ann	al displacive aled Low (e phase tran Carbon Steel	sformation	n. [6]
	normal air coolir	ng). ation of the microstr				[6]	-
	microstructure. Part I: H [6]	Diffusionlessdisplaciv ardening treatm g treatment of High o	ent of	Low		(0.2%C)	evolved steel [6]
	-	Experiment 3: An investigation on evolution of combined soft and hard phase through Intercritical heat treatment of low carbon steel.[6]					
	regard to chang Part I: Study of Part II: Study o	A study on phase of e in chemical comp the microstructure f the microstructure of the microstructure	oosition and of as-carbo of Carbor	d adopted l urized stee ized and c	neat treatme l [6] ore refined :	ent routes steel. [6]	

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	(case hardened) steel. [6]
Text Books,	Text Books:
and/or	1.Phase transformations in metals and alloys- D.A. Potter and K.E. Easterling, CRC
reference	Press,1992.
material	2. Solid state phase transformations, V. Raghavan, PHI Learning Pvt. Ltd., 2004.
	3. Principles of the heat treatment of plain carbon and low alloy steels- C.R.
	Brooks, ASM International, 1996
	Reference Books:
	1. Heat treatment of metals- B. Zakharov, CBS publishing, 1998.
	2. Heat Treatment: Principles and Techniques- T. V. Rajan, C. P. Sharma and A.
	Sharma, PHI Learning Pvt. Ltd., 2012.

	PO1	PO2	PO3	PO4
CO1	\checkmark	\checkmark	\checkmark	\checkmark
CO2	\checkmark	\checkmark		\checkmark
CO3	\checkmark			\checkmark
CO4	\checkmark	\checkmark	\checkmark	\checkmark

	Departi	nent of Metallurgical								
Course	Title of the course	Program Core	Total Nu	mber of cor	ntact hours		Credit			
Code		(PCR) /	Lecture	Tutorial	Practical	Total				
		Electives (PEL)	(L)	(T)	(P)	Hours				
MT1052	Process	PCR	0	0	4	4	2			
	Metallurgy									
D · ·	Laboratory		1 1			1				
Pre-requisi	tes	Course Assessme (EA))	nt methods	(Continuou	s (CT) and en	nd assessn	nent			
NIL		CT+EA								
Course	On completion	n of the course the le	earner shall	be able to	:					
Outcomes	• CO1:]	Learn the different n	nethods of	raw materi	als characte	rization.				
	• CO2:	Learn the operation	onal aspec	t of diffe	erent prope	erties of	burden			
	materi	als.	1							
	• CO3:	Analyze and solve	industrial	problems	to meet th	ne contei	nporary			
	need.			1			1 2			
Topics	1.Pelletizatior	with different ferr	ous and no	n-ferrous o	ores[3]					
Covered	2. Study of s	2. Study of sintering of ferrous material with change of parameters such as bed								
	•	y of air, amount of l	-	-						
		tion of ores and diff	0		-	-				
		ation of raw materia	. ,	• • • • •	• • •	e of repos	se [3]			
	•	e Reduction behavio			-		_			
	•	effect of velocity								
		lepth of Crater form					-			
		fect of inclusions in	0				5]			
	8. To Study th	e defects of the wax	ingot in th	e context	or steel ingo	ot. [3]				
Text Books	s, Text Books:									
and/or	-	heory and Laboratory	Experimen	ts in Ferrou	s Metallurgy	, PHI Lea	rning			
reference	Pvt. Ltd, New I	Delhi, India								
material		d Chatterjee, A., Prine	ciples, and l	Practices in	Iron and Ste	elmaking,	Prentice			
	Hall of India, N	lew Delhi, 2008.								
	Reference Bo									
	1.Modeling of	1. Modeling of Steelmaking Processes, D. Mazumdar and J. W. Evans.								

	PO1	PO2	PO3	PO4
CO1	\checkmark		-	-
CO2	\checkmark		-	-
CO3	-	-		

	Departme	ent of Metallurgical	and Materia	ls Engineer	ing						
Course	Title of the course	Program Core	Total Number of contact hours C				Credit				
Code		(PCR) /	Lecture	Tutorial	Practical	Total					
		Electives (PEL)	(L)	(T)	(P)	Hours					
MT2001	Principles and	PEL	3	1	0	4	4				
	Techniques of		_		-						
	Materials										
	Characterization										
Dra raquisi		Course Assessme	nt mothoday	Continuou	(CT) and a	nd accord	aant				
Pre-requisit	les	(EA))	nt methous	Continuou	s (CT) and e		lient				
NIL		CT+EA									
Course	On completion of	the course the lear	mer shall b	e able to:							
Outcomes	• CO1 • Le	arn fundamentals	of X-ra	v diffrac	tion ontic	al and	electron				
	microscop		5 01 2 1 14	y unnue	uon, opue	ai aila	ciccuon				
	-	•	- 4		41						
		ntify the crystal	structure a	and index	the diffrac	ction pati	erns of				
	different p										
		ve diffractograms o				U					
	• CO4: Le	arn different app	plications	of X-ray	diffractio	n and c	lifferent				
	microscop	es.		•							
Topics	1	graphy: metallo	ographic	specimen	preparatio	n metal	lurgical				
Covered	_	gnification, nume		-			-				
covered			-			-					
		ereological approa									
		nt method; grain				netnoa, 1	ntercept				
	method etc.; princ	method etc.; principles of quantitative image analysis. [8]									
	construction; Diff methods; Diffractor Intensity of diff Incoherent scatter	n Techniques: ers; Real and rec fraction methods— ometers; Diffraction racted beams: sc ing; scattering by ture factor, Stru-	ciprocal la Laue meth on under no cattering b an atom-at	ttice ; Br od, rotatin on- ideal co y an elec omic scatt	ng crystal 1 ondition. ctron- Coh tering factor	r; Ewald nethods, erent sca r, Scatteri	sphere powder attering, ng by a				
	Application of X-ray diffraction: Crystal structure determination; determination of precise lattice parameter; Phase diagram determination, Residual stress measurement, Chemical analysis by diffraction, particle size determination. [8]										
	Construction, mod Different contrast resolution and de Transmission elect transmission elect area diffraction: g pattern; basic rela $(Rd = L\lambda)$; Interp Indexing ring pa	bscopy: Specimo des of operation a t formation; Effe epth of field of a etron microscopy (tron microscope i generation of spot tionship of electro pretation of SAD p ttern, determination crystal (single gr	nd applicated ect of dif SEM; Sp (TEM): bas n view of pattern, sp n diffraction pattern for on of car	tion of Sca ferent op ecimen pro- sic princip Ewald sp otted ring on in trans- fine grain nera const	erational v reparation; les of electro phere const pattern and mission ele- ned polycry ant; Interpr	tron micr ariables EDS and con diffra ruction, S l continue etron mic stalline n retation of	oscope; on the WDS. ction in Selected pus ring roscope naterial: of SAD				

	M. TECH. IN METALLURGY AND MATERIALS TECHNOLOGY
	 standard patterns from different crystals,viz. simple cubic, BCC, FCC etc. [12] Thermal Analysis: Differential thermal analysis, Differential scanning calorimetry and Thermogravimetricanalysis. [8]
Text Books, and/or reference material	 Text Books: "Elements of X-Ray Diffraction", by B.D. Cullity, Addision Wesley Publishing Co., Massachusetts, 1968. 2. "X-ray diffraction-a practical approach", by C. Suryanarayana and M. Grant Norton, Springer, 1998. 3. "X-ray Diffraction: Its Theory and Applications", by S. K. Chatterjee, Prentice-Hall of India Pvt. Limited,2004. 4. "Electron Microscopy in the Study of Materials", by P.J. Grundy and G.A. Jones, Arnold, London, 1976. 5. "Transmission Electron Microscopy: A Textbook for Materials Science (4 Vol set)", by David B. Williams and C. Barry Carter, 2nd ed., Springer, 2009. Reference Books: "Electron Microscopy and Analysis", by Peter J. Goodhew, John Humphreys and Richard Beanland, Third Edition, CRC Press, 2000. Principles of Metallographic laboratory Practice – G. L. Kehl, London: McGraw-Hill Publishing Co., Ltd., 1939. Metallography, Principles and Practice-George F. Vander Voort, ASM International, 1984.

	PO1	PO2	PO3	PO4
CO1				
CO2			\checkmark	
CO3		\checkmark		
CO4				\checkmark

		ent of Metallurgical									
Course	Title of the course	6			Total Number of contact hours						
Code		(PCR) /	Lecture	Tutorial	Practical	Total					
		Electives (PEL)	(L)	(T)	(P)	Hours					
MT2051	Principles and	PCR	0	0	4	4	2				
	Techniques of										
	Materials										
	Characterization										
	Laboratory										
Pre-requisi		Course Assessme	nt methods	(Continuou	s (CT) and e	nd assessn	nent				
1		(EA))		((-)						
NIL		CT+EA									
Course	On completion	of the course the le	arner shall	be able to	•						
Outcomes	1					1	1. 66				
0		Learn fundament	tals of .	X-ray dif	fractometer	and c	lifferen				
	microsc	-									
		lentify the crystal	structure a	nd index t	he X-ray di	ffraction	patterns				
		ent phases.									
		earn the operation	nal aspect	of X-ray	diffractome	ter and c	lifferen				
	microsc	-									
	• CO4: A	Ability to analyze	diffractog	grams of	industrial s	samples 1	to mee				
	contemp	orary need.									
Topics	Experiment 1:	Characterization o	f a metal n	natrix com	posite.						
Covered	Part (I): Charate	Part (I): Charaterization by optical Metallography and Hardness measurement. [6]									
		Part (II): Characterization by X-Ray diffraction.[6]									
	Experiment 2.	Experiment 2. Indexing the X-ray diffraction (XPD) pattern of different phases									
	-	Experiment 2: Indexing the X-ray diffraction (XRD) pattern of different phases. Part (I): Indexing the XRD pattern of BCC structure. [4]									
		ng the XRD pattern			[*	-	4]				
	. ,	ng the XRD patter					4]				
	. ,	0 1			re of BCC a	-	-				
	[6]	Part(IV): Indexing the XRD pattern containing a mixture of BCC and FCC phases. [6]									
	Experiment 3: XRD. [6]	Experiment 3: Characterization of a nanocrystalline thin film electrodeposite by XRD [6]									
	Experiment 4:	Experiment 4: X-ray diffraction of powders exhibiting the effect of powder size									
	on peak broader	on peak broadening. [6]									
	r or	0° L°J									
	Exposiment 5	· Intornatation	of micros	tructures	obtained 4	rough -	oonnir				
	-	: Interpretation	JI IIICTOS	uuctures	obtained th	nougn s	camm				
	electron micros	electron microscopy. [6]									
	Experiment 6	: Indexing select	ed area d	liffraction	patterns (SADP) (obtaine				
	-	ssion electron mic			1	/ (
		ssion ciccuon inc	ioscopy.	ניין							
Toyt Docl											
Text Books	s, Text Book:	V Doy Differentiant	" h D D	Cu11:4	Adiaian W	loglow D					
and/or	s, Text Book:	X-Ray Diffraction	", by B.D.	Cullity, A	Addision W	esley Pu	blishing				
	s, Text Book:	-	", by B.D.	Cullity, A	Addision W	esley Pu	blishinş				

2. "Electron Microscopy in the Study of Materials", by P.J. Grundy and G.A. Jones, Arnold, London, 1976.

3. Principles of Metallographic Laboratory Practice – G. L. Kehl, London: McGraw-Hill Publishing Co., Ltd., 1939.

Reference Book:

1. "Transmission Electron Microscopy: A Textbook for Materials Science (4 Vol

set)", by David B. Williams and C. Barry Carter, 2nd ed., Springer, 2009.

2.*Metallography*, Principles and Practice-George F. *Vander Voort*, ASM International, 1984.

	PO1	PO2	PO3	PO4
CO1			\checkmark	
CO2		\checkmark	\checkmark	
CO3			\checkmark	
CO4		\checkmark		\checkmark

	Department of Metallurgical and Materials Engineering								
Course	Title of the courseProgramTotal Number of contact hours						Cr		
Code			Core	Lecture	Tutorial	Practical	Total	edi	
			(PCR) /	(L)	(T)	(P) [#]	Hours	t	
			Electives						
			(PEL)						
MT205	Mir	or Project With	PCR	0	0	6	6	3	
3	Sen	ninar							
Pre-requ	isites		Course As	sessment m	ethods: (Co	ntinuous eva	luation (C	E)	
	and end assessment (EA))								
NIL			CE+EA						
Course	se On completion of the course the learner shall be able to:								
Outcome	S	CO1: Ability to	o conduct literature review on selected topic.						
		•	to write and present a technical report with suitable						
		conclusion.CO.		-		-			
		a seminar.	2				1		
Topics		Topics will be prov	vided						
Covered									
Text Boo	ks,	To be notified sepa	rately.						
and/or		1	-						
reference	•								
material									

	PO1	PO2	PO3	PO4
CO1				
CO2				
CO3		\checkmark		

		Department of	f Metallurgica	l and Materi	als Engineer	ing		
Course	Title of	the course	Program	Total Nu	mber of co	ntact hours		Cr
Code			Core	Lecture	Tutorial	Practical	Total	edi
			(PCR) /	(L)	(T)	(P) [#]	Hours	t
			Electives					
			(PEL)					
MM305	Disserta	ition-I	PCR	0	0	24	24	12
1								
Pre-requi	isites					ntinuous eva	luation (C	E)
				sessment (E	EA))			
NIL			CE+EA					
Course		completion of	the course the	e learner sha	all be able to	o:		
Outcome	S	• CO1:A	bility to conduct exhaustive literature review on a selected					
		domair	of interest.					
		• CO2:A	bility to inter	rpret ideas a	and thoughts	s into practic	e in a proj	ect.
		• CO3:A	bility to an	alyze and	finding ou	it the unex	plored ar	ea of
		researc	h.	-	_		-	
		• CO4:	Ability to	conduct	experimen	tal or the	oretical	work
		indeper	ndently.		-			
		• CO5:A	bility to write	e a technica	al report.			
Topics	Top	pics will be pro			•			
Covered								
Text Books, To be notified separately.								
and/or								
reference	e							
material								

	PO1	PO2	PO3	PO4
CO1	\checkmark	\checkmark		
CO2	\checkmark		\checkmark	\checkmark
CO3	\checkmark		\checkmark	\checkmark
CO4	\checkmark		\checkmark	\checkmark
CO5		\checkmark		

	Departmen	t of Metallurg	ical and Ma	terials Engine	ering		
Course	Title of the	Program	Total N	umber of co	ntact hours		Cred
Code	course	Core	Lectur	Tutorial	Practic	Total	it
		(PCR) /	e (L)	(T)	al (P)#	Hours	
		Electives					
		(PEL)					
MM3052	Seminar – Non	PCR	0	0	4	4	2
	Project /						
	Evaluation of						
	Summer						
	Training						
Pre-requisite	es Course Assessment methods (As per PG regulation)						
NIL	AS PER PG REGULATION						
Course	On completion of	of the course	the learner	shall be able	e to:		
Outcomes	• CO1	:Ability to co	onduct liter	ature review	on selected	advances t	opic.
	• CO2	:Ability to	summarie	es the con	cept of t	he choser	n topic
	syste	matically from	m differen	t sources.			_
	• CO3	:Ability to	write and	present a t	echnical rep	port with	suitable
	conc	lusion.		-	_	-	
	• CO4	: Ability to	discuss an	d defend th	e outcome	of the rep	ort in a
	semi	nar				-	
Topics	Topics will be p	rovided					
Covered							
Text Books,	To be notified se	eparately.					
and/or							
reference							
material							

	PO1	PO2	PO3	PO4
CO1	\checkmark	\checkmark		
CO2				
CO3				
CO4			\checkmark	

	Department of Metallurgical and Materials Engineering								
Course	Title of the	Program	Total Nu	mber of co	ntact hours		Credit		
Code	course	Core	Lecture	Tutorial	Practical	Total			
		(PCR) /	(L)	(T)	(P) [#]	Hours			
		Electives							
		(PEL)							
MM4051	Dissertation –	PCR	0	0	24	24	12		
	II / Industrial								
	Project								
Pre-requis	ites	Course As	ssessment n	nethods (As	per PG regul	lation)			
NIL		AS PER P	G REGUL	ATION					
Course	On completion	n of the cour	se the learn	er shall be a	able to:				
Outcomes	• CO1:	Ability to a	nalyze and	interpret i	deas and u	nexplored	area of		
	resear	-		1		1			
	• CO2:	Ability to con	nduct exper	rimental or t	heoretical wo	ork indepe	ndently.		
		Ability to	-			-			
		tical work.		r		I. I			
	• CO4:	Ability to wr	ite report a	nd technical	documents a	as per inter	rnational		
	standa	•	r			~ r · · · · · ·			
Topics	Topics will b	e provided							
Covered	r	T							
Text Books	To be notified	To be notified separately.							
and/or	,	1 5							
reference									
material									

	PO1	PO2	PO3	PO4
CO1			\checkmark	\checkmark
CO2				\checkmark
CO3		\checkmark		
CO4		\checkmark		

	Department of Metallurgical and Materials Engineering								
Course	Title of the	Program	Total Nu	mber of con	ntact hours		Credit		
Code	course	Core	Lecture	Tutorial	Practical	Total			
		(PCR) /	(L)	(T)	(P) [#]	Hours			
		Electives							
		(PEL)							
MT4052	Project	PCR	0	0	4	4	2		
	Seminar								
Pre-requis	-requisites Course Assessment methods (As per PG regulation)								
NIL	AS PER PG REGULATION								
Course	On completion	on of the cour	se the learn	er shall be a	ble to:				
Outcomes	• C	O1: Ability to	assess and	l validate kr	nowledge gai	ined throu	gh years		
		f study in the			00				
		•	2: Ability to integrate technical question through all the years						
		udy.	0	1		0	5		
		O3: Ability to	express and	d communic	ate.				
		O4: Ability to	-						
Topics	Topics will b		· · · · · · · · · · · · · · · · · · ·						
Covered	· r · · · · · · · · · ·	I							
Text Book	s. To be notifie	To be notified separately							
and/or	,	ro de nomina separatory							
reference									
material									

	PO1	PO2	PO3	PO4
CO1				\checkmark
CO2			\checkmark	\checkmark
CO3		\checkmark	\checkmark	\checkmark
CO4		\checkmark	\checkmark	\checkmark

	De	partm	ent of Metallurgio	cal and Ma	terials Eng	ineering				
Course			Program Core			ntact hours		Credit		
Code	Code course		(PCR) /	Lecture	Tutorial	Practical	Total			
			Electives	(L)	(T)	(P)	Hours			
			(PEL)	2	0			-		
MT-	Advances	in	PEL	3	0	0	3	3		
9031	Production	of								
	Non-Ferrou	S								
	Metals									
Pre-requi	sites		Course Assess	nent metho	ods (Contin	uous (CT) a	nd end as	ssessment		
			(EA))							
NIL			CT+EA							
Course		-	to build up the con	-		_				
Outcome	002. 11	-	to learn the mode	ern advance	e technolog	ies for nonf	errous me	etal		
	extractio									
		-	to analyze and sol		industrial	problems du	iring proc	luction and		
			onferrous metal in	dustries						
Topics	Alumini									
Covered		-	ss, its chemistr							
	Heroult	proc	ess: carbon and	odes, theor	etical prir	nciples, facto	ors influ	encing the		
	-		nt and energy			-				
	-		s. Modern development of Aluminium production like Inert anode							
	drained	athod	le							
	Copper	(08L)								
			Concentration, Ro	-		-	-			
	and e	lectro	-refining process	. Slag-Ma	tte charact	eristics. Re	cent dev	elopment i		
	concentr	ation,	roasting and sme	lting proce	ss .Outoku	mpu and IN	CO proce	ess, Ausmel		
	/ Isasme	t pro	ocess							
	Zinc: (06	,								
	-	-	y, sinter-roasting					-		
	Hydrom	etallur	gical extraction	: roasting	, leaching	and electr	o- winnir	ng. Double		
	leaching	Jaros	site process, Direc	ct leaching	process					
	Lead:	06 L)								
	Direct s	meltir	ng of lead (ISP)	, thermo	dynamic c	onsideration	n, Moder	n practices		
	Refining	efining of lead bullion.								
	Titaniu	Titanium: (02L)								
	Up-grad	Up-gradation of ilmenite and Hunter and Kroll process, Specific advantages and								
	limitatio	limitations								
	Uraniur	Uranium: (02L)								
	Acid a	nd a	ılkali processes	for diges	stion of u	iranium oi	res. Pro	duction o		
	reactor	uranium.								
		-								
	Gold:(0	-								
		L)	process. Carbon-	-in pulp	process.					

