

Vision, Mission of the Institute

Vision of the Institute

• To provide valuable resources for industry and society through excellence in technical education and research

Mission of the Institute

- To offer state-of-the-art undergraduate, postgraduate and doctoral programmes
- To generate new knowledge by engaging in cutting-edge research
- To undertake collaborative projects with academia and industries
- To develop human intellectual capability to its fullest potential

Vision, Mission of MME department

Vision of the Department MME

• To evolve into a globally recognized department in the frontier areas of Metallurgical and Materials Engineering

Mission of the Department MME

- To produce Metallurgical and Materials Engineering graduates having professional excellence
- To carry out quality research having social & industrial relevance
- To provide technical support to budding entrepreneurs and existing industries

Summary of Flexible curriculum

Course Category	Courses	No. of Credits	Weightage (%)
GIR (General Institute Requirement Courses)	22	50	31.25
PC (Programme Core)	15**	52	32.50
Programme Electives (PE) / Open Electives (OE)	14 ^{\$}	42	26.25
Essential Laboratory Requirements (ELR)	08 (Maximum 2 per session up to 6 th semester)	16	10
Total		160	100
Minor (Optional)	Courses for 15 credits	15 Additional credits	-
Honours (Optional)	Courses for 15 credits	15 Additional credits	-

**Minimum of 4 programme core courses shall be 4 credits each

^{\$}Out of 14 elective courses (PE/OE), the students should study at least eight programme elective

courses (PE)

B.Tech. Curriculum Structure – Students admitted in 2019 – 2020

Sl. No.	COURSE	Credits	Category
1	English for Communication (Theory)	2	GIR
2	English for Communication (Lab)	2	GIR
3	Matrices and Calculus	3	GIR
4	Chemistry (Non-Circuit)	3	GIR
5	Chemistry Lab (Non-Circuit)	2	GIR
6	Introduction to Metallurgical and Materials Engineering*	2	GIR
7	Basics of Electrical and Electronics Engineering	2	GIR
8	Engineering Graphics	3	GIR
	Total	19	

Semester I (July Session)

Semester II (January Session)

Sl. No.	COURSE	Credits	Category
1	Complex Analysis and Differential Equations	3	GIR
2	Physics (Non-Circuit)	3	GIR
3	Physics Lab (Non-Circuit)	2	GIR
4	Introduction to Computer Programming (Theory & lab) (Non-Circuit)	3	GIR
5	Basics of Civil Engineering (Non-Circuit)	2	GIR
6	Energy and Environmental Engineering	2	GIR
7	Engineering Practice	2	GIR
8	Engineering Mechanics and Strength of Materials	4	PC
	Total	21	

* Mandatary course, offered by Industrial Experts / Alumni

Semester III (July Session)

Sl. No.	COURSE	Credits	Category
1	Industrial Economics and Foreign Trades	3	GIR
2	Metallurgical Thermodynamics and kinetics	4	PC
3	Physical Metallurgy	4	PC
4	Electrical, Electronic and Magnetic Materials	3	PC
5	Polymers, Composites and Ceramics	3	PC
6	Process Metallurgy Laboratory	2	ELR
7	Polymers, Composites and Ceramics Laboratory	2	ELR
8	Elective – I	3	PE/OE
	Total	24	

Note: Department(s) to offer Minor (MI) Course and ONLINE Course (OC) to those willing students in addition to 24 credits.

Semester IV (January Session)

Sl. No.	COURSE	Credits	Category
1	Partial Differential Equations and Numerical Methods	4	GIR
2	Phase Transformation and Heat Treatment	4	PC
3	Transport Phenomena	3	PC
4	Mechanical Behaviour and Testing of Materials	4	PC
5	Metallography and Heat Treatment Laboratory	2	ELR
6	Materials Testing and Inspection Laboratory	2	ELR
7	Elective – II	3	PE/OE
8	Elective – III	3	PE/OE
	Total	25	

Semester V (July Session)

Sl. No.	COURSE	Credits	Category
1	Iron Making and Steel Making	4	PC
2	Metal Casting Technology	3	PC
3	Materials Joining Technology	3	PC
4	Metal Forming Technology	3	PC
5	Foundry and Welding Laboratory	2	ELR
6	Metal Forming and Particulate Processing Laboratory	2	ELR
7	Professional Ethics (Non-Circuit)	3	GIR
8	Elective – IV	3	PE/OE
	Total	23	