I	Different production routes their advantages and limitation in Nickel and Magnesiun production (04L) Status of Non-ferrous metal production in India. (01L) Environmental aspects of Non-ferrous metal production(01L)
and/or reference material	 Textbooks: 11. K. Grjortheim and B.J. Welch: Aluminiu m Smelter Technology, Aluminium-Verlag. 2. A.K.Biswas and W.G. Davenport: Extractive Metallurgy of Copper, Pergamon. 3. S.W.K Morgaon: Zinc and its Alloy, Mac Donald and Evans. 4. H.S.Ray, R. Sridhar and K.P. Abraham: Ex traction of Non-Ferrous Metals, Affiliated East – West. Reference books: A.R. Burkin (ed.) : Production of Aluminium and Alumina Wiley. 2. A.R. Burkin (ed.): Extractive Metallurgy of Nickel, Wiley. 3. C.D.Harrington and AE. Reuhle: Uranium Production Technology, VanNaostrand. 4. N. Sevryukov, B.Kuzumin and Y. Chelishchev: General Metallurgy, Mir. 5. FathiHabashi; Principles of Extractive metallurgy, vol 1, 2, 3 and 4; Gordon and Breach

	PO1	PO2	PO3	PO4
CO1		-		-
CO2		-		-
CO3		-	-	

Course	Title of the course	t of Metallurgical Program Core					Credit		
Course Code	The of the course	(PCR) /		Total Number of contact hoursLectureTutorialPracticalTotal			Cieult		
		Electives (PEL)	(L)	(T)	(P)	Hours			
MT9032	Recent Advances in Agglomeration of iron ore fines	PEL	3	0	0	3	3		
Pre-requisi		Course Assessmen (EA))	nt methods	(Continuous	s (CT) and er	nd assessm	nent		
NIL		CT+EA							
Course Outcomes	 Aggloma CO2: Al place in CO3: Al 	Ability to under eration techniques bility to learn the agglomeration tech bility to analyze and d in iron and steel	fundament hnology. nd solve th	al basis of	recent dev	elopment	s taking		
Topics Covered	Topic 1:General techniques, Star agglomerates. [Topic 2:Sinteri and Preparation formation and b in sintering proc	ll Introduction: Ne ndard procedure f	bed and sco for charact o Sintering adamentals n, Heat tran tivity, Sint	Process, of sinter nsfer in sir	of raw mater Raw mater ing reaction thering laye	erials as ials requi ns, liquid rs, Gas dy	well as rements 1 phase ynamics		
	requirements an and organic bir	ization: General ad Preparation of C nders, Mechanism ons and Formatio [8]	Charge, Dia of green	fferent typ pellet for	es of binder mation and	rs both in kinetics	organic of bal		
	requirements a Briquetting, Me Topic 5: Advand like slimes, Blu sintering, Cor	Topic 4: Briquetting: General Introduction to Briquetting, Raw materials requirements and Preparation of Charge, Basic Industrial Technologies of Briquetting, Metallurgical Properties requirements of Briquettes. [2] Topic 5: Advances in agglomeration: Utilization of other source of fines and wastes like slimes, Blue dust, LD sludge, BF dust and also slag, Micropelletization and sintering, Composite agglomeration techniques, Nonconventional pellet strengthening process.[15]							
Text Books and/or reference material	1. Aggl 2. Pelle Reference Boo 1. Agglome	omeration of Iron etizing of iron ores, ks: eration in Metallu Publication	, Kurt Mey	er, Springe	er-Verlag		zhikova		

POs COs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	1	2
CO2	3	1	3	1	3
CO3	3	1	3	3	3

Mapping of CO (Course Outcome) and PO (Programme Outcome)

Correlation levels 1, 2 or 3 as defined below :

1: Slight (Low)

2: Moderate (Medium)

3: Substantial (High)

	-	ment of Metallurgical							
Course	Title of the course	Program Core	Total Nun	nber of cont	act hours		Credi		
Code		(PCR) / Electives	Lecture	Tutorial	Practical	Total			
		(PEL)	(L)	(T)	(P)	Hours			
MT 9033	Secondary Steel	PEL	3	0	0	3	3		
	Making								
Pre-requisite	es	Course Assessmer	t methods (C	Continuous (CT) and end	assessment	(EA))		
Transport Phenomena		CT+EA							
		damentals of physico	o-chemical p	principles o	f Secondar	y steel maki	ng.		
Outcomes	CO2: Identify a	nd solve reaction kir	netics and m	lechanisms					
	CO3: To learn th	ne design & operatio	nal aspects	of Vacuum	technology	у.			
	CO4: Ability to	analyze industrial pr	ocesses to r	neet the cu	rrent need.				
Topics Cove	ered Introduction: Brie	f review of primary ste	eel making p	rocesses, co	mposition of	the crude st	eel, nee		
	for secondary refi	ning, objective of sec	ondary steel	making, se	condary stee	el making eq	luipmei		
	· · · ·	and processes, preheating and recycling of ladles.[4]							
		Chemical equilibrium, Activity-Composition relationships: Concentrated solutions, Activity							
		Composition relationships: dilute solutions, interaction coefficient, chemical potential and							
		equilibrium, physico-chemical principles of Secondary steel making, Slag basicity and capacities [4]							
		Fluid flow in steel melts in Gas-Stirred ladle. [3]							
	Ū.	Mixing, Mass transfer and kinetics: Introduction, mixing in steel melts in Gas-stirred ladles,							
		kinetics of reactions among phases, Mass transferrin a Gas-Stirred ladle, Mixing Vs. Mass							
	transfer control.	[4]							
		refining: Introduction,		and disadva	antages, tran	sitory and pe	ermanei		
		ubbling-jetting phenomena.[3][1]1: Introduction, Advantages and application[1]							
		iquid steel: Introduction, slag Carry-over: Impact on Ladle Metallurg							
		of deoxidation of r							
	deoxidation in ind								
		Degassing and Decarburization in liquid steel: Introduction, thermodynamics of reactions i							
		vacuum degassing, side reactions during degassing, fluid flow and mixing in vacuum degassing							
		rates of vacuum degassing and decarburization, decarburization for Ultra-low carbon (ULC) and							
		stainless steel. [6]							
		Desulfurization in secondary steelmaking: Introduction, thermodynamics aspects, desulfurization							
		with only top slag, injection metallurgy for Desulfurization. [6]							
		Gas absorption during tapping and teeming from surrounding atmosphere, temperature changes of molton steel during secondary steelmaking phospherus control in secondary steelmaking							
		molten steel during secondary steelmaking, phosphorus control in secondary steelmaking							
		Nitrogen control in steel making.[5]Inclusions and inclusion modification: Introduction, origin of nonmetallic inclusions, Types							
		properties of inclusions, Influence of inclusions on the mechanical properties of steel, Inclusion							
		identification and cleanliness assessment, formation of inclusions during solidification, inclusion							
		151							
	modification.	[5] blogy: Introduction, re	fractories for	r secondarv	steelmaking	, Tundish m	etallurg		
	modification.	[5] blogy: Introduction, re	fractories for	r secondary	steelmaking [3]	, Tundish m	etallurg		

Text Books,	Text Books:
and/or reference	1. A. Ghosh, and A. Chatterjee, , Principles and Practices in Iron and Steel making,
material	Prentice Hall of India, New Delhi, 2008.
	2. A. Ghosh, Secondary Steelmaking, CRC Press, Boca Raton, 2000.
	Reference Books:
	1. Making, Shaping and Treating of Steel (Steelmaking and Refining), 10th Edition,
	1985, AISE, Pittsburgh

	CO1	CO2	CO3	CO4
PO1	✓	\checkmark	\checkmark	\checkmark
PO2	✓	\checkmark	\checkmark	\checkmark
PO3	✓	\checkmark	\checkmark	\checkmark
PO4	-	-	\checkmark	\checkmark

Course	Title	e of the course	Program Core	Total Number of contact hours			Credit		
Code			(PCR) /	Lecture	Tutorial	Practical	Total		
			Electives (PEL)	(L)	(T)	(P)	Hours		
MT 9034		Surface	PEL	3	0	0	3	3	
]	Engineering							
Pre-requisi	ites		Course Assessme	ent methods	(Continuous	(CT) and en	d assessme	ent (EA)	
NIL			CT+EA						
Course		CO1: To unders	tand the basic prir	nciple for su	urface degr	adation of m	aterials		
Outcomes		CO2: To learns	urface morpholog	y of differe	ent kind of	materials and	d their res	ponse	
		in working cond	itions						
		CO3: To unders	tand principles, th	eory, mech	anism and	key variable	es of differ	rent	
			e modification tec	-					
Topics Cov	vered		conventional cas	0					
			surface engineerir						
			ngineering compo				ties and	failures	
		importance and s	scope of surface e	ngineering.	L ²	4 hours]			
		Sumface Degrad	ation						
		Surface Degradation:							
		Basic principles of electrochemistry and aqueous corrosion processes; Oxidation and							
		related concept; Mechanical Friction and Wear like abrasive, erosive and sliding wear etc.; Interaction between wear and corrosion. Surface engineering processes and their							
		types (only basic idea, Conventional surface heat treatment processes. Surface							
						0 01			
		types (only bas	sic idea, Conven	tional surf	face heat	treatment p	rocesses.	Surfac	
		types (only bas engineering by	sic idea, Conven material removal	tional surf : Cleaning	ace heat , pickling,	treatment pr etching, gri	rocesses. inding, po	Surfac olishing	
		types (only bas engineering by buffing / puffing	sic idea, Conven material removal g (techniques emp	tional surf : Cleaning ployed, its	ace heat , pickling, principle).	treatment pr etching, gri Role and es	rocesses. inding, po stimate of	Surfac olishing surfac	
		types (only bas engineering by buffing / puffing roughness, mate	sic idea, Conven material removal	tional surf : Cleaning ployed, its rom liquid	ace heat , pickling, principle).	treatment pr etching, gri Role and es	rocesses. inding, po stimate of	Surfac olishing surfac	
		types (only bas engineering by buffing / puffing roughness, mate application with	sic idea, Conven material removal g (techniques emp erial addition: Fr examples). [12	tional surf : Cleaning ployed, its rom liquid	ace heat , pickling, principle).	treatment pr etching, gri Role and es	rocesses. inding, po stimate of	Surfac olishing surfac	
		types (only bas engineering by buffing / puffing roughness, mate application with Surface enginee	sic idea, Conven material removal g (techniques emp erial addition: Fr examples). [12 ering Process:	tional surf : Cleaning ployed, its rom liquid hours]	ace heat , pickling, principle). bath - ho	treatment pr etching, gri Role and es ot dipping (rocesses. inding, po stimate of principle	Surfactorishing surfactorian and it	
		types (only bas engineering by buffing / puffing roughness, mate application with Surface enginee General classifie	sic idea, Conven material removal g (techniques emperial addition: Fr examples). [12 ering Process: cation, scope and	tional surf : Cleaning ployed, its om liquid hours]	ace heat , pickling, principle). bath - ho	treatment pr etching, gri Role and es of dipping (d intensity/e	rocesses. inding, postimate of principle energy de	Surfac olishing surfac and it	
		types (only bas engineering by buffing / puffing roughness, mate application with Surface enginee General classifie profile; Laser a	sic idea, Conven material removal g (techniques emp erial addition: Fr examples). [12 ering Process: cation, scope and ssisted microstru	tional surf : Cleaning ployed, its om liquid hours] l principles ctural mod	ace heat , pickling, principle). bath - ho s, types an lification –	treatment pr etching, gri Role and es ot dipping (d intensity/e - surface me	rocesses. inding, postimate of principle energy de elting, ha	Surfac olishing surfac and it position	
		types (only bas engineering by buffing / puffing roughness, mate application with Surface enginee General classifie profile; Laser a shocking and si	sic idea, Conven material removal g (techniques emperial addition: Fr examples). [12 ering Process: cation, scope and ssisted microstru milar processes; 1	tional surf : Cleaning ployed, its rom liquid hours] l principles ctural mod Laser assis	ace heat , pickling, principle). bath - ho s, types an lification – ted composited	treatment pr etching, gri Role and es ot dipping (d intensity/e surface me sitionalmodi	rocesses. inding, postimate of principle energy de elting, ha fication –	Surfac olishing surfac and it position rdening surfac	
		types (only bas engineering by buffing / puffing roughness, mate application with Surface enginee General classifie profile; Laser a shocking and si alloying of stee	sic idea, Conven material removal g (techniques emperial addition: Fr examples). [12 ering Process: cation, scope and ssisted microstru milar processes; lel and non-ferrou	tional surf : Cleaning ployed, its om liquid hours] l principles ctural mod Laser assist s metals a	ace heat , pickling, principle). bath - ho s, types an lification – ted composi- nd alloys;	treatment pr etching, gri Role and es ot dipping (d intensity/e - surface me sitionalmodi surface cla	rocesses. inding, postimate of principle energy de elting, ha fication – dding, co	Surfac olishing surfac and it position rdening surfac omposit	
		types (only bas engineering by buffing / puffing roughness, mate application with Surface enginee General classifie profile; Laser a shocking and si alloying of stee surfacing and si	sic idea, Conven material removal g (techniques emperial addition: Fr examples). [12 ering Process: cation, scope and ssisted microstru milar processes; lel and non-ferrou milar techniques;	tional surf : Cleaning ployed, its rom liquid hours] I principles ctural mod Laser assist s metals a Electron	ace heat , pickling, principle). bath - ho s, types an lification – ted composind alloys; beam assis	d intensity/e surface cla ted modifica	rocesses. inding, postimate of principle energy de elting, ha fication – dding, co ation and	Surface olishing surface and it position rdening surface omposite	
		types (only bas engineering by buffing / puffing roughness, mate application with Surface enginee General classifie profile; Laser a shocking and si alloying of stee surfacing and si	sic idea, Conven material removal g (techniques emperial addition: Fr examples). [12 ering Process: cation, scope and ssisted microstru milar processes; lel and non-ferrou	tional surf : Cleaning ployed, its rom liquid hours] I principles ctural mod Laser assist s metals a Electron	ace heat , pickling, principle). bath - ho s, types an lification – ted composind alloys; beam assis	d intensity/e surface cla ted modifica	rocesses. inding, postimate of principle energy de elting, ha fication – dding, co ation and	Surface olishing surface and it position rdening surface omposite	
		types (only bas engineering by buffing / puffing roughness, mate application with Surface enginee General classifie profile; Laser a shocking and si alloying of stee surfacing and si Ion beam assiste	sic idea, Conven material removal g (techniques emperial addition: Fr examples). [12 ering Process: cation, scope and ssisted microstru milar processes; lel and non-ferrou milar techniques; d microstructure a	tional surf : Cleaning ployed, its rom liquid hours] I principles ctural mod Laser assist s metals a Electron	ace heat , pickling, principle). bath - ho s, types an lification – ted composind alloys; beam assis	d intensity/e surface cla ted modifica	rocesses. inding, postimate of principle energy de elting, ha fication – dding, co ation and	Surfac olishing surfac and it positio rdening surfac omposit	
		types (only bas engineering by buffing / puffing roughness, mate application with Surface enginee General classifie profile; Laser a shocking and si alloying of stee surfacing and si Ion beam assiste Advanced Proc	sic idea, Conven material removal g (techniques emperial addition: Fr examples). [12 ering Process: cation, scope and ssisted microstru milar processes; I el and non-ferrou milar techniques; d microstructure a	tional surf : Cleaning ployed, its om liquid hours] l principles ctural mod Laser assist s metals a Electron band compos	ace heat , pickling, principle). bath - ho bath - ho s, types an lification – ted compos ind alloys; beam assis sitional mod	treatment pr etching, gri Role and es ot dipping (d intensity/e surface me sitionalmodi surface cla ted modifica dification. [1	rocesses. inding, postimate of principle energy de elting, ha fication – dding, co ation and 2 hours]	Surface olishing surface and it position rdening surface pomposite joining	
		types (only bas engineering by buffing / puffing roughness, mate application with Surface enginee General classifie profile; Laser a shocking and si alloying of stee surfacing and si Ion beam assiste Advanced Proc Physical vapour	sic idea, Conven material removal g (techniques emperial addition: Fr examples). [12 ering Process: cation, scope and ssisted microstru milar processes; lel and non-ferrou milar techniques; d microstructure a	tional surf : Cleaning ployed, its rom liquid hours] l principles ctural mod Laser assist s metals a Electron l and compose	Face heat , pickling, principle). bath - ho s, types an lification – ted composind alloys; beam assis sitional moo	d intensity/e- surface me sitionalmodi surface cla dification. [1	rocesses. inding, postimate of principle energy de elting, ha fication – dding, co ation and 2 hours]	Surface olishing surface and it position rdening surface position joining	
		types (only bas engineering by buffing / puffing roughness, mate application with Surface enginee General classifie profile; Laser a shocking and si alloying of stee surfacing and si Ion beam assiste Advanced Proc Physical vapour Anodizing, Galv	sic idea, Conven material removal g (techniques emp erial addition: Fr examples). [12 ering Process: cation, scope and ssisted microstru milar processes; lel and non-ferrou milar techniques; d microstructure a ess: deposition, PEPVI ranizing, Thermal	tional surf : Cleaning ployed, its fom liquid hours] I principles ctural mod Laser assist s metals a Electron b and compose D, Chemica Spraying (a	ace heat , pickling, principle). bath - ho s, types an lification – ted compose and alloys; beam assis sitional model all vapourde all types), I	treatment pr etching, gri Role and es ot dipping (d intensity/e - surface me sitionalmodi surface cla ted modifica dification. [1 position, Ele Plasma based	rocesses. inding, postimate of principle energy de elting, ha fication – dding, co ation and 2 hours] ectrodepos I techniqu	Surfac olishing surfac and it position rdening surfac omposit joining sition, es like	
		types (only bas engineering by buffing / puffing roughness, mate application with Surface enginee General classifie profile; Laser a shocking and si alloying of stee surfacing and si Ion beam assiste Advanced Proc Physical vapoure Anodizing, Galv plasma nitriding	sic idea, Conven material removal g (techniques emperial addition: Fr examples). [12 ering Process: cation, scope and ssisted microstru milar processes; I el and non-ferrou milar techniques; d microstructure a ess: deposition, PEPVI	tional surf : Cleaning ployed, its om liquid hours] l principles ctural mod Laser assist s metals a Electron la and compos D, Chemica Spraying (a ng, PSII, L	ace heat , pickling, principle). bath - ho s, types an lification – ted compose and alloys; beam assis sitional model all vapourde all types), I	treatment pr etching, gri Role and es ot dipping (d intensity/e - surface me sitionalmodi surface cla ted modifica dification. [1 position, Ele Plasma based	rocesses. inding, postimate of principle energy de elting, ha fication – dding, co ation and 2 hours] ectrodepos I techniqu	Surfac olishing surfac and it position rdening surfac omposit joining sition, es like	
		types (only bas engineering by buffing / puffing roughness, mate application with Surface enginee General classifie profile; Laser a shocking and si alloying of stee surfacing and si Ion beam assiste Advanced Proc Physical vapour Anodizing, Galv plasma nitriding friction surfacing	sic idea, Conven material removal g (techniques emp erial addition: Fr examples). [12 ering Process: cation, scope and ssisted microstru milar processes; le and non-ferrou milar techniques; d microstructure a ess: deposition, PEPVI ranizing, Thermal , plasma carburizi g, explosive cladd	tional surf : Cleaning ployed, its om liquid hours] I principles ctural mod Laser assist s metals a Electron la and compose D, Chemica Spraying (a ng, PSII, L ing.	ace heat , pickling, principle). bath - ho s, types an lification – ted compose and alloys; beam assis sitional model all vapourde all types), I	treatment pr etching, gri Role and es ot dipping (d intensity/e- surface me sitionalmodif surface cla ted modifica dification. [1 position, Ele Plasma based LSM etc.We	rocesses. inding, postimate of principle energy de elting, ha fication – dding, co ation and 2 hours] ectrodepos I techniqu	Surfac olishing surfac and it position rdening surfac omposit joining sition, es like	
		types (only bas engineering by buffing / puffing roughness, mate application with Surface enginee General classifie profile; Laser a shocking and si alloying of stee surfacing and si Ion beam assiste Advanced Proc Physical vapoure Anodizing, Galv plasma nitriding friction surfacing	sic idea, Conven material removal g (techniques emperial addition: Fr examples). [12 ering Process: cation, scope and ssisted microstru milar processes; let and non-ferrou milar techniques; d microstructure a ess: deposition, PEPVI vanizing, Thermal , plasma carburizi g, explosive cladd on of engineereds	tional surf : Cleaning ployed, its om liquid hours] l principles ctural mod Laser assist s metals a Electron la and compos D, Chemica Spraying (a ng, PSII, L ing. urface:	ace heat , pickling, principle). bath - ho bath - ho s, types an lification - ted composi- ind alloys; beam assis sitional mod all vapourde all types), H SH, LSA, I	treatment pr etching, gri Role and es ot dipping (d intensity/e surface me sitionalmodif surface cla ted modifica dification. [1 position, Ele Plasma based _SM etc.We [12 hours]	rocesses. inding, postimate of principle energy de elting, ha fication – dding, co ation and 2 hours] ectrodepos I techniqu Idsurfacin	Surface olishing surface and it position rdening surface omposite joining sition, es like	
		types (only bas engineering by buffing / puffing roughness, mate application with Surface enginee General classifie profile; Laser a shocking and si alloying of stee surfacing and si Ion beam assiste Advanced Proc Physical vapoure Anodizing, Galv plasma nitriding friction surfacing	sic idea, Conven material removal g (techniques emp erial addition: Fr examples). [12 ering Process: cation, scope and ssisted microstru milar processes; I el and non-ferrou milar techniques; d microstructure a ess: deposition, PEPVI ranizing, Thermal , plasma carburizi g, explosive cladd on of engineereds ace-mechanicalch	tional surf : Cleaning ployed, its om liquid hours] l principles ctural mod Laser assist s metals a Electron la and compos D, Chemica Spraying (a ng, PSII, L ing. urface:	ace heat , pickling, principle). bath - ho bath - ho s, types an lification - ted composi- ind alloys; beam assis sitional mod all vapourde all types), H SH, LSA, I	treatment pr etching, gri Role and es ot dipping (d intensity/e surface me sitionalmodif surface cla ted modifica dification. [1 position, Ele Plasma based _SM etc.We [12 hours]	rocesses. inding, postimate of principle energy de elting, ha fication – dding, co ation and 2 hours] ectrodepos I techniqu Idsurfacin	Surface olishing surface and it position rdening surface omposite joining sition, es like	

Text Books, and/or reference material	Text Books:1. T Burakowski and T. Wierzchon, Surface engineering of metals, CRC Press2. A. W. Batchelor, L. N. Lam and M. Chandrasekaran, Materials degradation and itscontrol by surface engineering, Imperial college press3. S Grainger and J. Blunt, Engineering coatings, William Andrew Publishing
	 Reference Books: 1. K.G. Budinski, Surface Engineering for Wear Resistances, Prentice Hall, Englewood Cliffs, 1988. 2. Laser Surface Engineering Processes and Applications, J. R. Lawrence, C. Dowding, D. Waugh and J. B. Griffiths, A volume in Woodhead Publishing, 2015

	PO1	PO2	PO3	PO4
CO1		\checkmark		-
CO2	\checkmark	\checkmark		-
CO3	\checkmark	\checkmark	\checkmark	\checkmark

		Total Number of contact hours			course Program Core	e of the course	Title	Course	
	Total Hours	Practical (P)	Tutorial (T)	Lecture (L)	(PCR) / Electives (PEL)			Code	
3	3	0	0	3	PEL	erials Modelling and ulation		MT 9035	
t (EA))	ssessmen	T) and End A	ontinuous (C	methods (C	Course Assessment	Pre-requisites		Pre-reau	
t (L/1))	ssessmen	1) and Life 7	Sittinuous (C	methods (C	CT+EA	NIL			
					M.M. Ghosh	Developer			
			on.	ics simulati	ials. nd molecular dynam	CO3:To understan			
fits an [4 h s (MD	neir bene dynamic	elling and th - molecular	aterials mod	s used in ma modelling	n to materials model different approaches erview of atomistic ecarlo (MC) tech	modelling; o drawbacks 2. General ove	l	Topics Covered	
	-	-		-	dynamics modellin potential; initial a tion; integration alg	interatomic			
			•	gorithms; th	l property calculatio	analysis and			
[18 h metho d; type	atting; N element	g and barost es - finite o	ermostattin	gorithms; th ns m modellin		4. General ove (FEM) mod			
[18 h metho d; type [3 h elemer ypes o ntinuit ural an	atting; M element he method eriving nethod; t uring; co	g and barost es - finite of wbacks of th ches for do Galerkin's n d substructu	ermostatting ng techniqu ges and dra ent approa proach, and lensation ar	gorithms; th ns m modellin on - advanta teps; differ tiational app ctions; cond	l property calculation erview of continuu elling and simulation tions of the method elling - general so direct approach, van dinterpolation fun tes; mesh refining; G	 4. General over (FEM) mode and applicat 5. FEM mode properties: or elements and applicat 			
[18 h metho d; type [3 h elemer ypes o ntinuit ural an [15 h	atting; N element he method eriving nethod; t uring; co or structu	g and barost es - finite of wbacks of th ches for do Galerkin's n d substructu modelling fo	ermostatting ng techniqu ges and dra ent approa proach, and lensation ar ature; FEM	gorithms; th ns m modellin on - advanta teps; differ riational app ctions; cond auss quadra	l property calculation erview of continuu elling and simulation tions of the method elling - general so direct approach, van dinterpolation fun tes; mesh refining; G	 4. General over (FEM) mode and applicate 5. FEM mode properties: or elements and requirement thermal protection of the second secon			

	M. TECH. IN METALLURGY AND MATERIALS TECHNOLOGY
Text Books, and/or reference material	 Text Books: 1. Understanding Molecular Simulation: D. Frenkel and B. Smit, Academic Press, 2002 2. The Finite Element Method for Engineers, 4th Edition: Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith, Ted G. Byrom, Wiley, 2001
	 Reference Books: 3. The Art of Molecular Dynamics Simulation: <i>D.C. Rapaport</i>, Cambridge University Press, 2004 4. Statistical mechanics: <i>Donald A. Mcquarrie</i>, Harper Row, 1976 5. An Introduction to the Finite Element Method (Mcgraw Hill Series in Mechanical Engineering)3rd Edition: <i>J. N. Reddy</i>

CO/PO	PO1	PO2	PO3	PO4
CO1		\checkmark		\checkmark
CO2				
CO3				
CO4	\checkmark	\checkmark	\checkmark	\checkmark

	Depar	rtment of Metallurgic	cal & Materi	als Engineer	ing					
Course	Title of the course	Program Core	То	tal Number	of contact hou	irs	Credit			
Code		(PCR) /	Lecture	Tutorial	Practical	Total				
		Electives (PEL)	(L)	(T)	(P)	Hours				
MT	Advance Welding	PEL	3	0	0	3	3			
9036	Metallurgy									
Pre-requ	isites	Course Assessmen	t methods ((ontinuous (CT) and end a	Issessment	(EA))			
-	Aetallurgy and	CT+EA	it methods (C	continuous (issessment				
•	s Engineering									
Course		rinciples of all the w	elding and o	ther joining	processes.					
Outcome		metallugy of welding				enginneing				
	metal/alloys.									
<u> </u>		all-metal welding de				A				
Topics Covered		istorical introduction				• •				
Covered	weiding procedure	e, welding terms a	nd characte	ristics, weld	ding design,	welding p	ositions			
	welding vs. other	joining processes.			(06)					
	Gas Welding: ox	y-acetylene weldir	ng, flame cl	haracteristic	es, advantag	ges and dr	awback			
	of ga	s wel	ding,	oxy	-acetylene		cutting			
	(02)									
	× /	(02) Arc Welding: Arc welding power sources, power source characteristics (PSC); Shielded								
	U	Metal Arc Welding (SWAM)- welding electrodes, AWS and BIS electrodes								
		blow, weaving, a								
	-	•	-			-				
		es, limitations and				0				
		modes of metal tr		-						
	-	elding (GTAW), p		cription, w	elding techn	iques, adv	antage			
	limitations and ap	-	(10)							
	Resistance Weldi	ng: Heat generat	tion and p	process de	scription, v	velding s	equence			
	resistance seam w	resistance seam welding, limitations and application, projection welding. (03)								
	Radiant Welding	Radiant Welding : Electron beam welding (EBW), process description, power density,								
	weld characterist	weld characteristics, advantages, limitations and applications; Laser beam welding								
		(LBW) – principles of LASE generation, process description, laser welding units								
					1 /		0			
	6	advantages, limitations and applications. (06) Other Welding processes: Friction welding, diffusion welding, induction, welding,								
	-	ltrasonic welding e	-	, unitasion	weiding, in	luuction,	(04)			
	-	-		1 1 /	· .·	11 /				
		rgy : introduction,								
	- ·	at affected zone,		ty, carbon	equivalent		lity v			
	3 /	al weldability tests				(08)				
	Welding of Speci	fic Alloys: Weldir	ng of stainle	ess steels, w	elding of cas	st irons, we	elding o			
	copper base alloys	s, welding of dissin	nilar metals	and alloys.			(04)			
	Weld Defects and	l Cracking: Weld	defects, hot	cracking, c	cold cracking	, etc.				
	(03)	-		C	C					
	× /	ection: All weld te	ests – tensio	on, best. har	dness. impac	t. Non des	tructive			
	• -	cance, reliability of		, ,	,p***	(02)				
		dering: Introduct		nrocasa L	razing filler	. ,	aldarin			
	Dialing and sol	uering. muouuet	ion, Diazing	5 process, t	nazing miel	metals, S	JUCTIII			

	M. TEC	CH. IN METALLURG	Y AND MATERIA	LS TECHNOLOG	Y
	soldering (02)	processes,	solder	alloys,	applications.
Text Books, and/or reference material	Delhi, 1 2. Welding 3. Theory 1992. 4. Introduc Butterw 5. Welding Refernce book	Metallurgy, Sindo K of Weldabilty of Met tion to the Pysical M orths, London, 1983. Technology. N K S WedldingHandboook,	Kou, John Wiley a als and Alloys, Iv etallurgy of Weld Srinivasan, Khann	nd Sons, New Yor an Hrivnak, Elsev ling. Kenneth Eate ma Publisher, New	rk,1987. iew, Amsterdam, rling, v Delhi, 1994.

	CO1	CO2	CO3
PO1	\checkmark	\checkmark	\checkmark
PO2	\checkmark	\checkmark	\checkmark
PO3	\checkmark	✓	\checkmark
PO4	\checkmark	-	\checkmark

Course	Title of the	Program	Total Nu	mber of co			Credit		
Code	course	Core (PCR) / Electives (PEL)	Lecture (L)	Tutorial (T)	Practical (P)	Total Hours			
MT 9037	Advanced Metal Forming Processes	PEL	3	1	0	52	4		
Pre-requisites		Assessment (E	Course Assessment methods (Continuous (CT) and End Assessment (EA))						
NIL		CT + EA							
Develope		M.M. Ghosh							
Course Outcome	es processes CO2: To kno forming meth	derstand the theory w about advance ods we problems and a	d forming	methods in	comparison	with conv	ventiona		
Topics Covered	other [4] Theoretical a strain relation	of metal forming nalyses (theory o ships, strain hard extent of plastic	of elasticity dening, plas	v and plast	icity in 3 di ation, yield	p mensions) criteria, fl	rocesses): stress low rule		
	forming met mechanics of	various metal f hods, effects of various plastic f forming; wor	strain rat	e and tem ms - rolling	perature, m g; forging; e	aterials b xtrusion;	ehavior drawing		
	explosive fo	gh energy rate for rming; electro-h erplastic forming,	ydraulic f	· -		-	-		
	Severe pla	stic deformat	ion: prir	nciples a	ind differ	ent tec	hniques		
Text Bo	oks, Text	Books:							
and/or reference material	Book 2. Princi Publis 3. Metal	anical Metallurgy Company, Londo ples of Industr hers & Distributo Forming: Mec rd and Robert M	on, 1988 ial Metal ors, New D hanics and	Working elhi, 2005 I Metallurg	Processes, gy, 3rd Ed	G.W. Ro	owe,CBS Iliam F		

Page **39** of **72**

4.	2007 Principles of Metal Working, <i>Surender Kumar</i> , Oxford & IBH Publishing Company, 1985
	Reference Books:
	Metal Forming: Processes and Analysis, <i>B. Avitzur</i> , McGraw-Hill Book Company, New York, 1968 Mechanical Working of Metals: Theory and Practice, <i>J.N. Harris</i> , Pergamon Press, 1983
7.	An Introduction to Plasticity, G.C. Spencer, Chapman & Hall, London, 1968
8.	Advanced High Energy Rate Forming, American Society of Tool Manufacturing, <i>Henry E. Conrad</i> (Editor), 2013
	Severe Plastic Deformation: Methods, Processing and Properties, <i>GhaderFaraji, H.S. Kim, HessamTorabzadeh Kashi,</i> Elsevier, 2018 Severe Plastic Deformation: Toward Bulk Production of Nanostructured Materials, <i>BurhanettinAltan,</i> Nova Science Publishers, Inc, 2006

CO/PO	PO1	PO2	PO3	PO4
CO1	\checkmark	\checkmark	\checkmark	\checkmark
CO2	\checkmark		\checkmark	
CO3				

Course	Title of the course	nent of Metallurgi Program Core		mber of con			Credit
Code	The of the course	(PCR) /		Tutorial		Total	Creat
Code		· ,	Lecture		Practical		
		Electives	(L)	(T)	(P)	Hours	
MT		(PEL)	2	0	0	2	2
MT	Mechanical	PEL	3	0	0	3	3
9038	Behaviour of						
	Materials						
Pre-requ	uisites	Course Assessn (EA))	nent method	ds (Continu	ous (CT) and	d end asse	ssment
	tion to materials and engineering	CT+EA					
¥¥		ndamental unders	tanding of	mechanical	behaviour o	f solid ma	terials
Outcom	es CO2: Develop d	letailed understand	ding of plas	tic deformation	tion, fractur	e mechani	ics, cree
	and fatigue						
		erent design proble					
	CO4: Ability to	analyze and solve	industrial p	problems to	meet the con	ntemporar	y need
Topics		y: Basics of crysta	al structure	, Crystal sy	vstem, Crysta	allographi	c points
Covered	directions and pl	anes, Lattice defe	cts.				[4
	hours]						
Plastic deformation: Deformation by slip, Slip in a perfect lattice, I					attice, Dis	slocatio	
		slip, Concept of					
		of single crystal.					
		ation theory: Fun			-		-
	-	Dislocation in the irces of dislocation		-		ation inte	ractions
		strengthening: Bas nechanism, Grain					• •
	metals, Different elastic plastic fr energy release r crack tip plastic mechanics: CTC	ifferent types of at design philosop cacture mechanics cate; Rcurve; Diff ity; concepts of p DD, J integral, H ening mechanisms	ohies; stres (LEFM): Ferent mode plane stress RR singula ; Fracture t	s concentra Griffith's t es of loadi and plane arity; micro	ation effects heory of br ng; Stress a strain. Elas structural as	of flaws ittle fractu inalysis of tic plastic spects of	; Linea ure; The f cracks fracture fracture
	cycle prediction strain curve; low surface effects; e	der cyclic load - F , application of fr v cycle fatigue; e effect of metallurg verse plastic zone;	ffect of str	chanics for ess concen les on fatig	fatigue crac tration on fa ue; cumulati	king, cycl atigue; siz ve fatigue	lic stres e effect damag

	[8 hours]
	Deformation at High temperature: Time dependent deformation - creep, different stages of creep, creep and stress rupture, creep mechanisms and creep mechanism maps, Superplasticity; microstructural aspects of creep and design of creep resistant alloys, Presentation of engineering creep data; Prediction of long time properties; Creep-fatigue interaction. [5 hours]
Text	Text books:
Books,	1. Mechanical Metallurgy, George E. Dieter, International Student Edition, Mc. Graw-
and/or reference	Hill Kogakusha Ltd. /Fourth(S. I. Metric) Edition, 1988.
material	2. Mechanical Behavior of Materials, Marc André Meyers and Krishan Kumar Chawla,
material	Cambridge University Press, 2008.
	Reference books:
	1. Introduction to dislocations, D. Hull and D.J. Bacon, Fifth Edition,
	ButterworthHeinemann, 2011.
	2. Plastic Deformation of Metals, R. W. K. Honeycombe, Edward Arnold, 1984.
	3. Deformation and Fracture Mechanics of Engineering Materials, Richard
	W.Hertzberg, Richard P. Vinci, Jason L. Hertzberg, 5th Edition, 2012.