Semester VI (January Session)

Sl. No.	COURSE	Credits	Category
1	Industrial Lecture	1	GIR
2	Non-Ferrous Metallurgy	4	PC
3	Material Characterization	3	PC
4	Corrosion Engineering	3	PC
5	Non-Ferrous Metallography and Characterization	2	ELR
	Laboratory		
6	Corrosion and Surface Engineering Laboratory	2	ELR
7	Elective – V	3	PE/OE
8	Elective - VI	3	PE/OE
9	Elective - VII	3	PE/OE
	Total	24	

Note: Department(s) may offer Minor (MI) Course, ONLINE Course (OC) and Honours Course (HO) to those willing students in addition to 23 credits

Semester VII (July Session)

Sl. No.	COURSE	Credits	Category
1	Summer Internship	2	GIR
2	Elective – VIII	3	PE/OE
3	Elective – IX	3	PE/OE
4	Elective – X	3	PE/OE
5	Elective – XI	3	PE/OE
	TOTAL	14	

Note: $\mbox{Department}(s)$ may offer Minor (MI) Course, ONLINE Course (OC) and Honours Course

(HO) to those willing students in addition to 14 credits

COURSE Sl. No. Credits Category 1 Comprehensive Viva Voce 1 GIR 2 Project Work^{\$} / Equivalent no. of Electives 6 3 Elective – XII 3 PE/OE Elective – XIII PE/OE 4 3 5 Elective – XIV PE/OE 3 TOTAL 10

Semester VIII (January Session)

Note: Department(s) may offer Minor (MI) Course, ONLINE Course (OC) and Honours Course (HO) to those willing students in addition to 10 credits ^{\$}Optional course

Semester	Ι	II	III	IV	V	VI	VII	VIII	Total
Credit	19	21	24	25	23	24	14	10	160

Note:

- 1. Minimum of 4 programme core courses shall be 4 credits each.
- 2. Out of 14 elective courses (PE/OE), the students should study at least eight programme elective courses (PE).
- 3. MI Minor Degree: **15 credits over and above** the minimum credit as specified by the departments. The details of MINOR will be mentioned only in the transcript not in the Degree certificate.
- 4. HO Honours Degree: **15 credits over and above** the minimum credit as specified by the departments. The project work is compulsory.

GIR COURSES

S.No.	Name of the Course	Number of Courses	Max. Credits
1.	Mathematics	3	10
2.	Dhusies	1 Theory	3
۷.	Physics	1 Lab	2
3.	Chemistry	1 Theory	3
5.	Chemistry	1 Lab	2
4.	Industrial Economics and Foreign Trade	1	3
5.	English for Communication	1 Theory	2
5.	English for Communication	1 Lab	2
6.	Energy and Environmental Engineering	1	2
7.	Professional Ethics	1	3
8.	Engineering Graphics	1	3
9.	Engineering Practice	1	2
10.	Basic Engineering	2	4
11.	Introduction to computer Programming	1	3
12.	Branch Specific Course [#] (Introduction to the branch of study)	1	2
13.	Summer Internship	1	2
14.	Project work*		
15.	Comprehensive viva	1	1
16.	Industrial Lecture	1	1
17.	NSS/NCC/NSO	1	Compulsory Participation
	Total	22	50

[#]Offered by Industrial Experts / Alumni of NITT, *Optional course

I. GENERAL INSTITUTE REQUIREMENTS (Course and Course details)

1. MATHEMATICS

Sl.No.	Course	Course Title	Credits
	Code		
1.	MAIR11	Matrices and Calculus	3
2.	MAIR21	Complex Analysis and Differential Equations	3
3.	MAIRYY ^{\$}	Partial Differential Equations And Numerical Methods	4
Total			10

2. PHYSICS

Sl.No.	Course	Course Title	Credits
	Code		
1.	PHIR11	Physics	3
2.	PHIR12	Physics Lab	2
Total		·	5

3. CHEMISTRY

Sl.No.	Course	Course Title	Credits
	Code		
1.	CHIR11	Chemistry	3
2.	CHIR12	Chemistry Lab	2
Total			5

4. HUMANITIES

Sl.No.	Course	Course Title	Credits
	Code		
1.	HSIR13	Industrial Economics and Foreign Trade	3
Total		L	3

5. COMMUNICATION

Sl.No.	Course	Course Title	Credits
	Code		
1.	HSIR11	English for Communication (Theory)	2
2.	HSIRYY ^{\$}	English for Communication (Lab)	2
Total	1		4

6. ENERGY AND ENVIRONMENTAL ENGINEERING

Sl.No.	Course	Course Title	Credits
	Code		
1.	ENIR11	Energy and Environmental Engineering	2
Total			2

7. PROFESSIONAL ETHICS

Sl.No.		Course Title	Credits
	Code		
1.	HSIR14	Professional Ethics	3
Total	1		3

8. ENGINEERING GRAPHICS

Sl.No.	Course	Course Title	Credits
	Code		
1.	MEIR12	Engineering Graphics	3
Total			3

9. ENGINEERING PRACTICE

Sl.No.	Course	Course Title	Credits
	Code		
1.	PRIR11	Engineering Practice	2
Total			2

10.BASIC ENGINEERING

Sl. No.	Course Code	Course Title	Credits
1.	CEIR11	Basics of Civil Engineering	2
2.	EEIR11	Basics of Electrical and Electronics Engineering	2
Total		·	4

11.INTRODUCTION TO COMPUTER PROGRAMMING

Sl.No.	Course	Course Title	Credits
	Code		
1.	CSIR11	Introduction to Computer Programming	3
		(Theory and Lab)	
Total			3

12.BRANCH SPECIFIC COURSE

Sl.No.	Course	Course Title	Credits
	Code		
1.	MTIR15	Branch Specific Course – Introduction to	2
		MME	
Total			2

13.SUMMER INTERNSHIP[#]

Sl.No.	Course	Course Title	Credits
	Code		
1.	MTIR16	Internship / Industrial Training / Academic	2
		Attachment	
Total	•		2

The student should undergo industrial training/internship for a minimum period of two months during the summer vacation of 3rd year. Attachment with an academic institution within the country (IISc/IITs/NITs/IIITs and CFTIs) or university abroad is also permitted instead of industrial training.

[#] To be evaluated at the beginning of VII semester by assessing the report and seminar presentations.

14. INDUSTRIAL LECTURE

Sl.No.	Course	Course Title	Credits
	Code		
1.	MTIR17	Industrial Lecture	1
Total			1

A course based on industrial lectures shall be offered for 1 credit. A minimum of five lectures of two hours duration by industry experts will be arranged by the Department. The evaluation methodology, will in general, be based on quizzes at the end of each lecture.

15. COMPREHENSIVE VIVA

Sl.No.	Course	Course Title	Credits
	Code		
1.	MTIR18	Comprehensive viva	1
Total			1

16.PROJECT WORK (OPTIONAL COURSE)

Sl.No.	Course	Course Title	Credits
	Code		
1.	MTIR19	Project Work (Optional)	6
Total	1		6

17.NSS /NCC/ NSO

Sl.No.	Course	Course Title	Credits
	Code		
1.	SWIR11	NSS / NCC/ NSO	0
Total	•		0

^{\$} The last two digits YY to be allotted by the Department.

Programme Core Courses

SI.	Course			Cre	dits	;	Pre	
No.	Code	Course Title	L	Т	Р	C	requisites	Credits
1.	MTPC10	Engineering Mechanics and Strength of Materials	3	1	0	4	Nil	4
2.	MTPC11	Metallurgical Thermodynamics and kinetics	3	1	0	4	Nil	4
3.	MTPC12	Physical Metallurgy	3	1	0	4	Nil	4
4.	MTPC13	Electrical, Electronic and Magnetic Materials	3	0	0	3	Nil	3
5.	MTPC14	Polymers, Composites and Ceramics	3	0	0	3	Nil	3
6.	MTPC15	Phase Transformation and Heat Treatment	3	1	0	4	MTPC12	4
7.	MTPC16	Transport Phenomena	3	0	0	3	Nil	3
8.	MTPC17	Mechanical Behaviour and Testing of Materials		1	0	4	MTPC12	4
9.	MTPC18	Iron Making and Steel Making	3	1	0	4	MTPC11, MTPC16	4
10.	MTPC19	Metal Casting Technology	3	0	0	3	Nil	3
11.	MTPC20	Materials Joining Technology	3	0	0	3	Nil	3
12.	MTPC21	Metal Forming Technology	3	0	0	3	MTPC17	3
13.	MTPC22	Non-Ferrous Metallurgy	3	1	0	4	MTPC12	4
14.	MTPC23	Material Characterization	3	0	0	3	Nil	3
15.	MTPC24	Corrosion Engineering	3	0	0	3	Nil	3
	0.MIPC13Treatment3104MIPC127.MTPC16Transport Phenomena3003Nil8.MTPC17Mechanical Behaviour and Testing of Materials3104MTPC129.MTPC18Iron Making and Steel Making3104MTPC11, MTPC1610.MTPC19Metal Casting Technology3003Nil11.MTPC20Materials Joining Technology3003MTPC1713.MTPC21Metal Forming Technology3104MTPC1214.MTPC23Material Characterization3003Nil15.MTPC24Corrosion Engineering3003Nil					52		