	PO1	PO2	PO3	PO4
CO1	-	-		-
CO2		-		-
CO3			-	-
CO4		-	-	

	Title of the course	ment of Metallurgic		Ū.	of contact hou	120	Credit	
Course Code	The of the course	Program Core					Credit	
Code		(PCR) / Electives (PEL)	Lecture (L)	Tutorial (T)	Practical (P)	Total Hours		
MT9039	Composite	PEL	3	0	0	3	3	
	Material and its							
	Development							
D	-	Comment Assessment				1		
Pre-requis		Course Assessme		(Continuou	s (CT) and en	d assessme	ent (EA)	
Developer	ge on Physics,	Prof. J. Maity + S CT+EA	5. Bera					
	y, Mathematics, and	CI+LA						
•	evel knowledge-							
	Engineering							
	and Basic Physical							
Metallurg	-							
Course		and classification a	and differer	nt synthesis	routs of com	posite ma	terials in	
Outcomes		ly practised routes		•		•		
		- , F						
	CO2: To learn th	e different steps of	processing	composites	through powd	ler metallu	rgy rout	
	and casting route;	in turn, the correla	tion of evolv	ved microstr	ucture with p	roperties.		
							c	
		ne application of t	-					
	joining metal ma	atrix composites with regard to basic process mechanism and joint						
	CC · 1 ·	1 1 • .1 •	1	-				
	efficiency achie	ved along with inc	lustrial rele	evance.				
Topics					trix and reir	forcemer	nt: Meta	
Topics Covered	Introduction: Cl	assification of co	mposites ba	ased on ma				
-	Introduction: Cl matrix composit	assification of co	mposites back composite	ased on ma	matrix comp	posite and	carbon	
-	Introduction: Cl matrix composition carbon composition	assification of co	mposites back composite	ased on ma	matrix comp	posite and	carbon	
-	Introduction: Cl matrix composit	assification of co	mposites back composite	ased on ma	matrix comp	posite and	carbon	
-	Introduction: Cl matrix composit carbon composit composite	assification of co	mposites back composite	ased on ma	matrix comp	oosite and licromech	carbon	
-	Introduction: Cl matrix composit carbon composit composite materials	assification of co	mposites back composite different of	ased on ma es,ceramic composite	matrix comp materials. M	oosite and licromech (1 y route.	carbon nanics o 0 hours	
-	Introduction: Cl matrix composit carbon composit composite materials Synthesis routes	assification of co e, polymer matrix te; application of of composites: ca	mposites back composite different of asting route	ased on ma es,ceramic composite e and powde	matrix comp materials. M er metallurgy	oosite and licromech (1 y route.	carbon nanics o 0 hours (4 hours	
-	Introduction: Cl matrix composit carbon composit composite materials Synthesis routes Powder metallu	assification of co e, polymer matrix te; application of of composites: ca rgy processed Co	mposites back composite different of asting route mposite: hi	ased on ma es,ceramic composite e and powde	matrix comp materials. M er metallurgy milling, Me	oosite and licromech (1 y route. (chanical a	carbon anics o 0 hours (4 hours alloying	
-	Introduction: Cl matrix composit carbon composit composite materials Synthesis routes Powder metallu Fundamentals a	assification of co e, polymer matrix te; application of of composites: ca rgy processed Co nd parameters; C	mposites back composite different of asting route mposite: hi ompaction	ased on ma es,ceramic composite e and powde igh energy and Sinter	matrix comp materials. M er metallurgy milling, Me ing:material	oosite and licromech (1 y route. (chanical a depender	carbon anics o 0 hours (4 hours alloying	
-	Introduction: Cl matrix composit carbon composit composite materials Synthesis routes Powder metallu Fundamentals a	assification of co e, polymer matrix te; application of of composites: ca rgy processed Co	mposites back composite different of asting route mposite: hi ompaction	ased on ma es,ceramic composite e and powde igh energy and Sinter	matrix comp materials. M er metallurgy milling, Me ing:material	oosite and licromech (1 y route. (chanical a depender ation.	carbon anics o 0 hours (4 hours alloying nt route	
-	Introduction: Cl matrix composit carbon composit composite materials Synthesis routes Powder metallu Fundamentals a and process para	assification of co e, polymer matrix te; application of of composites: ca rgy processed Co nd parameters; C meters; process p	mposites back composite different of asting route mposite: hi ompaction arameter-st	ased on ma es,ceramic composite e and powde igh energy and Sinter tructure-pro	matrix comp materials. M er metallurgy milling, Me ing:material operty correl	oosite and licromech (1 y route. (1 chanical a dependen ation. (1	carbon anics o 0 hours (4 hours alloying nt route 5 hours	
-	Introduction: Cl matrix composit carbon composit composite materialsSynthesis routesPowder metallu Fundamentals a and process paraCast metal materials	assification of context e, polymer matrix te; application of of composites: ca rgy processed Co nd parameters; Co uneters; process p rix composites: o	mposites back composite different of asting route mposite: his ompaction arameter-st	ased on ma es,ceramic composite e and powde igh energy and Sinter tructure-pro	matrix comp materials. M er metallurgy milling, Me ing:material operty correlutes: dispert	oosite and licromech (1 y route. (1 chanical a depender ation. (1 sion proc	carbon anics o 0 hours (4 hours alloying nt route 5 hours ess (sti	
-	Introduction: Cl matrix composite carbon composite materialsSynthesis routesPowder metallu Fundamentals a and process paraCast metal mat casting, composite	assification of context e, polymer matrix te; application of of composites: ca rgy processed Co nd parameters; C uneters; process p rix composites: c casting and screw	mposites back composite different of asting route mposite: his ompaction arameter-st different sy c extrusion	ased on ma es,ceramic composite e and powde igh energy and Sinter tructure-pro ynthesis ro)-contact at	matrix comp materials. M er metallurgy milling, Me ing:material operty correl- utes: disper- ngle, wettab	oosite and licromech (1 y route. (1 chanical a depender ation. (1 sion proc ility and	carbon anics o 0 hours (4 hours alloying nt route 5 hours ess (sti particle	
-	Introduction: Cl matrix composit carbon composit composite materials Synthesis routes Powder metallu Fundamentals a and process para Cast metal mat casting, composite matrix bonding;	assification of context, polymer matrix te; application of of composites: ca rgy processed Co nd parameters; Context uneters; process p rix composites: ca casting and screw Liquid metal imp	mposites back composite different of asting route mposite: his ompaction arameter-st different sy extrusion pregnation/	ased on ma es,ceramic composite e and powde igh energy and Sinter tructure-pro ynthesis ro)-contact at infiltration	matrix comp materials. M er metallurgy milling, Me ing:material operty correl utes: disper- ngle, wettab (pressure in	oosite and licromech (1 y route. (1 chanical a dependen ation. (1 sion proc ility and filtration,	carbon anics o 0 hours (4 hours alloying nt route 5 hours ess (sti particle squeez	
-	Introduction: Cl matrix composite carbon composite materialsSynthesis routesPowder metallu Fundamentals a and process paraCast metal mat casting, compoor matrix bonding; casting and Lan	assification of correct, polymer matrix te; application of of composites: ca rgy processed Co nd parameters; Co meters; process p rix composites: c casting and screw Liquid metal imp xide process)- pri	mposites back composite different of asting route mposite: his ompaction arameter-st different sy v extrusion pregnation/ nciple of n	ased on ma es,ceramic composite e and powde igh energy and Sinter tructure-pro ynthesis ro)-contact as infiltration nolten meta	matrix comp materials. M er metallurgy milling, Me ing:material operty correl- utes: disper- utes: disper- ngle, wettab (pressure in l infiltration	oosite and licromech (1 y route. (1 chanical a depender ation. (1 sion proc ility and filtration, i-capillary	carbon anics o 0 hours (4 hours alloying nt route 5 hours ess (sti particle squeeze	
-	Introduction: Cl matrix composit carbon composit composite materials Synthesis routes Powder metallu Fundamentals a and process para Cast metal mat casting, compoor matrix bonding; casting and Lan molten metal; S	assification of con- te, polymer matrix te; application of of composites: ca rgy processed Co- nd parameters; Co- meters; process p rix composites: ca casting and screw Liquid metal imp xide process)- pri pray process (Osp	mposites back composites different of asting route mposite: his ompaction arameter-st different sy extrusion pregnation/ nciple of n rey process	ased on ma es,ceramic composite e and powde igh energy and Sinter tructure-pro ynthesis ro)-contact at infiltration nolten meta s and rapid	matrix comp materials. M er metallurgy milling, Me ing:material operty correl- utes: disper- ngle, wettab (pressure in l infiltration solidificatio	oosite and licromech (1 y route. (1 chanical a depender ation. (1 sion proc ility and filtration, -capillary n process	carbon anics o 0 hours (4 hours alloying nt route 5 hours ess (sti particle squeez y flow o); In-sit	
-	Introduction: Cl matrix composite carbon composite materialsSynthesis routesPowder metallu Fundamentals a and process paraCast metal mat casting, compoo matrix bonding; casting and Lan molten metal; S production of d	assification of context, polymer matrix te; application of of composites: ca rgy processed Co nd parameters; Context meters; process p rix composites: ca casting and screw Liquid metal imp xide process)- pri pray process (Osp ispersoids-XD pro-	mposites back composites different of asting route mposite: his ompaction arameter-st different sy pregnation/ nciple of no rey process occess; evol	ased on ma es,ceramic composite e and powde igh energy and Sinter tructure-pro ynthesis ro)-contact as infiltration nolten meta s and rapid	matrix comp materials. M er metallurgy milling, Me ing:material operty correl utes: disper- ngle, wettab (pressure in al infiltration solidificatio structure: str	oosite and licromech (1 y route. (1 chanical a dependen ation. (1 sion proc ility and filtration, n-capillary n process uctural de	carbon anics o 0 hours (4 hours alloying nt route 5 hours ess (sti particle squeeze y flow o); In-situ efects in	
-	Introduction: Cl matrix composite carbon composite materialsSynthesis routesPowder metallu Fundamentals a and process paraCast metal mat casting, compoor matrix bonding; casting and Lan molten metal; S production of d cast metal matr	assification of context, polymer matrix te; application of of composites: ca rgy processed Co nd parameters; Co meters; process p rix composites: c casting and screw Liquid metal imp xide process)- pri pray process (Osp ispersoids-XD pro- ix composites- polymer	mposites back composite different of asting route mposite: his ompaction arameter-st different sy regnation/ nciple of no rey process ocess; evoloprosity, par	ased on ma es,ceramic composite e and powde igh energy and Sinter tructure-pro ynthesis ro)-contact as infiltration nolten meta s and rapid lved micros	matrix comp materials. M er metallurgy milling, Me ing:material operty correl utes: disper- ngle, wettab (pressure in al infiltration solidificatio structure: str gation (mac	oosite and licromech (1 y route. (1 chanical a depender ation. (1 sion proc ility and filtration, i-capillary n process uctural de rosegrega	carbon anics o 0 hours (4 hours alloying nt route 5 hours ess (sti particle squeeze y flow o); In-situ efects in tion and	
-	Introduction: Cl matrix composite carbon composite materialsSynthesis routesPowder metallu Fundamentals a and process paraCast metal mat casting, compoo matrix bonding; casting and Lan molten metal; S production of d cast metal matr microsegregatio	assification of context, polymer matrix te; application of of composites: ca rgy processed Co nd parameters; Context meters; process p rix composites: ca casting and screw Liquid metal imp xide process)- pri pray process (Osp ispersoids-XD pro-	mposites back composite different of asting route mposite: his ompaction arameter-st different sy regnation/ nciple of no rey process ocess; evoloprosity, par	ased on ma es,ceramic composite e and powde igh energy and Sinter tructure-pro ynthesis ro)-contact as infiltration nolten meta s and rapid lved micros	matrix comp materials. M er metallurgy milling, Me ing:material operty correl utes: disper- ngle, wettab (pressure in al infiltration solidificatio structure: str gation (mac	oosite and licromech (1 y route. (1 chanical a depender ation. (1 sion proc ility and filtration, i-capillary n process uctural de rosegrega	carbon anics o 0 hours (4 hours alloying nt route 5 hours ess (sti particle squeeze y flow o); In-situ efects in tion and	
-	Introduction: Cl matrix composite carbon composite materialsSynthesis routesPowder metallu Fundamentals a and process paraCast metal mat casting, compoo matrix bonding; casting and Lan molten metal; S production of d cast metal matr	assification of context, polymer matrix te; application of of composites: ca rgy processed Co nd parameters; Co meters; process p rix composites: c casting and screw Liquid metal imp xide process)- pri pray process (Osp ispersoids-XD pro- ix composites- polymer	mposites back composite different of asting route mposite: his ompaction arameter-st different sy regnation/ nciple of no rey process ocess; evoloprosity, par	ased on ma es,ceramic composite e and powde igh energy and Sinter tructure-pro ynthesis ro)-contact as infiltration nolten meta s and rapid lved micros	matrix comp materials. M er metallurgy milling, Me ing:material operty correl utes: disper- ngle, wettab (pressure in al infiltration solidificatio structure: str gation (mac	oosite and licromech (1 y route. (1 chanical a dependen ation. (1 sion proc ility and filtration, n-capillary n process uctural de rosegrega structure-	carbon anics o 0 hours (4 hours alloying nt route 5 hours ess (sti particle squeeze flow o); In-situ efects in tion and property	
-	Introduction: Cl matrix composit carbon composit composite materials Synthesis routes Powder metallu Fundamentals a and process para Cast metal mat casting, compoor matrix bonding; casting and Lan molten metal; S production of d cast metal matr microsegregatio correlation.	assification of context, polymer matrix te; application of of composites: ca rgy processed Co nd parameters; Co meters; process p rix composites: c casting and screw Liquid metal imp xide process)- pri pray process (Osp ispersoids-XD pro- ix composites- po n), interfacial rea	mposites back composite different of asting route mposite: his ompaction arameter-st different sy regnation/ nciple of no rey process occess; evolo prosity, paraction and	ased on ma es,ceramic composite e and powde igh energy and Sinter tructure-pro ynthesis ro)-contact as infiltration nolten meta s and rapid lved micros rticle segre particle d	matrix comp materials. M er metallurgy milling, Me ing:material operty correl utes: disper- ngle, wettab (pressure in al infiltration solidificatio structure: str gation (mac- egradation;	oosite and licromech (1 y route. (1 chanical a dependen ation. (1 sion proc ility and filtration, i-capillary n process uctural de rosegrega structure- (1	carbon anics o 0 hours (4 hours alloying nt route 5 hours ess (sti particle squeeze y flow o); In-situ efects in tion and property 5 hours	
-	Introduction: Cl matrix composite carbon composite materialsSynthesis routesPowder metallu Fundamentals a and process paraCast metal mat casting, compo matrix bonding; casting and Lan molten metal; S production of d cast metal matr microsegregatio correlation.	assification of context, polymer matrix te; application of of composites: ca rgy processed Co nd parameters; Co meters; process p rix composites: c casting and screw Liquid metal imp xide process)- pri pray process (Osp ispersoids-XD pro- ix composites- polymer	mposites back composite different of asting route mposite: his ompaction arameter-st different sy extrusion/ pregnation/ nciple of no rey process occess; evolo prosity, para action and sites, limit	ased on ma es,ceramic composite e and powde igh energy and Sinter tructure-pro ynthesis ro)-contact at infiltration nolten meta s and rapid lyed micros rticle segre particle d	matrix comp materials. M er metallurgy milling, Me ing:material operty correl- utes: disper- ngle, wettab (pressure in al infiltration solidificatio structure: str gation (mac- egradation; conventional	(1 (1) (1) (1) (1) (1) (1) (1) (1) (1) (carbon anics o 0 hours 4 hours alloying nt route 5 hours ess (sti particle squeeze flow o); In-situ efects in tion and property 5 hours welding	

	different stages of TLP bonding process for monolithic and composite system, process parameters of TLP bonding, joint efficiency. (6 hours)
Text Books,	Text Books:
and/or	1. Metal Matrix Composites - Chawla and Chawla, Springer, 2006.
reference	2. 'Joining of aluminium based metal matrix composites'- JoydeepMaity, in
material	'Engineered Metal Matrix Composites: Forming Methods, Material Properties and
	Industrial Applications', Editor: Luca Magagnin, 2012, NOVA Science Publishers,
	Inc., New York, USA, pp 329-354.
	3. Materials Science and Engineering: An Introduction - William D. Callister, Jr., John
	Wiley & Sons, Inc., 2007.
	4. Fundamentals of Metal-Matrix Composites - Andreas Mortensen and Alan
	Needleman, Butterworth-Heinemann, 1993.
	5. An Introduction to CompositeMaterials–Derek Hull, Cambridge University Press,
	6. Composite Materials –Deborah D.L. Chung, Springer, 2009.
	7. Metal-Matrix composite – P.K. Rohatgi, Defence Science Journal, Vol 43, No 4,
	October 1993, pp 323-349.
	8. Y. B. Liu, S. C. Lim, L. Lu, M. O. Lai, Recent development in the fabrication of
l	metalmatrix-particulate composites using powdermetallurgy techniques, Journal of
	MateralsScience 29 (1994) 1999-2007.