Programme Elective Courses (PE)

Sl.No.	Course Code	Course Title	Prerequisites	Credits
1.	MTPE01	Mineral Processing and Metallurgical analysis	Nil	3
2.	MTPE02	Instrumentation and Control Engineering	Nil	3
3.	MTPE03	Fatigue, Creep and Fracture Mechanics	MTPC17	3
4.	MTPE04	Special Steels and Cast Irons	MTPC15	3
5.	MTPE05	Special Casting Techniques	MTPC19	3
6.	MTPE06	Special Topics in Metal Forming	MTPC21	3
7.	MTPE07	PE07 Economics of Metal Production Processes		3
8.	MTPE08	Particulate Technology	Nil	3
9.	MTPE09	Additive Manufacturing	Nil	3
10.	MTPE10	Computational Materials Science	Nil	3
11.	MTPE11	Materials for New and Renewable Energy	Nil	3
12.	MTPE12	Non-Ferrous Extraction	Nil	3
13.	MTPE13	Metallurgical Waste Management	Nil	3
14.	MTPE14	Non-destructive Testing	Nil	3
15.	MTPE15	Welding Metallurgy	MTPC20	3
16.	MTPE16	Materials for extreme environments	Nil	3
17.	MTPE17	Thermodynamics of Solidification	MTPC11, MTPC19	3
18.	MTPE18	Design aspects of Welding and Casting	MTPC19, MTPC20	3
19.	MTPE19	Alloy Development	Nil	3
20.	MTPE20	Ceramic Materials	Nil	3
21.	MTPE21	Ceramic Processing	MTPC14	3
22.	MTPE22	High Temperature Materials	MTPC12	3
23.	MTPE23	Emerging Materials	Nil	3
24.	MTPE24	Automotive Materials	MTPC12	3
25.	MTPE25	Metallurgical Failure Analysis	Nil	3
26.	MTPE26	Biomaterials	Nil	3
27	MTPE27	Stainless steels and Advanced Ferrous Alloys	Nil	3

Sl.No.	Course Code	Course Title	Prerequisites	Credits
1.	MTOE10	Nanomaterials and Applications	Nil	3
2.	MTOE11	Mathematical Techniques in Materials Research	Nil	3
3.	MTOE12	Design and Selection of Materials	Nil	3
4.	MTOE13	New Product Development	Nil	3
5.	MTOE14	Introduction to Quality Management	Nil	3
6.	MTOE15	Surface Engineering	Nil	3
7.	MTOE16	Process Modelling and Applications	Nil	3
8.	MTOE17	Intellectual Property Rights	Nil	3
9.	MTOE18	Business and Entrepreneurship for Engineers	Nil	3

Open Elective Courses (Offered by Dept. of MME)

Essential Programme Laboratory Requirements (ELR)

Sl.No.	Course Code	Course Title	Pre-/Co- requisites	Credits
1.	MTLR30	Process Metallurgy Laboratory	Nil	2
2.	MTLR31	Polymers, Composites and Ceramics Laboratory	MTPC14	2
3.	MTLR32	Metallography and Heat Treatment Laboratory	MTPC15	2
4.	MTLR33	Materials Testing and Inspection Laboratory	MTPC17	2
5.	MTLR34	Foundry and Welding Laboratory	MTPC19, MTPC20	2
6.	MTLR35	Metal Forming and Particulate Processing Laboratory	MTPC21	2
7.	MTLR36	Non-Ferrous Metallography and Characterization Laboratory	MTPC22, MTPC23	2
8.	MTLR37	Corrosion and Surface Engineering Laboratory	MTPC24	2
		Total	1	16

Sl. No.	Course Code	Course Title	Prerequisites	Credits
1			N7'1	2
1.	MTMI10	Materials Technology	Nil	3
2.	MTMI11	Fundamentals of Metallurgy	Nil	3
3.	MTMI12	Physical Metallurgy and Heat Treatment	Nil	3
4.	MTMI13	Deformation Processing	Nil	3
5.	MTMI14	Manufacturing Methods	Nil	3
6.	MTMI15	Testing and Evaluation of Materials	Nil	3
7.	MTMI16	Non-Metallic Materials	Nil	3

Minor Courses (MI)

Advanced Level Courses for B.Tech. (Honours)

Sl.No.	Course Code	Course Title	Prerequisites	Credits
1.	MTHO10	Advanced Thermodynamics of Materials	MTPC11	3
2.	MTHO11	Crystallography	MTPC12	3
3.	MTHO12	Aerospace Materials	Nil	3
4.	MTHO13	Ladle Metallurgy and Continuous Casting of steels	MTPC18	3
5.	MTHO14	Recent Trends in Nano materials	Nil	3
6.	MTHO15	Advanced Solidification Processing	MTPC19	3
7.	MTHO16	Recent Developments in Welding Processes	MTPC20	3
8.	MTHO17	Recent Developments in Forming Processes	MTPC21	3

No.	Programme Educational Objectives (PEO)
I.	Choose their careers as practicing Metallurgical and Materials Engineers in traditional Metallurgical and Materials industries as well as in expanding areas of materials,
II.	environmental and energy-related industries. Engage in post-baccalaureate study and make timely progress toward an advanced degree in Metallurgical and Materials Engineering or a related technical discipline or business.
III.	Function effectively in the complex modern work environment with the ability to assume professional leadership roles.

No.	Programme Outcomes (PO)
PO1	Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and Sustain ability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Cou	ırse Code	:	HSIR11					
Cou	ırse Title	:		r Commu	nication (Theory & Lab)		
Nur	nber of Credits		2+2			•		
LTI	PC Breakup	:	L	Т	Р	Contact hours	С	
			2	0	2	4	4	
Pre	requisites (Course code)	:	Nil	-				
	irse Type	:	GIR					
	rse Learning Objectives	-	ont					
The com	primary objective is to develope tence in English required for al needs.							
Cou	irse Content							
prece externation Ana thin Effe app defi Rec prace List - Pr of li Bar prace Fluc orie pers Bar	guage and communication- dicting and responding to co- ension - speed reading pract- alytical and critical reading king – thinking process and ective writing practice – Vo- ropriateness, brevity & clan- nitions, descriptions - Para iprocal relationship betwee etice – Perspectives in writi- cening process & practice – roblems in comprehension istening in the corporate wo riers to listening: Physical etice – Active listening and ency & accuracy in speech- onted speaking -Group discu- suasive speaking skills. riers to speaking – Building ponding capacity - Extempo	ont tice pradiation diational caling grace nr mg Ex & r orld & p ant -In ussi g se	ent – Guess – use of exactice- critic nguage dev oulary expa in writing - ph writing. eading and –profession posure to re etention – N l. osychologic ticipating the nproving se on practice	ing from c tensive re cal, creativ elopment. nsion - Eff - Cohesion writing –t al writing ecorded & Note-takin al – Steps le speaker lf-express – Interpen ce & fluer	context – ading tex e and late fective se n & coher hinking a - Narrati structure g practice to overco – Use of ion – Tor csonal Co	Note making – ts. eral thinking- lar ntences: role of rence in writing nd writing - Arg ve writing. ed talks, class roc e – Listening tes ome them – Purp technology to ir nal variations – I nversation -Dev	Vocabular nguage and acceptabil –Writing o gument Wr om lecture ts- Import osive liste nprove the Listener eloping	d lity, of riting ance ening e skil
D . f								
	erence Books M. Ashraf Rizvi, <i>Effective</i>	T	abrical C-		on Tata	MaCrow IIII N	Jow Dalk:	
1	2005.	10	chnicul Co	mmunican	on, rata	wicoraw-fill, N		,
2	Strunk, William, and E B. Pearson Edition, 1999.	W	hite, <i>The El</i>	ements of	<i>Style</i> . Bo	ston: Allyn and	Bacon,	
3	Garner, Bryan A, <i>HBR Gu</i> Press, Boston, Massachus			Business W	<i>riting</i> , Ha	arvard Business	Review	
Cou	irse Outcomes							
At t	he end of the course, students	wil	ll be able to					_
CO	Express themselves in a academic and social dom	me	aningful ma	nner to di	fferent le	vels of people ir	their	