	PO1	PO2	PO3	PO4
C01	\checkmark	\checkmark	-	\checkmark
CO2	\checkmark	\checkmark	\checkmark	-
CO3	\checkmark	\checkmark	\checkmark	-

	Departm	ent of Metallurgical	and Materi	als Engine	ering				
Course	Title of the course	Program Core	Total Nu	mber of cor	ntact hours		Credit		
Code		(PCR) /	Lecture	Tutorial	Practical	Total			
		Electives (PEL)	(L)	(T)	(P)	Hours			
MT	Advanced	PEL	3	0	0	3	3		
9040	Ceramic								
Dra raqui	Materials	Course Assessme	nt mathada	Continuor	(CT) and a	nd account	mont		
Pre-requi	sites	(EA))	nt methous	(Continuot	is (CT) and e	assessi	nent		
NIL		CT+EA							
Course	• CO1·	Describes generic	classifics	ation of a	peramics a	nd their	specific		
Outcomes	2	ering applications.	classifie		conditiones di	na then	specific		
	U	earn structure-prop	portų rolati	onchine of	coromics				
		olve problems of f	•	-		oromio n	orta		
Topics		Introduction: Pr		0 1		<u> </u>			
Covered	-		ocessing,	characteri	Zation and	applica			
0010100	Advanced Cera	Advanced Ceramics [12]							
	Topic 2:	Ceramic Struct	ures: Mi	icrostructu	ral Design	n of C	eramics.		
	-	Topic 2: Ceramic Structures: Microstructural Design of Ceramics, Mesoscopic Ceramic Structures in One, Two, and Three Dimensions; Bulk							
	Ceramic Nanos		,	,			[10]		
							[10]		
	Topic 3:	Classification a	nd prop	erties: O	xides; Nit	trides; C	Carbides;		
	Mechanical Pro	operties; Thermal,	Electrical,	and Magn	etic Propert	ties	[10]		
	Transfer 4.	A	C 4	A	- 4 ¹				
	-	Topic 4: Applications: Structural Applications; Nanosized and Nanostructured Hard and Superhard Materials and Coatings; High-Temperature							
		eramics; Advanced			0	0	-		
	[10]	erannics, Auvanceu		Olow Flug	s, merman	Darrier C	oatings		
Text Boo									
and/or		ience and Technol	ogy, Edite	d byRalf F	Riedel and I-	Wei Che	n, 2008		
reference	WILEY-VCH	1. Ceramics Science and Technology, Edited byRalf Riedel and I-Wei Chen, 2008 WILEY-VCH							
material	2. Advanced	2. Advanced Ceramic Materials, Ashutosh Tiwari, Rosario A. Gerhardt,							
Magdalena Szutkowska, Wiley, 2016									
		itkowska, Wiley, 2	2016						
		•	2016						
	Magdalena Szu Reference Boo	•		ization, H	Raw Mater	rials, Pro	ocessing,		

	PO1	PO2	PO3	PO4
CO1	\checkmark		\checkmark	\checkmark
CO2	\checkmark	\checkmark	\checkmark	\checkmark
CO3	\checkmark	\checkmark		\checkmark

		Departm	ent of Metallurgical	and Materia	ls Engineer	ing		
Course	Ti	tle of the course	Program Core	Total Nu	mber of cor	tact hours		Credit
Code			(PCR) /	Lecture	Tutorial	Practical	Total	
	_		Electives (PEL)	(L)	(T)	(P)	Hours	
MT		lvanced	PEL	3	0	0	3	3
9041		owder						
<u> </u>		etallurgy						
Pre-requi	isites		Course Assessmen (EA))	nt methods ((Continuous	s (CT) and er	nd assessm	nent
NIL			CT+EA					
Course		• CO1: L	earn science and	technologi	cal aspect	s of the A	dvanced	Powder
Outcome	S		gy Techniques.	U	I			
			mphasis is put or	methods	for those	types of r	owders	that are
			nt for production of					
		-	olve problems of 1	-	• •		wder me	tallurov
			ough tutorials/ assi		-	unon or po		uniungy
Topics		=	introduction: Ba		-	tion and	character	ization
Covered		_	ent and Sintering		er produc	and and	cilaracter	[12]
		Powders by ele Plasma synthes metallurgy of ti Topic 3: A Plasma Sinterin Topic 4: A	Applications:Powe f powder metallu	ochemical powders; I cation Pro [10] ler metal	synthesis Powder m c esses: Mi lurgy in	of nanocrys etallurgy fo crowave sin automotiv	stalline p or steel; tering; Sj ze appli	owders; Powder park cations;
Text Books, and/or reference material								

	PO1	PO2	PO3	PO4
CO1	\checkmark		\checkmark	\checkmark
CO2	\checkmark	\checkmark		\checkmark
CO3	\checkmark	\checkmark		\checkmark

Course	Title of the course	Program Core	Total Nu	mber of con	tact hours		Credit
Code		(PCR) / Electives (PEL)	Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
MT9042	Nano-Materials	PEL	3	0	0	3	3
	and Nano- Technology						
Pre-requis	ites	Course Assessm	ent methods	(Continuou	is (CT) and er	nd assessme	ent (EA))
Knowled chemistry	ge on physics, , mathematics, wledge of materials	CT+EA		X			
Course Outcomes	CO1: Learn the h CO2: Learn the	istory of nano-tech synthesis, characte of nano-materials	rization and				ur daily li
Topics Covered		asics of nano-sca nufactured) in nar	•				chnolog (4h
	Nano-materails,	different types of	f nano-mate	erails			(6h
	Basics of mecha	nical, electrical,	magnetic a	nd optical p	properties of	materials	(6h
	Effect of miniat properties of ma	urization (nano-s terials	cale) on m	echanical, e	electrical, ma	agnetic an	-
	Synthesis of nam	o-materials, char	acterization	n of nano-n	naterials		(12h (14h
	Aapplication of	nano-materials, e	environmen	tal concern			(8h
Text Book and/or reference material	 Materials Science Wiley & Sons, I Nanomate Ferreira, M.F.As 		hnologies -Heineman	and c n, 2009	lesign –	D.L.Sc	chodek,P

	PO1	PO2	PO3	PO4
CO1		\checkmark		\checkmark
CO2	\checkmark	\checkmark	\checkmark	
CO3	\checkmark	\checkmark	\checkmark	\checkmark

Course	Title of the	Program	Total Nu	mber of co	ntact hours		Credi
Code	course	Core (PCR) / Electives (PEL)	Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
MT9043	Human Behavior and Management	PEL	3	0	0	3	3
Pre-requisi	tes	Course Assess assessment (EA	Assessment methods (Continuous (CT) and end nent (EA))				
Nil		CT+EA					
Course Outcomes Topics	CO1: To study the CO2: To study the when working with CO3: To obtain kn Manage Individual	understanding of people. owledge of differ Behaviour, Perc	the perenr rent aspects ceptual Pro	nial issues a s of labor ir ocess, Perco	n an industry eptual Grou	/ ping, Imj	pression
Covered	Management; Self Fulfilling Prophecy; Attributions: Kelly's theory of attribution Locus of control; [3h]						
	Social learning the						
	Emotions: Primary	emotions, Emot	ional Labo	ur, Emotioi	nal intellige	nce;	
	Positive and Nega Performance and c commitment; psych	customer satisfac	tion; cause				
	Content and proces	s theories of mot	ivation; [2ł	n]			
	Goal setting and reinforcement theo justice, equity se Creativity in workp	ry, Rewards; Or nsitivity; QWL;	ganization	al Justice-	Distributiv	e and pro	ocedura
Personality and Stress management; Kelly's theory of Personality; B Personality dimensions; MBTI; Personality and Vocational choice; Trans analysis; Characteristics of Healthy personality; Self Development. Concept of stress model; [8h]						actiona	
	Work stressors-Inc and management. knowing the detail Characteristics of g making; [8h]	Group behaviour s of Groups, Ty	and the cost of grou	lynamics o 1ps, group	f interperson formation a	onal Influ and devel	ence by opment
	Leadership. Manag						

	consequences of dysfunctional inter group conflict; managing inter group conflict through resolution; stimulating constructive inter group conflict; negotiations-tactics; increasing negotiation effectiveness. [6h]
Text	Text books:
Books, and/or reference	1. Organizational Behaviour, Robbins, Judge & Sanghi, Pearson Education Publication.
material	2. Organizational Behaviour, McShane & Glinow, McGraw Hill Publication.

	PO1	PO2	PO3	PO4
CO1	\checkmark	-	\checkmark	\checkmark
CO2	-	\checkmark	\checkmark	\checkmark
CO3	\checkmark	-	-	\checkmark

~	-	nent of Metallurgi					
Course	Title of the course	Program Core		nber of cont		1	Credit
Code		(PCR) /	Lecture	Tutorial	Practical	Total	
		Electives (PEL)	(L)	(T)	(P)	Hours	
MT9044	Electron	PEL	3	0	0	3	3
	Microscopy						
Pre-requisi	e-requisites Course Assessment methods (Continuous (CT) and end assessment (EA))						ent
Basic phys	ics, optics	CT+EA					
Course Outcomes	CO1: To learn the f Transmission electr andcrystallographic a CO2: To identify the CO3: To learn the pr	on microscope nalysis difficulties and sul	and unders	stand the asurements	concept of associated wi	image th electron	formation
Topics	Basics on light ar		-	·	•	•	nification
Covered	resolution, depth of	field; Abberations;	Comparisor	n between el	ctron and ligh	nt	6
	Electron-specimen different signals and Componenets of ele	their utilization		-		atom; Gen	eration o
			. 2				51
	Electron diffraction patterns and analysis	•			·		
				c :	C		101
	Scanning electron images/information;					Different	types o
							10
	Transmission electron	ron microscope: E	Basic mechar	nism; Contra	ist mechanism	n	01
	Chemical analysis:	Generation of X-ra	avs: Quantita	ative analysi	S		8
			•	·			4
	Sample preparation	n technique: Powe	ler sample p	reparation; S	Solid sample	preparatior	
Tort	Text Books:						21
Text Books, and/or	1. Electron Microsco Beanland	py and Analysis, 3	rd Edition: P	Peter J. Good	lhew, John H	umphreys,	Richard
reference material	2.Transmission Ele	ctron Microscopy	: David B.	Williams,	C. Barry Car	rter	

	Program O	Program Outcomes						
	PO1	PO2	PO3	PO4				
CO1	\checkmark	\checkmark	\checkmark	-				
CO2	\checkmark	-	\checkmark	\checkmark				
CO3	\checkmark	\checkmark	\checkmark	\checkmark				