Course Code	:	MAIR11					
Course Title	:	Matrices an	nd Calculu	IS			
Number of Credits		3					
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		3	0	0	3	3	
Prerequisites (Course code)	:	Nil			1 1		
Course Type	:	GIR					
Course Learning Objectives							
 Introduce eigen value and eigen vectors and its properties. Determine canonical form of given quadratic form. Discuss the convergence of infinite series. Analyze and discuss the extrema of the functions of several variables. Evaluate the multiple integrals and apply in solving problems. Introduce vector differential operator for vector function and important theorems on vector functions to solve engineering problems 							
Course Content							
Quadratic form.Sequence and series: Convergentest, comparison test, Ratio testPower series.Functions of two variables: LiTaylor series, Maxima, minimtriple integrals, change of varialGradient, divergence and curl;Gauss divergence theorem (withReference Books1Dennis Zill, Warren S. WrigJones & Bartlett Learning, 22Erwin Kreyszig, Advance3Jerrold E. Marsden, Anthe4Strauss M.J, G.L. Bradley5Ward Cheney, David Kin	t, R mit a an able Lin tho d E d E \overline{d} E	coot test, Ra , continuity nd saddle po es, multiple ne and surfa ut proofs). Michael R. C <u>ngineering</u> Tromba, V d K.J. Smit	abe's test and partia pints; Meth integral ir ace integra Cullen, Adv Mathemat ector Calc h, Multiva	, Logarith Il derivati hod of La a cylindrid ls; Green vanced Eng <i>ics</i> , John <i>culus</i> , W. <i>riable ca</i>	mic test, and Le ves; Total deriva grange multiplie cal and spherical 's theorem, Stoke gineering Mathem Wiley & Sons, 2 H. Freeman, 200 culus, Prentice I	ibnitz's t ative, Jac ers; Doub coordina es theore atics, 2019. 03 Hall, 200	est; obian, le and ates. m and
Bartlett Publishers, 2012. Course Outcomes At the end of the course, students							
CO1 Compute eigenvalues and CO2 Transform given quadrati CO3 Discuss the convergence CO4 Compute partial derivativ CO5 Write taylor's series for f CO6 Evaluate multiple integra	c fo of i res o unc	orm into car nfinite serie of function tions with t	nonical for es by apply of several wo variab	m. ving vario variables les.	ous test.		
CO7 Compute the dot product						vectors	
compute the dot product	51			and, and	ungies between	,	

CO8 Perform gradient, div, curl operator on vector functions and give physical interpretations.							
Course Code	:	CHIR11					
Course Title	:	Chemistry	7				
Number of Credits	3						
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		3	0	0	3	3	
Prerequisites (Course code)	:	Nil					
Course Type	:	GIR					

To introduce the student's basic principles of Electrochemistry and Corrosion. They will be familiar with phase rule & its applications. Students will know about the essential requirements of water and its importance in day-to-day life. To provide students with a brief outline of the types and applications of polymers. Finally, students will be equipped with the usage of spectroscopy in industrial applications.

Course Content

Electrochemistry and Corrosion

Cell EMF- its measurement and applications - concentration cell - electrode electrolyte concentration cell - concentration cell with and without transference - Dry corrosion and wet corrosion, mechanisms, types of corrosion, Differential metal corrosion, differential aeration corrosion, intergranular, Passivity, Pitting, Polarization - Chemical conversion coatings and organic coatings- Paints, enamels.

Phase rule

Definition of terms – phase- components- degree of freedom- derivation of Gibbs phase rule – one component system – H₂O, CO₂, Sulfur – Two-component system – Eutectic systems – reduced phase rule - Pb-Ag system – Compound Formation with congruent melting – Zn- Mg Alloy system- Copper-nickel alloy system - systems with incongruent melting – Na₂SO₄- H₂O system and simple three-component systems.

Water

Sources, Hard & soft water, Estimation of hardness by EDTA method, Scale & Sludge- Caustic embrittlement - softening of water, zeolite process & demineralization by ion exchangers, boiler feed water, internal treatment methods-specifications for drinking water, BIS & WHO standards, treatment of water for domestic use, desalination - Reverse osmosis & Electrodialysis.

Spectroscopy

Interaction of electromagnetic radiation with matter, Electronic spectroscopy - Theory of electronic transitions, instrumentation, Beers Lambert law, Woodward FIESER rule, applications. IR spectroscopy - Fundamentals, Instrumentation, and applications, Raman spectroscopy – Fundamentals and applications.

Polymers and Composites

Concept of macromolecules- Tacticity- Classification of Polymers- Types of PolymerizationMechanism- - Ziegler Natta Polymerization - Effect of Polymer structure on properties - important addition and condensation polymers –synthesis and properties – Molecular mass determination of polymers- Static and dynamic methods, Light scattering-Rubbers – Vulcanization – Synthetic rubbers – Conducting polymers- Composite materials

Ref	erence Books
1	P.C. Jain, M. Jain, Engineering Chemistry, Dhanpat Rai Publishing Company, New
	Delhi, 2005.
2	P. Atkins, J.D. Paula, <i>Physical Chemistry</i> , Oxford University Press, 2002.

3	B.R. Puri, L.R. Sharma, M.S. Pathania, Principles of Physical Chemistry, Vishal
	Publishing Company, 2008
4	F.W. Billmayer, <i>Textbook of Polymer Science</i> , 3rd Edison, Wiley. N.Y. 1991.
5	S.S. Darer, S.S. Umare, A Text Book of Engineering Chemistry, S. Chand Publishing, 2011.
Cou	urse Outcomes
At th	he end of the course, students will be able to
COI	Understand the principles of electrochemistry and corrosion
CO2	2 Explain the phase rule and appreciate the applications of phase rule
CO3	Students will be familiarized with the importance of polymer and its application in industries.
CO4	A brief introduction in the area of water, spectroscopy will be very useful for the students in

Course Code	:	CHIR12					
Course Title	:	: Chemistry Lab					
Number of Credits		2					
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		0	0	2	2	2	
Prerequisites (Course code)	:	Nil	1	1			
Course Type	:	GIR					
Course Learning Objectives							
The chemistry laboratory cour			-		strating the princ	ples of	
chemistry relevant to the study	/ of	science and	d engineer	ing.			
~ ~ ~							
Course Content							
1. Estimation of carbonate,					n the given wate	r sample.	
2. Estimation of dissolved o		-		-			
3. Determination of the perc	ent	age of Fe ir	n the given	steel san	nple.		
4. Estimation of Fe3+ by sp	ectr	ophotomete	er.				
5. Corrosion rate by polarization	atio	n technique	•				
6. Conductometric titration							
7. Potentiometric titration							
8. pH-metric titration							
9. Percentage purity of blead	chir	g powder					
10. Determination of molecul		• •	e polvme	• hy Visco	ometry		
11. Study of three componen			r ronginoi		J		
12. Demonstration experimen	•		nced Snec	troscopic	Techniques (UN	V-Vis FTIP	
1	115 1	ising Auva	need spee	uoscopic	reeningues, (U	v - v 13, 1°1111,	
Raman)							
Reference Books							
1 Laboratory Manual, Depart	nen	t of Chemist	ry, Nationa	l Institute	of Technology,		
Tiruchirappalli.							
2 S.K. Bhasin, S. Rani, <i>Lab</i>			al on Engi	neering C	<i>hemistry</i> , Dhanp	oat Rai	
Publishing Company New	w D	elhi 2011					

Publishing Company, New Delhi, 2011

Course Outcomes

CO1	The students will learn how to estimate various components from the corresponding
	bulk

Course Code	:	MTIR15					
Course Title	:	Introductio	on to Meta	llurgical a	nd Materials Eng	gineering	
Number of Credits		2					
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		2	0	0	2	2	
Prerequisites (Course code)	:						
Course Type	:	GIR					

To develop an understanding of the basic knowledge of Metallurgical and Materials Engineering and gain knowledge on overview of developments in the field of materials over periods ; to become familiar with the metals and materials industry.