Course Code		t of Metallurgical					Credi		
Course Code	de Title of the course Program Core (PCR)		Total Number of contact hoursLectureTutorialPracticalTotal				Credi		
		Electives (PEL)	(L)	(T)	Practical (P)	Total Hours			
MT9045	Strenghening	PEL	3	0	0	3	3		
	Mechanism of								
	Materials								
Pre-requisite	es	Course Assess (EA))	ment metho	ds (Continue	ous (CT) and	end assess	sment		
NIL		CT+EA							
Course	CO1: To understand t	he basic Funda	mentals of	strengtheni	ng mechani	sm of mat	terials		
Outcomes	CO2:To learn the pr	esence of differ	rent kinds	of defects	in metal o	r crystal	that ha		
	significant effect on m	aterial propertie	es.						
	CO3: To learn scient			ts for desig	ning high te	mperature	e mater		
	or materials for advers	se emvironments	8						
Topics	Introduction:						-		
Covered	Basic structure of al	•		-					
	structure of materials	and their mec	hanical, the	ermal cher	nical and el	lectrical r	nagnet		
	properties. [4 hours]								
			thoorv						
	Hamontal Placticity	Elemental Plasticity and dislocation theory: Mechanism and micromechanism of strengthening in engineering materials. Plastic flow							
				ng in engir	eering mate	rials Pla	stic flo		
	Mechanism and micro	mechanism of s	strengtheni						
	Mechanism and micro in metals and alloy	omechanism of s s, Strengthenin	strengthening and dis	slocation s	structure an	nd solid	solutio		
	Mechanism and micro in metals and alloy strengthening, Resista	omechanism of s s, Strengthenin nce to dislocatio	strengthening and dis on induced	slocation s flow, Stren	structure an gthening du	nd solid e to sub a	solutio nd grai		
	Mechanism and micro in metals and alloy strengthening, Resista	omechanism of s s, Strengthenin nce to dislocation ation strength	strengthening and dison induced mening, d	slocation s flow, Stren lispersion	structure an gthening du strengthen	nd solid e to sub a ing, ma	solutio nd grai		
	Mechanism and micro in metals and alloy strengthening, Resista boundaries, precipit	omechanism of s s, Strengthenin nce to dislocatio ation strength ze strengthening	strengthening ag and dis on induced mening, d g, order har	slocation s flow, Stren lispersion dening, du	structure an gthening du strengthen al phase. Ph	nd solid te to sub a ing, ma ysical phe	solutio and grain artensit		
	Mechanism and micro in metals and alloy strengthening, Resista boundaries, precipit strengthening, grain si	omechanism of s s, Strengthenin nce to dislocatio ation strength ze strengthening ls high mechani	strengthening and dison induced mening, d g, order har cal strengt	slocation s flow, Stren lispersion dening, du h in engine	structure an agthening du strengthen al phase. Ph cering mater	nd solid te to sub a ing, ma ysical phe rials. Prin	solution and gradurtensit enomer ciple for		
	Mechanism and micro in metals and alloy strengthening, Resista boundaries, precipit strengthening, grain si that contribute toward designing high streng Phase hardening, Solu	s, Strengthenin nce to dislocatio ation strength ze strengthening ls high mechani th materials with thigh hardening,	strengthening ag and dison induced mening, d g, order har cal strengt ill be addr Order stre	slocation s flow, Stren lispersion rdening, du h in engine ressed, Hig engthening.	structure an gthening du strengthen al phase. Ph cering mater h temperatu Strengtheni	nd solid te to sub a ing, ma ysical phe rials. Prin tre mater ing mecha	solution and gradurtensit enomer ciple for ials.Twa		
	Mechanism and micro in metals and alloy strengthening, Resista boundaries, precipit strengthening, grain si that contribute toward designing high streng Phase hardening, Solu amorphus materials,	omechanism of s s, Strengthenin nce to dislocatio ation strength ze strengthening ls high mechani gth materials wittion hardening, Polymer, cer	strengthening and dison induced bening, d g, order har cal strength ill be addr Order stre ramic, gla	slocation s flow, Stren lispersion dening, du h in engine ressed, Hig engthening. ass and o	structure an agthening du strengthen al phase. Ph eering mater h temperatu Strengtheni composites	nd solid ie to sub a ing, ma ysical phe ials. Prin ure mater ing mecha material	solution and grad artensit enomer ciple for ials.Two anism of s, fib		
	Mechanism and micro in metals and alloy strengthening, Resista boundaries, precipit strengthening, grain si that contribute toward designing high streng Phase hardening, Solu amorphus materials, reinforcement, Four s	omechanism of s s, Strengthenin nce to dislocatio cation strength ze strengthening ls high mechani gth materials wittion hardening, Polymer, centage of deforma	strengthening and dison induced mening, d g, order har cal strength ill be addr Order stre ramic, gla tion, tensilo	slocation s flow, Stren lispersion rdening, du h in engine ressed, Hig engthening. ass and o e strength,	structure an gthening du strengthen al phase. Ph pering mater h temperatu Strengthenic composites Anisotropy.	nd solid te to sub a ing, ma ysical phe ials. Prin tre mater ing mecha material Strengths	solution and grad artensit enomer ciple for ials.Twanism anism s, fibe at Hig		
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	Mechanism and micro in metals and alloy strengthening, Resista boundaries, precipit strengthening, grain si that contribute toward designing high streng Phase hardening, Solu amorphus materials, reinforcement, Four si Temperature, Strengt creep, Strengthening a [20 hours] CERAMIC AND CO Advanced Ceramic M	omechanism of s s, Strengthenin nce to dislocatio ation strength ze strengthening ls high mechani gth materials wi ition hardening, Polymer, cen tage of deforma hening against gainst high rate OMPOSITE MA laterials - Crysta	strengthening and dison induced nening, d g, order har cal strengti ill be addr Order stre ramic, gla tion, tensile diffusion to of deformation al Structure	slocation s flow, Stren lispersion rdening, du h in engine ressed, Hig engthening. ass and o e strength, flow, Stren ation. S: es - Silicato	structure an agthening du strengthen al phase. Ph eering mater h temperatu Strengtheni composites Anisotropy. ngthening ag	d solid te to sub a ing, ma ysical phe ials. Prin tre mater ing mecha material Strengths gainst dis	solution and grad artensit enomer ciple for ials.Tw anism of s, fibo at Hig slocation		
	Mechanism and micro in metals and alloy strengthening, Resista boundaries, precipit strengthening, grain si that contribute toward designing high streng Phase hardening, Solu amorphus materials, reinforcement, Four si Temperature, Strengt creep, Strengthening a [20 hours] CERAMIC AND CO Advanced Ceramic M Ceramics – Functiona	omechanism of s s, Strengthenin nce to dislocatio ation strength ze strengthening ls high mechani gth materials wi ition hardening, Polymer, cer tage of deforma hening against gainst high rate OMPOSITE MA laterials - Crysta l properties and	strengthening and dison induced mening, d g, order har cal strength ill be addr Order stre ramic, gla tion, tensile diffusion to of deformator ATERIALS al Structure l applicatio	slocation s flow, Stren lispersion rdening, du h in engine ressed, Hig engthening. ass and o e strength, flow, Stren ation. S: es - Silicato ons of cerai	structure an agthening du strengthen al phase. Ph eering mater h temperatu Strengthening composites Anisotropy. agthening ag e Ceramics nic material	d solid le to sub a ing, ma ysical pho- ials. Prin tre mater ing mecha material Strengths gainst dis - Glasses ls – Class	solutio and grain artensit enomer ciple for ials.Two anism of s, fibo at Hig slocation – Glas dification		
	Mechanism and micro in metals and alloy strengthening, Resista boundaries, precipit strengthening, grain si that contribute toward designing high streng Phase hardening, Solu amorphus materials, reinforcement, Four si Temperature, Strengt creep, Strengthening a [20 hours] CERAMIC AND CO Advanced Ceramic M Ceramics – Functiona of composites - Fibe	omechanism of s s, Strengthenin nce to dislocatio ation strength ze strengthening ls high mechani gth materials wit ition hardening, Polymer, centage of deformation hening against against high rate OMPOSITE MA faterials - Crysta I properties and r reinforced material	strengthening and dison induced nening, d g, order har cal strengti ill be addr Order stre ramic, gla tion, tensile diffusion to of deformator ATERIALS al Structure application terials – I	slocation s flow, Stren lispersion rdening, du h in engine ressed, Hig engthening. ass and o e strength, flow, Stren ation. S: es - Silicato ons of ceran Law of miz	structure an agthening du strengthen al phase. Ph eering mater h temperatu Strengtheni composites Anisotropy. agthening ag e Ceramics nic material stures – Co	d solid e to sub a ing, ma ysical phe ials. Prin are mater ing mecha material Strengths gainst dis - Glasses ls – Class ontinuous	solution and grad artensit enomer ciple for ials.Tw anism of s, fibe slocation – Glas fibers		
	Mechanism and micro in metals and alloy strengthening, Resista boundaries, precipit strengthening, grain si that contribute toward designing high streng Phase hardening, Solu amorphus materials, reinforcement, Four si Temperature, Strengt creep, Strengthening a [20 hours] CERAMIC AND CO Advanced Ceramic M Ceramics – Functiona of composites - Fibe discontinuous fibers –	omechanism of s s, Strengthenin nce to dislocatio ation strength ze strengthening ls high mechani gth materials within hardening, Polymer, centage of deformation hening against against high rate OMPOSITE MA laterials - Crysta I properties and r reinforced matic	strengthening and dison induced nening, d g, order har cal strengti ill be addr Order stre ramic, gla tion, tensile diffusion to of deforma ATERIALS al Structure l application trenals – I rced materi	slocation s flow, Stren lispersion rdening, du h in engine ressed, Hig engthening. ass and o e strength, flow, Stren ation. S: es - Silicato ons of ceran Law of min als – Cerm	structure an agthening du strengthen al phase. Ph eering mater h temperatu Strengtheni composites Anisotropy. agthening ag e Ceramics nic material xtures – Co ets – Disper	d solid le to sub a ing, ma ysical phe ials. Prin ure mater ing mecha material Strengths gainst dis - Glasses ls – Class ontinuous rsion stren	solutio and grai artensit enomen ciple fo ials.Tw anism o s, fibe at Hig slocatio - Glas dificatio fibers ngthene		
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	Mechanism and micro in metals and alloy strengthening, Resista boundaries, precipit strengthening, grain si that contribute toward designing high streng Phase hardening, Solu amorphus materials, reinforcement, Four si Temperature, Strengt creep, Strengthening a [20 hours] CERAMIC AND CO Advanced Ceramic M Ceramics – Functiona of composites - Fibe discontinuous fibers – materials – Laminat	omechanism of s s, Strengthenin nce to dislocatio ation strength ze strengthening ls high mechani gth materials within hardening, Polymer, centage of deformation hening against against high rate OMPOSITE MA laterials - Crysta I properties and r reinforced mation Particle-reinfor es - Application industry.	strengthening and dison induced nening, d g, order har cal strengti ill be addr Order stre ramic, gla tion, tensile diffusion to of deforma ATERIALS al Structure l application trenals – I rced materi	slocation s flow, Stren lispersion rdening, du h in engine ressed, Hig engthening. ass and o e strength, flow, Stren ation. S: es - Silicato ons of ceran Law of miz als – Cerm nposites in	structure an agthening du strengthen al phase. Ph eering mater h temperatu Strengthening composites Anisotropy. agthening ag e Ceramics mic material stures – Co ets – Disper n electrical	d solid le to sub a ing, ma ysical phe ials. Prin ure mater ing mecha material Strengths gainst dis - Glasses ls – Class ontinuous rsion stren	solution and graf artensit enomer ciple for ials.Tw anism of s, fibe at Hig slocation - Glas dification fibers ngthene		
	Mechanism and micro in metals and alloy strengthening, Resista boundaries, precipit strengthening, grain si that contribute toward designing high streng Phase hardening, Solu amorphus materials, reinforcement, Four si Temperature, Strengt creep, Strengthening a [20 hours] CERAMIC AND CO Advanced Ceramic M Ceramics – Functiona of composites - Fibe discontinuous fibers – materials – Laminat components – nuclear	omechanism of s s, Strengthenin nce to dislocatio ation strength ze strengthening ls high mechani gth materials wittion hardening, Polymer, centage of deformation hening against against high rate OMPOSITE MA laterials - Crysta il properties and r reinforced mation Particle-reinfor es - Applicatio industry.	strengthening and dison induced nening, d g, order har cal strengt ill be addr Order stre ramic, gla tion, tensile diffusion to of deformation al Structure l application terials – I rced materi on of con	slocation s flow, Stren lispersion rdening, du h in engine ressed, Hig engthening. ass and o e strength, flow, Stren ation. S: es - Silicato ons of ceran Law of min als – Cerm nposites in	structure an agthening du strengthen al phase. Ph eering mater h temperatu Strengthening composites Anisotropy. agthening ag e Ceramics mic material stures – Co ets – Disper n electrical [10 hours]	nd solid ne to sub a ing, ma ysical pho- ials. Prin ure mater ing mecha material Strengths gainst dis - Glasses ls – Class ontinuous rsion stren and me	solutio and grai artensiti enomen ciple fo ials.Tw anism o s, fibe at Hig slocatio fibers ificatio fibers agthene		
	Mechanism and micro in metals and alloy strengthening, Resista boundaries, precipit strengthening, grain si that contribute toward designing high streng Phase hardening, Solu amorphus materials, reinforcement, Four si Temperature, Strengt creep, Strengthening a [20 hours] CERAMIC AND CO Advanced Ceramic M Ceramics – Functiona of composites - Fibe discontinuous fibers – materials – Laminat components – nuclear	 bmechanism of s s, Strengthening nce to dislocation ation strength ze strengthening ls high mechaning gh materials with the materials with t	strengthening and dison induced nening, d g, order har cal strengtl ill be addr Order stre ramic, gla tion, tensile diffusion to of deforma ATERIALS al Structured application terials – I reced materi on of com	slocation s flow, Stren lispersion rdening, du h in engine ressed, Hig engthening. ass and o e strength, flow, Stren ation. S: es - Silicato as of ceran Law of min als – Cerm nposites in	structure an agthening du strengthen al phase. Ph eering mater h temperatu Strengthenic composites Anisotropy. agthening ag e Ceramics mic material xtures – Co ets – Disper h electrical [10 hours] ation – Sor	nd solid ne to sub a ing, ma ysical phe ials. Prin ure mater ing mecha material Strengths gainst dis - Glasses ls – Class ontinuous rsion stren and me	solutio and grai artensiti enomen ciple fo ials.Tw anism o s, fibe at Hig slocatio – Glas dification fibers ngthene echanica		
	Mechanism and micro in metals and alloy strengthening, Resista boundaries, precipit strengthening, grain si that contribute toward designing high streng Phase hardening, Solu amorphus materials, reinforcement, Four si Temperature, Strengt creep, Strengthening a [20 hours] CERAMIC AND CO Advanced Ceramic M Ceramics – Functiona of composites - Fibe discontinuous fibers – materials – Laminat components – nuclear POLYMER MATER Classification of pol important individual p	omechanism of s s, Strengthenin nce to dislocatio ation strength ze strengthening ls high mechani gth materials wit ition hardening, Polymer, cent tage of deformat hening against gainst high rate OMPOSITE MA laterials - Crysta d properties and r reinforced mat Particle-reinfor es - Applicatio industry. RIALS: ymer – Mechan polymer – Therm	strengthening and dison induced nening, d g, order har cal strengti ill be addr Order stre ramic, gla tion, tensile diffusion to of deformator ATERIALS al Structure l application terials – I reed materi on of com	slocation s flow, Stren lispersion rdening, du h in engine ressed, Hig engthening. ass and o e strength, flow, Stren ation. S: es - Silicato ons of ceran Law of min als – Cerm nposites in polymeris Elastomer	structure an agthening du strengthen al phase. Ph eering mater h temperatu Strengthening composites Anisotropy. agthening ag e Ceramics mic material stures – Co ets – Disper h electrical [10 hours] ation – Son s – Thermos	nd solid ne to sub a ing, ma ysical pho- ials. Prin ure mater ing mecha material Strengths gainst dis - Glasses ls – Class ontinuous rsion stren and me me comm sets – Eng	solutio and grain artensiti enomera- ciple fo- ials.Two anism of s, fibe- slocation at Hig slocation fibers ngthene echanics nerciall gineerin		
	Mechanism and micro in metals and alloy strengthening, Resista boundaries, precipit strengthening, grain si that contribute toward designing high streng Phase hardening, Solu amorphus materials, reinforcement, Four si Temperature, Strengt creep, Strengthening a [20 hours] CERAMIC AND CO Advanced Ceramic M Ceramics – Functiona of composites - Fibe discontinuous fibers – materials – Laminat components – nuclear POLYMER MATER Classification of pol	omechanism of s s, Strengthenin nce to dislocatio ation strength ze strengthening ls high mechani gth materials within hardening, Polymer, centage of deformation hening against against high rate OMPOSITE MA laterials - Crystal l properties and r reinforced materials - Crystal l properties and r reinforced materials Particle-reinforties - Application industry. RIALS: ymer – Mechatoolymer – Thermital polymers - O	strengthening and dison induced nening, d g, order har cal strengt ill be addr Order stre ramic, gla tion, tensile diffusion to of deforma ATERIALS al Structured application terials – I reced materi on of com anisms of noplastics - Conductive	slocation s flow, Stren lispersion rdening, du h in engine ressed, Hig engthening. ass and o e strength, flow, Stren ation. S: es - Silicato ons of ceran Law of min als – Cerm nposites in polymeris Elastomer	structure an agthening du strengthen al phase. Ph eering mater h temperatu Strengthening composites Anisotropy. agthening ag e Ceramics mic material stures – Co ets – Dispen n electrical [10 hours] ation - Son s – Thermos – High Per	nd solid ne to sub a ing, ma ysical pho- ials. Prin ure mater ing mecha material Strengths gainst dis - Glasses ls – Class ontinuous rsion stren and me me comm sets – Eng	solutio and grain artensiti enomera- ciple fo- ials.Two anism of s, fibe- slocation at Hig slocation fibers ngthene echanics nerciall gineerin		

Text Books,	Text Books:
and/or	1. William D. Callister, Jr., Materials Science and Engineering an Introduction, 6th
reference	Edition, John Wiley & Sons, Inc., 2004.
material	2. Structure of Metals, 3rd revised edition, C. S. Barrett, T. B. Massalski, Pergamon
	press Oxford, 1981.
	3. George Dieter, Mechanical Metallurgy, McGraw-Hill, 3rd Edition
	Deferrer of Declary
	Reference Books:
	1. William F.Smith, Structural Properties of Engineering Alloys, Tata Mc-Graw-Hill,
	Inc., 1993.
	2. Kingery. W.D., Bowen H.K. and Uhlmann D.R., Introduction to Ceramics, 2nd
	Edition, John Wiley & Sons, New York, 1976.

	PO1	PO2	PO3	PO4
C01		\checkmark		-
CO2	\checkmark	\checkmark	\checkmark	-
CO3	\checkmark			\checkmark

	Department	t of Metallurgica	l and Mate	rials Engin	eering				
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Nu Lecture (L)	umber of co Tutorial (T)	Practical (P)	Total Hours	Credit		
MT9046	Environmental Degradation of Materials	PEL	3	0	0	3	3		
Pre-requisi	tes	Course Asses assessment (EA		ethods (C	Continuous	(CT) an	nd end		
Nil		CT+EA							
Outcomes	CO1: To study the CO2: To study the CO3: To obtain principles used in c Fault tree diagram	causes of failure detailed unders ombating degrad	analysis of tanding o ation of ma	f materials f current aterials in s	methods a pecific envi	ronment			
Text	leakage , welding ofFailureanalysis s Study of cement str Introduction to I kinetics, oxide de of binary and ter prevention of high Study of corrosion Chemical degrada during transit [3h Corrosion of Com Nature Prevention Paints and detailed Corrosion Control: Study of Delhi Iron	such s automotive ructures and RCC high temperatur fect structures, c rnary alloys, Co temperature cor of ofweldjoints. [tion of non-met aposite Materials [3h] analysis for corre	e compone C structures e corrosio atastrophic onsideration rosion-used 2h] allic mater : Galvanic osion comb	nt, railway and their f on, Pilling- coxidation ns in high of coatings rials like c c Effects M oat [2h] ethods [3h]	bridge. [10 ailures Bedworth , internal or temperatu [10h eramics, tin latrix Natur	(5h) [5h] ratio, ox xidation. re alloy] nbers. Co	idation Scaling design, rrosion		
Books, and/or reference material	 Principles and Prevention of Corrosion (2nd Edition) By Denny A. Jones Prentice Hall, 1995. Environmental Degradation of Materials, R Balasubramaniam, Cengage International, 2010. Corrosion and Corrosion Control, H.H. Uhlig and W. Revie, Wiley, New York, 2007. Corrosion Science and Technology, By David Talbot, James Talbot, CRC Press, 1998. 								

 6. Corrosion Basics: An Introduction By Pierre R. Roberge, 2nd Edition, NAC Press Book, 2006. 	 Corrosion Engineering By Mars. G. Fontana, Third ed., TMI Corrosion Basics: An Introduction By Pierre R. Roberge, 2nd Press Book 2006 	
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	PO1	PO2	PO3	PO4
CO1	\checkmark	\checkmark	\checkmark	-
CO2	\checkmark	\checkmark	\checkmark	-
CO3	\checkmark	-	\checkmark	\checkmark

Code (PCR) / Electives (PEL) Lecture (L) Tutorial (T) Practical (P) Total Hours MT9047 Advanced Casting and Solidification PEL 3 0 0 3 3 Pre-requisites Course Assessment methods (Continuous (CT) and end assessment (EA)) OT+EA CO1: To understand the Fundamentals of solidification of metals. Outcomes CO1: To understand the Fundamentals of solidification of metals. CO2: To understand the basic meachanism and difficulties of different metal castin process CO3: To identify the major challenges encountered in metal casting and solification industrial production of a components Introduction of conventional casting: Introduction of casting, Design of Casting: Factors to be considered in casting design Conventional casting process of Cast iron, Steel and non-ferrous alloys. [4 hours Solidification of Casting: Concept of solidification of pure metals and alloys. Eutectic solidification, Eutectic alloys Peritectic solidification, Solidification of ingots and casting, Mechanism of columnan dendritic growth and freezing in alloys. Freezing in Ingots. The evolution of solidification microstructure, grain structure, segregation, inclusions, gas porosity, Inverse segregatio and homogenisation in casting, Solidification time and Chvorinov's rule. Concept o progressive and directional solidifications. Principle of solidification processing [15 hours] Special Casting: Special Casting:	Course	Title of the course	ent of Metallurgica Program Core		mber of cont			Credit		
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Text Books, and/or reference material	 Text Books: 1. Phase Transformations in Metals and Alloys, D.A Porter, K.E Easterling and M.F Sherif 2. Foundry Technology, P.R. Beelely, Butterworth, 1972. 3. Principle of Metal Casting - Heine, et. al - Tata-McGraw-Hill Publication - 2003.
	REFERENCE BOOKS: 1. Casting technology and cast alloys, <u>A. K. Chakrabarti</u> , PHI Learning Pvt. Ltd., 2005 2. A Test Book of FoundryTechnology, M. Lal and O.P. Khanna, Dhanpat Rai Publication.
	Department of Metallurgical & Materials Engineering

	PO1	PO2	PO3	PO4
CO1				-
CO2				-
CO3				

Course	Title of the course	Program Core	Total Number of contact hours				Credit		
Code		(PCR) / Electives (PEL)	Lecture (L)	Tutorial (T)	Practical (P)	Total Hours			
MT 9048	Physical and Finite Difference Based Modelling Approaches in Metallurgy	PEL	3	0	0	3	3		
Pre-requisit	0.	Course Assessme	nt methods	(Continuous	(CT) and end	d assessme	1 nt (EA))		
Transport F		CT+EA	int methous	(continuous			(Ei I))		
Course Outcomes	CO1: To learn fundam CO2: To identify natu	CO1:To learn fundamentals of Modelling. CO2: To identify nature of engineering problems and solving by numerical methods. CO3:To build physical and mathematical models to describe the complex physical phenomena							
Topics Covered	Basic principles of p analysis, physical m Classification of Par Equations, Initial and concept of discretization Introduction to finite uniform Grid, Central of solution, method of Methods of solving s systems. One Dimensional S Diffusive-convective (4) Multidimensional par Direction Implicit (Al Method, MATLAB C Elliptic Steady-State Elliptic Two-Dimens Conduction equat (6) Nonlinear Diffusion: Scheme, Linearization Simultaneous Condu Newton-Raphson M (6) Phase Change Problet Step Approach for S solidification, (5) Application related to	ohysical and mathe nodelling of iron tial Differential E Boundary Condition on process, method, difference method, l Difference Express of Choosing Optimur sets of Algebraic ex Steady-state system arabolic Systems: S DI) method, Alterna ode. diffusion, Elliptic sional Flow, Hype tion, System Lagging properties on, Method of F action and Radiati ethod for solving erms: Mathematical Single-Phase solidi	making an Equations (ons, initial mesh and c Central, Fo sion for a n n step Size. quations: I ns: Diffusi with imple Expl tive Directi Velocity H rbolic Con of Ve s by One T False Trans ion in par Nonlinear Formulation fication, V	nd steel m PDEs), Elli Value and F ells/elements orward and F ion-uniform (4) Direct method ion Explicit (Field for Ind vection (Wa ector Eq Fime Step, U sients for se rticipating F r system of n of Phase C ariable Time	aking proces ptic, Parabol Boundary values Back differen grid, Numeric ods, Iterative , Diffusive-C MAT , Combined , Combined (ADE) metho compressible, ave) equation uations, I Use of Three- solving Stea Media-Diffusion f equations, Change Probl	sses. lic and H ue problen (2 ce express cal Errors, Methods, Convective TLAB Method, A d, Modifie Constant n, Hyperb MATLAB -Time leve dy-State ion Appro MATLA ems, Varia	(5 (yperboli ns , Basi) ions for Accuracy Nonlinea (4) System Code (4) Property olic Hea code (1 Implic) Diffusior eximatior B Code		
Text Books, and/or reference material	Text Books: 1. Finite difference M 2.Computational Flu 3.The Mathematical Szekely, J.W. Evans Reference Books:	id dynamics and h and Physical Mod and J.K. Brimaco	eat transfe elling of P mbe	r – P.S. Gh rimary Meta	als Processin				
	1. Getting Started wi	th MATLAB 7: A	Quick Int	roduction fo	or Scientists	and Engin	eers- R.		
						Page 57 c	of 72		

Pratap.

2. Numerical Methods for Engineers - D. Vaughan Griffiths and .I.M. Smith

	CO1	CO2	CO3
PO1	\checkmark	\checkmark	\checkmark
PO2	\checkmark	\checkmark	\checkmark
PO3	-	\checkmark	\checkmark
PO4	-	-	\checkmark

	Departmen	t of Metallurgica	and Mate	erials Engir	neering					
Course	Title of the	Program			ntact hours		Credit			
Code	course	Core (PCR) /	Lecture	Tutorial	Practical	Total				
		Electives	(L)	(T)	(P)	Hours				
		(PEL)								
MT-9049	Plasma	PEL	3	0	0	3	3			
	technology for									
	metallurgical									
	applications									
Pre-requisi	tes	Course Assess	ment meth	ods (Conti	nuous (CT)	and end				
		assessment (E	A))							
MT-2002:		CT+EA								
Advances i Metallurgy										
Course	CO1: Ability to un	derstand the con	cepts of pl	lasma techr	ology					
Outcomes	CO2: Ability to le					S				
	CO3: Ability to an						plication			
	of plasma in surfac					1	L			
Topics	Introduction: His						[1h]			
Covered		1				are charac				
	Fundamentals: Plasma metallurgy-Basic principles, types of arcs, arc characteristics [4h]									
	Plasma Generation: Electrical and mechanical components, types of plasma									
	torches, comparison of AC and DC plasma, evaluation of plasma techniques as									
	compared to conventional in the light of energy, environment and economy. [10h]									
	Applications:									
		smasmelt plasm	ared plasr	nacan Elre	d Sustained	l Shockw	ave			
	Iron Making : Plasmasmelt, plasmared, plasmacan, Elred, Sustained Shockwa Plasma(SSP)									
	Steel making: Inn	netco process SI	VF nlasma	dust proce	ee		[6h] [5h]			
	Steel melting and	-	-	-						
	U	•		-	U U					
	Induction Furnace,	0		0	. ,		[6h]			
	Ferro-Alloy Tech	nology: Carbo-ti	nermic sm	elting reduc	ction (Fe-C					
	Fe-V).						[6h]			
	Plasma Arc Reme						[2h]			
	Plasma in Nonfer	rous Metals: Pr	ocessing o	f sulphideo	ores(Mo and	,				
	ore(Ti)					[4h]			
	Plasma Technology in Ceramic Material Coating.						4h]			
	Assessment, Development and Future Prospects.									
Text	Textbooks:									
Books,	1. V Dembovsky: Plasma Metallurgy -The Principle (Elsevier)									
and/or	2. Jerome Feiman:	Plasma technolo	ogy in Met	allurgical F	Processing; 1	Iron & Ste	eel			
reference material	Society, USA				_					
	Reference books:									
	iterer ence books.									

2.FP Edernal, Electro metallurgy of Ferro alloy, 01, MIR Publication 1979

	PO1	PO2	PO3	PO4
CO1		-	\checkmark	-
CO2		-	\checkmark	-
CO3	-	-	-	

	Depart	ment of Metallurgic	al & Materi	ials Enginee	ring				
Course	Title of the course	U	Total Nu	mber of con	tact hours		Credit		
Code		Core (PCR) /	Lecture	Tutorial	Practical	Total			
		Electives (PEL)	(L)	(T)	(P)	Hours			
MT 9050	Technology of	PEL	3	0	0	3	3		
	Advanced								
	Materials								
Pre-requisit	tes	Course Assessmen (EA))	nt methods ((Continuous	(CT) and end	d assessme	ent		
NIL		CT+EA							
Course	CO1: To understa	nd the Fundamen	tals of mat	erials desig	gn for advan	ced appli	cations.		
Outcomes	CO2: To underst	and the principles,	theory and	d mechanis	ms of differe	ent kind o	of		
	advanced metaria	l processing techn	iques.						
	CO3: To learn se	cience and technol	ogical aspo	ects of the	advanced ma	aterials			
Topics	Introduction:								
Covered	Introduction of			mportance		nced M	aterials.		
		Engineering mater	ials, advan	ced Metals	[2 hours]				
	Advanced Metal								
		Metals, advanced			0 0		, , ,		
	Types of AHSS, Strengthening mechanism of AHSS steels, Processing, structure and								
	properties of Dual phase (DP), High strength low alloy (HSLA), Back Hardening								
	(BH), Complexphase (CP), Transformation Induced Plasticity (TRIP) and Twin Induced plasticity (TWIP) and quenched and tempered (Q&P) steels. [8]								
	·	(TWIP) and quer	iched and f	tempered (Q&P) steels.		[8		
	hours]								
	High temperatur		ad avera	llow The		lova Dre	aaaina		
		atures, Nickel bas	-		-	•			
	-	s, Al-Li alloy, Rap					pounds		
	[6	hours]		1	C	•			
	Ultra Light Mat	erials and Metalli	c Foams:						
	Material Definit	ion and Proces	sing, Clas	ssification	of making	g metal	foams		
	Material Definition and Processing, Classification of making metal foams, Characterisation of cellular Metals, Materials Properties and application.								
	[4 hours]								
	Smart Materials:								
		smart structure, C				, Introdu	ction to		
		tors, Piezo-electric	es, shape m	nemory allo	oys				
	[4 hours]								
	Bio-Materials								
	1	r biomaterials, C			materials, I	Dental M	aterials		
	Materials for replacement of joints and surgical								
	[4 hours]								
	Advanced Ceran		· D			F 4 -			
		n, Structure of cera	_	-	Application	s. [4	hours]		
		perature Ceramic		-	anotara Ca	mic C-	nonit-		
		B_2 and HfB_2 base					iposites		
	-	anical behaviour a	na oxidatio	on resistant	te [4 nours]	I			
	Bulk Metallic Gl		lac and ma	chanical b	haviour [/	1 hours]			
	Nano-materials:	formation, Examp	ies and me		mavi0uf. [²	+ noursj			
	rvano-materiais:								

	Classification, Processing and properties of nanocrystalline materials, Nanofluids.[4 hours]Advanced Processes applied for Advanced Materials:Rapid Solidification, Sputtering, Physical and Chemical Vapor Deposition. [4 hours]Intermetallics:Structure, processing, properties and application[4 hours]
Text Books, and/or reference material	 Text Books: (1) Materials Science and Engineering- An Introduction W. D. Callister, John Wiley & Sons Inc 1985 New York. (2) W. O. Soboyejo and T. S. Srivastan (ed.), Advanced Structural Materials: Properties, Design, Optimization and Applications, CRC Press, New York (2007). (3) G.W. Meetham and M.H. Van de Voorde, Materials for High Temperature Engineering Applications, Springer, Berlin (2000).
	 Reference books: (1) D. Vollath, Nanomaterials: Synthesis, Properties and Application, WILEY_VCH, Germany (2008). (2) Lecture Notes and Published Papers (3) Introduction to Ceramics - Kingery, Bowen and Uhlmann 2. ASM Handbook Volume 21: Composites

	PO1	PO2	PO3	PO4
CO1				-
CO2		\checkmark		-
CO3	\checkmark	\checkmark		

Course	Title of the course	rtment of Metallur Program Core	-	mber of cont	-		Credit		
Code		(PCR) /	Lecture	Tutorial	Practical	Total	-		
		Electives (PEL)	(L)	(T)	(P)	Hours			
MT 9051	Severe Plastic	PEL	3	0	0	3	3		
	Deformation								
Pre-requisit	tes	Course Assessm	nent method	s (Continuou	us (CT) and e	nd assessr	ment (EA))		
NIL		CT+EA							
Course	CO1: To understand	the Fundamenta	ls of Sever	e Plastic De	eformation.				
Outcomes	CO2: To understand					ostructure	ed bulk metal		
	production processes		· · · ·		,				
	CO3: To identify th		es encounte	ered in seve	ere plastic de	eformatio	n (SPD)		
	is the industrial prod	• •			-				
Topics	The ultrafine-graine								
Covered	Condensation, Spra								
	methods: High-Ener								
	Deformation Method	ds.	·	-	(4	4 hours)			
	Fundamentals of S	evere PlasticDe	formation:	History: T	he Ancient	Age,The	Scientific Ag		
	and The Microstrue	ctural Age, Bas	ic Principl	les of Sev	ere Plastic	Deforma	tion Method		
	Difference between	and The Microstructural Age, Basic Principles of Severe Plastic Deformation Methods, Difference between Severe Plastic Deformation and Conventional Metal-Forming Processes,							
	Grain Refinement Mechanisms under Severe Plastic Deformation conditions: Face-Centered								
	Cubic (FCC) Metals an Hexagonal Close-Packed (HCP) Metals. (4 hours)								
	Severe Plastic Deformation Methods for Bulk Samples: High-Pressure Torsion, Equal-								
		Channel Angular Pressing, Dual Equal Channel Lateral Extrusion, Channel Angular Pressing							
	W/1 0 ' D'	11							
	With ConvergingBi	-		-	-	sion Extr	-		
	Direct Extrusion,	Accumulated Ex	trusion, Pu	ure Shear I	Extrusion, H	sion Extr Equal Cha	annel Forwa		
	Direct Extrusion, Extrusion, C-Shape	Accumulated Ex Equal Channel R	trusion, Pu eciprocatin	ure Shear Ing Extrusion	Extrusion, I n, Twist Ext	sion Extr Equal Cha trusion, N	annel Forwa Iultidirection		
	Direct Extrusion, Extrusion, C-Shape Forging, Multiaxial	Accumulated Ex Equal Channel R I Incremental F	trusion, Pu eciprocatin orging Ar	ure Shear I ng Extrusion nd Shearin	Extrusion, H n, Twist Ext g, Repetitiv	sion Extr Equal Cha trusion, M ve Forgin	annel Forwa Iultidirection ng, Repetitiv		
	Direct Extrusion, Extrusion, C-Shape Forging, Multiaxial Upsetting, Cylinder	Accumulated Ex Equal Channel R Incremental F Covered Comp	trusion, Pu eciprocatin orging An pression, I	ure Shear I ng Extrusion nd Shearin Repetitive	Extrusion, H n, Twist Ext g, Repetitiv Upsetting	sion Extr Equal Cha trusion, M ve Forgin And Ext	annel Forwa Iultidirection ng, Repetitiv rusion, Cycl		
	Direct Extrusion, Extrusion, C-Shape Forging, Multiaxial Upsetting, Cylinder ExtrusionCompressi	Accumulated Ex Equal Channel R Incremental F Covered Comp on, Cyclic Expa	trusion, Pu eciprocatin orging An pression, I ansionExtru	are Shear I ng Extrusion nd Shearin Repetitive asion, Acc	Extrusion, H n, Twist Ext g, Repetitiv Upsetting umulative H	sion Extr Equal Cha trusion, M ve Forgin And Ext Back Ext	annel Forwa Iultidirection ng, Repetitiv rusion, Cycl rusion, Cycl		
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	M. TECH. IN METALLURGY AND MATERIALS TECHNOLOGY
	W. TECH. IN METALEOROT AND MATERIALS TECHNOLOGY
	Severe Torsion Straining, Integrating Forward Extrusion And Torsion Deformation, Kobo Process, Cryo-Rolling. (6 hours) Effective Parameters For The Success of Severe Plastic Deformation Methods:Grain Size, Equivalent Plastic Strain And Hydrostatic Stress, Dislocations And Disclinations, Grain Boundaries, Multiphase Materials, Texture. (4 hours) Mechanical Properties of Ultrafine-Grained and Nanostructured Metals:Superior Strength And Ductility, Mechanical Anisotropy, Young's Modulus, Fracture Toughness, Hardness, Fatigue Properties, Wear Resistance. (4 hours) Physical, Chemical, and Functional Properties of UFG and NS Metals:Electrical Conductivity, Thermal Conductivity,Thermal Stability, Thermoelectricity, Hydrogen Storage Capability, Magnetic Properties, Corrosion, Biocorrosion, Biocompatibility, Cryogenic Properties. (4 hours) Applications of Ultrafine-Grained and Nanograined Metals:Biomedical, Structural Examples, Hydrogen Storage Capacity Of NanostructuredMg Alloys, Sputtering Targets for The Service Instructure Space Parametering Properties Prop
	The SemiconductorIndustry,Superplastic Properties, Military Applications, Sport, Microforming, Nanostructured Magnets, Anostructured Al And Cu Alloys With High Conductivity and Strength, UFG Metals for Semisolid Forming. (5 hours)
Text	Text Books:
Books, and/or reference material	 Severe Plastic Deformation Technology-ARosochowski, Whittles Publishing, 2017. Severe Plastic Deformation: Methods, Processing and Properties- GhaderFaraji, H.S. Kim, and HessamTorabzadehKashi, Elsevier, 2018. Severe Plastic Deformation: Toward Bulk Production of Nanostructured Materials-BurhanettinAltan, Nova Science Publishers, Inc., New York, 2006.
	Reference Books:
	 Investigations and Applications of Severe Plastic Deformation-Terry C. LoweandRuslan Z. Valiev, Springer, 2000.

	PO1	PO2	PO3	PO4
C01		\checkmark		-
CO2		\checkmark		-
CO3		\checkmark		

Course	Departmen	nt of Metallurgica	al & Materi	als Engine	ering		
	Title of the course	Program	Total Nu	mber of co	ntact hours		Credit
Code		Core (PCR) /	Lecture	Tutorial	Practical	Total	
		Electives	(L)	(T)	(P)	Hours	
		(PEL)					
MT 9052	Finite Element	PEL	3	0	0	3	3
	Method for						
	Metallurgy and						
Materials							
Pre-requisi	tes	Course Assess assessment (EA		ods (Contin	uous (CT) ai	nd end	
NIL		CT + EA	//				
Course	CO1: To understand	the concept of F	inite Eleme	ent Method	(FEM).		
Outcomes	CO2 : To recognize	1			· ,	ering wor	·ld.
	CO3: To solve the ch	-				0	
Topics	Introduction: Math						-
Covered	work? Main ideas o						
	with Analytical Solu	tions.					
							(3
	hours)						
	The Weak Formula						
	Method Procedure, V						-
	Theorems, Integr	ation by	Parts, W	Veak Fo	rmulations,	Exerci	ses .
	(5 hours)		_				
	Linear Interpolation				-	0	
	Interpolation, Weigh						
	One-Dimensional A						
	-	Interpolation Fu					
	Coordinate Systems	Used in Deriva			ions, Isopara	imetric E	
	Exercises.						lements,
	Derivation of Fler	· · · · · · · · · · · · · · · · · · ·		(8 hours)	4 f. 41		
		nent Matrices,	Assembly	and Solu		Finite I	Element
	Equation: Derivat	ion of Element	Assembly Matrix for	and Solu r One-Dim	ensional Pro	Finite I blems U	E lement sing the
	Equation: Derivat Galerkin Method, A	ion of Element Assembly and S	Assembly Matrix for olution, D	and Solu r One-Dim perivation of	ensional Pro of Element	Finite l blems U Matrix fo	Element sing the or Two-
	Equation: Derivat Galerkin Method, A Dimensional Proble	ion of Element Assembly and S ms Using the G	Assembly Matrix for olution, D alerkin Me	and Solu r One-Dim perivation of ethod, Deriv	ensional Pro of Element vation of El	Finite I bblems U Matrix fo ement Ma	Element sing the or Two- atrix for
	Equation: Derivat Galerkin Method, A Dimensional Proble Three-Dimensional	ion of Element Assembly and S ms Using the G Problems Usin	Assembly Matrix for olution, D alerkin Me g the Ga	and Solu r One-Dim perivation of thod, Deriv lerkin Me	ensional Pro of Element vation of El thod, Tra	Finite I blems U Matrix fo ement Ma nsient Pr	Element sing the or Two- atrix for oblems,
	Equation: Derivat Galerkin Method, A Dimensional Proble Three-Dimensional Derivation of Matr	ion of Element Assembly and S ms Using the G Problems Usin ix Equations for	Assembly Matrix for olution, D alerkin Me g the Ga or Axisym	and Solu r One-Dim perivation of thod, Deri- lerkin Me metric Pro	ensional Pro of Element vation of El thod, Tra blems, sam	Finite l bblems U Matrix fo ement Ma nsient Pr ple Solut	Element sing the or Two- atrix for roblems, ions on
	Equation: Derivation Galerkin Method, A Dimensional Proble Three-Dimensional Derivation of Matri Elements Matrix Co	ion of Element Assembly and S ms Using the G Problems Usin ix Equations for mputation, Asse	Assembly Matrix for olution, D alerkin Me g the Ga or Axisymm mbly and S	and Solu r One-Dim perivation of thod, Deri- lerkin Me metric Pro Solution, O	ensional Pro of Element vation of El thod, Tra blems, sam ne-Dimensio	Finite l bblems U Matrix fo ement Ma nsient Pr ple Solut onal Fourt	Element sing the or Two- atrix for oblems, ions on h Order
	Equation: Derivation Galerkin Method, A Dimensional Proble Three-Dimensional Derivation of Matri Elements Matrix Co Differential Equation	ion of Element Assembly and S ms Using the G Problems Usin ix Equations for mputation, Asse n, The Use of	Assembly Matrix for olution, D alerkin Me g the Ga or Axisymm mbly and S	and Solu r One-Dim perivation of thod, Deri- lerkin Me metric Pro Solution, O	ensional Pro of Element vation of El thod, Tra blems, sam ne-Dimensio stems in De	Finite I bblems U Matrix fo ement Ma nsient Pr ple Solut onal Fourt rivation o	Element sing the or Two- atrix for oblems, ions on h Order
	Equation: Derivation Galerkin Method, A Dimensional Proble Three-Dimensional Derivation of Matri Elements Matrix Co Differential Equation Element Equation, E	ion of Element Assembly and S ms Using the G Problems Usin ix Equations for mputation, Asse n, The Use of xercises.	Assembly Matrix for olution, D alerkin Me g the Ga or Axisymmetry mbly and S Other Coo	and Solu r One-Dim perivation of thod, Deri- lerkin Me metric Pro Solution, O ordinate System	ensional Pro of Element vation of El thod, Tra blems, sam ne-Dimensio stems in De (12 hours)	Finite 1 bblems U Matrix for ement Mansient Pr ple Solut onal Fourt rivation o	Element sing the or Two- atrix for roblems, ions on th Order of Finite
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	Equation: Derivation Galerkin Method, A Dimensional Proble Three-Dimensional Derivation of Matri Elements Matrix Co Differential Equation Element Equation, E Steps of Finite Elem Drawing the Problem	ion of Element Assembly and S ms Using the G Problems Usin ix Equations for mputation, Asse n, The Use of xercises. nent Modeling u n Geometry, Spe	Assembly Matrix for olution, D alerkin Me g the Ga or Axisymm mbly and S Other Coo using MAT cifying the	and Solu r One-Dim perivation of thod, Derivation, Me metric Pro Solution, O ordinate System LAB: Spe PDE, Spe	ensional Pro of Element vation of El thod, Tra blems, sam ne-Dimensio stems in De (12 hours) ecifying the cifying Bou	Finite I bblems U Matrix for ement Mansient Pr ple Solut onal Fourt rivation of Application ndary Con	Element sing the or Two- atrix for roblems, ions on th Order of Finite on Type, aditions,
	Equation: Derivation Galerkin Method, A Dimensional Proble Three-Dimensional Derivation of Matri Elements Matrix Co Differential Equation Element Equation, E Steps of Finite Eler Drawing the Problem Meshing the Domain	ion of Element Assembly and S ms Using the G Problems Usin ix Equations for mputation, Asse n, The Use of xercises. nent Modeling u n Geometry, Spe n and Mesh Refin	Assembly Matrix for olution, D alerkin Me g the Ga or Axisymmetry mbly and S Other Coor using MAT cifying the nement, Sp	and Solu r One-Dim perivation of thod, Deri- lerkin Me metric Pro Solution, O ordinate System LAB: Spe PDE, Spe pecifying In	ensional Pro of Element vation of El thod, Tra blems, sam ne-Dimensio stems in De (12 hours) ecifying the ccifying Bou nitial Condit	Finite 1 bblems U Matrix for ement Ma nsient Pr ple Solut onal Fourt rivation of Application ndary Con ions for T	Element sing the or Two- atrix for roblems, ions on h Order of Finite on Type, nditions, ransient
	Equation: Derivat Galerkin Method, A Dimensional Proble Three-Dimensional Derivation of Matr Elements Matrix Co Differential Equatio Element Equation, E Steps of Finite Eler Drawing the Probler Meshing the Domain Problems, Solving t	ion of Element Assembly and S ms Using the G Problems Usin ix Equations for mputation, Asse n, The Use of xercises. nent Modeling u n Geometry, Spen and Mesh Refin he PDE, Extracti	Assembly Matrix for olution, D alerkin Me g the Ga or Axisymm mbly and S Other Coon using MAT cifying the nement, Sp ng Values	and Solu r One-Dim perivation of thod, Derivation, Of lerkin Me metric Pro Solution, Of ordinate System LAB: Spe PDE, Spe pecifying In from Plots,	ensional Pro of Element vation of El thod, Tra blems, sam ne-Dimensio stems in De (12 hours) ecifying the ccifying Bou nitial Condit Exercises.	Finite 1 bblems U Matrix for ement Mansient Prople Solut ple Solut onal Fourt rivation of Application ndary Con ions for T (5 hou	Element sing the or Two- atrix for roblems, ions on th Order of Finite on Type, additions, transient urs)
	Equation: Derivation Galerkin Method, A Dimensional Proble Three-Dimensional Derivation of Matri Elements Matrix Co Differential Equation Element Equation, E Steps of Finite Element Drawing the Problem Meshing the Domain Problems, Solving the Appliaction of Ho	ion of Element Assembly and S ms Using the G Problems Usin ix Equations for mputation, Asse n, The Use of xercises. nent Modeling u n Geometry, Spe n and Mesh Refin he PDE, Extracti eat Transfer P	Assembly Matrix for olution, D alerkin Me g the Ga or Axisymm mbly and S Other Coon using MAT cifying the nement, Sp ng Values for roblems:	and Solu r One-Dim perivation of thod, Derivation, Of the perivation, Of Solution, Of ordinate System LAB: Spee PDE, Spee pecifying In from Plots, Steady-Sta	ensional Pro of Element vation of El thod, Tra blems, sam ne-Dimensio stems in De (12 hours) ecifying the cifying Bou nitial Condit Exercises. te Heat Tr	Finite I bblems U Matrix for ement Ma nsient Pr ple Solut onal Fourt rivation of Application ndary Con ions for T (5 hou ansfer, T	Element sing the or Two- atrix for roblems, ions on th Order of Finite on Type, nditions, fransient urs) fransient
	Equation: Derivation Galerkin Method, A Dimensional Proble Three-Dimensional Derivation of Matri Elements Matrix Co Differential Equation Element Equation, E Steps of Finite Eler Drawing the Problem Meshing the Domain Problems, Solving the Problems (Heating	ion of Element Assembly and S ms Using the G Problems Usin ix Equations for mputation, Asse n, The Use of xercises. nent Modeling u n Geometry, Spe n and Mesh Refin he PDE, Extracti eat Transfer P	Assembly Matrix for olution, D alerkin Me g the Ga or Axisymm mbly and S Other Coon using MAT cifying the nement, Sp ng Values for roblems:	and Solu r One-Dim perivation of thod, Derivation, Of the perivation, Of Solution, Of ordinate System LAB: Spee PDE, Spee pecifying In from Plots, Steady-Sta	ensional Pro of Element vation of El thod, Tra blems, sam ne-Dimensio stems in De (12 hours) ecifying the cifying Bou nitial Condit Exercises. te Heat Tr	Finite I bblems U Matrix for ement Ma nsient Pr ple Solut onal Fourt rivation of Application ndary Con ions for T (5 hou ansfer, T	Element sing the or Two- atrix for roblems, ions on th Order of Finite on Type, nditions, transient trs)
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	Computational Micromechanics, Alternative Finite elements models, Nonlinear						
	problems, errors in finite element analysis.						
	(8 hours)						
Text	Text Books:						
Books,	1. An Introduction to the Finite Element Method- J. N. Reddy, Mcgraw Hill Series in						
and/or	Mechanical Engineering, 2005.						
reference							
material	2. The Finite Element method Basic Concepts and Applications- D. W. Pepper and J. C.						
material	Heinrich, CRC Press, 2013						
	3.Textbook of Finite Element Analysis- P. Seshu, PHI, 2016.						
	Reference Books:						
	1. The Finite Element Method for Engineers -Kenneth H. Huebner, Donald L.						
	Dewhirst, Douglas E. Smith, and Ted G. Byrom, Wiley, 2012.						
	2. An Introduction to Computational Micromechanics-T. I. Zohdi and P. Wriggers,						
	Springer, Berlin Heidelberg NewYork,2010.						

	CO1	CO2	CO3
PO1	\checkmark	\checkmark	\checkmark
PO2	\checkmark	\checkmark	\checkmark
PO3	-	\checkmark	\checkmark
PO4	-	✓	\checkmark

Title of the course Solidification Processing es		Lecture (L)	nber of cont Tutorial (T) 0	Practical (P) 0	Total Hours	Credit
Processing	Course Ass	3	0	0	2	
28					3	3
	(EA))	essment metl	hods (Contin	uous (CT) ar	id end asso	essment
	CT+EA					
CO2: To un CO3: To ob	udy the solidifi derstand the bo tain detailed u ect free produc	ehavior of in nderstanding	clusions	-	pes of cast	tings to
growth, [8h] Growth of dendritic tra micro-morp problems in Rapid soli Conventiona Amorphous The importa technologies Inclusions - casting, cast	single crystal ansition, plane hology of eut solidification of dification pro al and uncon state. Glaze-al unce of RSP fo s. their formation ing of compos	ls of high j front solid ectic growth of polyphase cesses (RSI nventional pility. Metho r heat treatm h and distribu- ites. [10h]	perfection, of ification of alloys, [12h P). Classific effects. Un ods for prepa nent, foundry [8 h] ution; Rheoc	cellular solid polyphase a f graphite in ation of hi dercooling a ring rapidly so , powder me asting, thixoo	lification, lloys, may cast iror gh coolin and recal solidified etallurgy a casting, ele	cellular cro- and ns, some ng rates lescence material nd beam ectroslag
	RD, R B STI leníhybnosti, e	nergie a hmo	oty. Praha : A	Academia, 19	68. 799 p.	
	Inclusions - their formation and di casting, casting of composites. [10 Case studies of selected casting [2h] TEXT BOOKS: 1. BIRD, R B STEWAR Sdíleníhybnosti, energie a			Sdíleníhybnosti, energie a hmoty. Praha : ABatyšev, A. I. Kristallizacijametallovi splav	Sdíleníhybnosti, energie a hmoty. Praha : Academia, 19Batyšev, A. I. Kristallizacijametallovi splavov pod davla	 BIRD, R B STEWART, W E LIGHTFOOT, E N. Přenosov Sdíleníhybnosti, energie a hmoty. Praha : Academia, 1968. 799 p. Batyšev, A. I. Kristallizacijametallovi splavov pod davlenijem., Iz Metallurgija Moskva 1990

	Young,K.P. Semi-solid processing of Alloys. Springer – Verlag Berlin Heidelberg, 2010, ISBN 978-3-642-00705-7, e-ISBN 978-3-642-00706- 4
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	PO1	PO2	PO3	PO4
CO1	\checkmark	-	\checkmark	-
CO2	✓	-	-	-
CO3	\checkmark	\checkmark	\checkmark	\checkmark

	Departme	nt of Metallurgica	and Mate	erials Engin	eering		
Course	Title of the	Program Core	Total Nu	mber of co	ntact hours		Credit
Code	course	(PCR) /	Lecture	Tutorial	Practical	Total	
		Electives (PEL)	(L)	(T)	(P)	Hours	
MT9054	Environmental Management	PEL	3	0	0	3	3
	in						
	Metallurgical Industries						
Pre-requisi	e-requisites Course Assessment methods (Continuous (CT) and end assessment (EA))						
NIL		CT+EA	())				
Course	• CO1: Abilit	y to gain the ki	nowledge	regarding	various nol	lutants a	nd their
Outcomes		ontrol in metallur			various por	iutunto u	ile then
	• CO2: Abilit	y to understand	the current	t methods	and technol	logical pi	inciples
		onmental manage			-		
		ty to analyze an					
	environment	and recycling of	wastes on a	applications	s of metallul	rgical ind	ustries.
Topics	Fundamentals	of	e	nvironmen	tal	mana	agement
Covered	[4]						U
	A brief outline of the different metallurgical industries and its status						
	[4]						
	Sources and ty	pes of pollutan	ts (wastes	s) from n	netal / mir	nerals in	dustries.
	[4]						
		ons: control of	SPM, ha	zardous g	ases, viz.	sulphur	
	fluorides,		nitrog	gen			oxides.
	[4]	a 1					
		es: Greenhouse e	effect, glob			Kyoto p	orotocol,
	carbon trading			-	4]		
		ntrol from different					
		used DRI unit, Sm inium producing	-				•
	led product				metallurgica		dustries
	[8]	ing industri	cs, 0		inclanuigica	u 11	uusuics
		treatment of wa	aste water	with exar	nples from	metal in	lustries
	[4]	. troutmont of we	uste water,	with onu	iipies iioiii	motur m	
		bes, disposal and	utilization	of slime. r	ed mud and	spent po	t lining.
	iron and	-	slags,	Fly		bottom	ash
	[8]			2			
		of pollu	tants	on	humar	ı	health,
	[2]	_					
	Management of	radioactive was	tes, e-was	te, noise j	pollution, th	nermal p	ollution.

Text	Text Books:
Books,	1. R.C. Gupta: Energy and Environmental Management in Metallurgical Industries,
and/or	PHI Learning
reference	2. H.S. Ray. B.P. Singh, S. Bhattcharya, V. N. Misra, Energy in Mineral and
material	Metallurgical Industries, Allied Publisher
	3. C. S. Rao: Environmental Pollution Control Engineering, Wiley Eastern Ltd.
	4. J. A. Nathanson: Basic Environmental Technology, prentice-Hall India
	Reference Books:
	1. R.C. Gupta(ed.): Proc. Environmental Management in Metallurgical
	Industries(EMMI-2010), Allied Publishers
	2. FathiHabashi: Pollution Problems in Mineral and Metallurgical
	Industries, Metallurgie Extractive Quebec.
	3. H.S.Peavy et al.: Environmental Engineering, McGraw Hill

	PO1	PO2	PO3	PO4
CO1		-		
CO2	-		-	-
CO3		-	-	

Cred	rs	of contact hou	ls Engineeri	То	Program Core (PCR)	Title of the	Course
						course	Code
	Hours	(P)	(T)	(L)	/ Electives (PEL)	course	Code
3	3	0	0	3	PEL	Corrosion Engineering	MT 9055
A))	ssment (EA	and end asses	inuous (CT)	ethods (Cont	Course Assessment me	ites	Pre-requisi
					CT+EA	g Materials and	Engineeing
						mistry	Basic Cher
on.				aqueous cor	damentals of corrosion p nd the different forms of he methods of corrosion	CO2: To understan	Course Outcomes
onmen		corrosion,			Cost of corrosio	-	Topics
						[01]	Covered
e energ	mics, free	thermodyna	al reaction,	ctrochemic	iples: Introduction, ele	Corrosion princ	
on of ce	convention	es, IUPAC c	lvanic seri	F series, ga	al, cell potential, EMI	electrode potenti	
electrode potential, cell potential, EMF series, galvanic series, IUPAC convention of cell reaction, electrode kinetics, exchange current density, polarisation, passivity, Poubaix							
diagram	•	-					
Juagran	a	рн		_	(E	diagram	
anagran	u	pН		—	(E	diagram	
C		-	or two-me	– Galvanic	Ň	[10]	
eries a	, EMF se	tal corrosion			sion: Uniform attack	[10] Forms of corros	
eries ar rgranul	, EMF se	tal corrosion and preven	al effects	s, benefici	sion: Uniform attack metallurgical effects	[10] Forms of corros galvanic series,	
eries an rgranul Assiste	, EMF se ntion.Inter ronment	tal corrosion and preven aching. Envi	al effects selective le	s, benefici orrosion. S	sion: Uniform attack metallurgical effects ce corrosion. Pitting c	[10] Forms of corros galvanic series, corrosion. Crevio	
eries an rgranul Assiste	, EMF se ntion.Inter ronment	tal corrosion and preven aching. Envi	al effects selective le	s, benefici orrosion. S	sion: Uniform attack metallurgical effects	[10] Forms of corros galvanic series, corrosion. Crevid /Induced Crackin	
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eries ar rgranul Assiste n damag cathod coatin	, EMF se ntion.Inter ronment Hydrogen hibitors, SRT, pol	tal corrosion and preven aching. Envi (SCC), and I (SCC), and I ronments, in n,	al effects selective le n cracking ration envir protection	s, benefici orrosion. S ess corrosio ection, alter pression, s	sion: Uniform attack metallurgical effects ce corrosion. Pitting c ag (EAC/ EIC) - Stre ention: Materials sele anodic	 [10] Forms of corrosing galvanic series, corrosion. Crevia / Induced Cracking (HE). [10] Corrosion prevaland [06] Corrosion testing 	
eries ar rgranul Assiste n damag cathod coatin	, EMF se ntion.Inter ronment Hydrogen hibitors, SRT, pol	tal corrosion and preven aching. Envi (SCC), and I (SCC), and I ronments, in n,	al effects selective le n cracking ration envir protection	s, benefici orrosion. S ess corrosio ection, alter pression, s	sion: Uniform attack metallurgical effects ce corrosion. Pitting c ag (EAC/ EIC) - Stre ention: Materials sele anodic	 [10] Forms of corrosing galvanic series, corrosion. Crevia / Induced Cracking (HE). [10] Corrosion prevaland [06] Corrosion testing 	
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Text	Text Books:			
Books,	1. Corrosion Engineering – Mars G Fontana, McGraw Hill Publication.			
and/or	2. The fundamental of corrosion – J C Scully			
reference	3. Corrosion vol. 1 and vol. 2 – L LShrier			
material	4. Corrosion and corrosion control – H HUhlig			
	5. The corrosion and oxidation of metals $- U R$ Evans			
	6. The principle of electroplating – Shrain and Narain			
	References			
	1. ASM Handbook on Corrosion vol. 13, 13A, 13B, 13C.			

	CO1	CO2	CO3
PO1	~	\checkmark	\checkmark
PO2	~	\checkmark	\checkmark
PO3	-	\checkmark	\checkmark
PO4	-	\checkmark	