Course Content

Historical perspective, scope of materials science and of materials engineering – Role of metals in civilization and in wars – rise and fall of emperors who conquered world- Metallurgy and materials of India – Damascus sword – Delhi iron Pillar etc.

Metals and Materials – Classification – Properties – Mechanical, electrical, thermal, magnetic, optical, decorative and its applications. Illustrative examples of practical uses of materials.

Modern materials - Bio and Nano materials.

Role of metals and materials in aerospace and telecommunication, Role of metals and materials in Indian medicines – Siddha, Ayurveda, etc.

Reference Books

1	Rajput R.K. "Engineering Materials and Metallurgy" S. Chand & Co.	, New De	elhi. 2006					
2	Transaction of Indian Institute of Metals, Special issue on Nonferrous materials – Heritage of							
	India. Vol.59, No.6, 2006.							
3	Pooler and F.J. Owens, Introduction to nano technology, Wiley stude	nt edition	, 2003.					
4	Sujata V Bhat, Bio Materials, Narosa Publishing House, New Delhi, 2	2004.						
5	Ravisankar B and Angelo P.C., Periodic table of elements, Mahi Publ	ications,	2019					
Cou	rse Outcomes							
At th	he end of the course, students will be able to	F	PO Correlati	ion				
		Low	Medium	High				
CO1	Define engineering materials technology and understand each stage			1,2				
	of the materials cycle, material selection criteria							
CO2	Understand the impact of Metallurgical and Materials			1,3,6				
	Engineering solutions in a global, economic, environmental, and							
	societal context							
CO3	Become familiar with the science behind the development of			1				
	metals and materials							
COA	Decome families with summent trends / developments and the			1.12				
CO4	I			1,12				
	prevailing industrial scenario in metals and materials							

	:	EEIR11						
source Title : Basic Electrical and Electronics Engineering umber of Credits 2								
					1 1			
LTPC Breakup	:	L	Т	Р	Contact hours	С		
		2	0	0	2	2		
Prerequisites (Course code)	:	Nil						
Course Type	:	GIR						
Course Learning Objectives								
 This course aims to equip the students with a basic understanding of Electrical circuits and machines for specific types of applications. The course gives a comprehensive exposure to house wiring. This course also equips students with an ability to understand basics of analogue and digital electronics. 								
Course Content								
DC & AC Machines: DC Motor, I and Transformers- construction, p House wiring & safety: Single pha house wring - tools and componer coiling for basic safety measures	orin ase nts,	ciple of oper and three ph different typ	ration, type	s and appl	ications. neutral and earth,	basic		
amplifier – principle of operation	or d anc	evices – p-n l application umbers syste	dustry. junction d s – Introdu ems, basic 1	iode, Zene ction to U	r diode, BJT, ope PS.	rational		
Analog Electronics: semiconducto amplifier – principle of operation Digital Electronics: Introduction t	or d anc	evices – p-n l application umbers syste	dustry. junction d s – Introdu ems, basic 1	iode, Zene ction to U	r diode, BJT, ope PS.	rational		
Analog Electronics: semiconducto amplifier – principle of operation Digital Electronics: Introduction t expressions and implementation v	or d and o n with	evices – p-n l application umbers syste logic gates.	dustry. junction d s – Introdu ems, basic 1 nn Hilcy an	iode, Zene ction to U Boolean la	r diode, BJT, ope PS. ws, reduction of I	rational Boolean		
 Analog Electronics: semiconducto amplifier – principle of operation Digital Electronics: Introduction t expressions and implementation v Reference Books Hughes revised by Mckenzie Electronics Technology, 8th R.J. Smith, R.C. Dorf, Circuit 2001. 	or d anc o n vith Edi its I	evices – p-n l application umbers syste logic gates. nith with Joh tion, Pearso Devices and	dustry. junction d s – Introdu ems, basic f n Hilcy an n, 2012. Systems, 5	iode, Zene ction to U Boolean la d Keith Br th Edition	r diode, BJT, oper PS. ws, reduction of I rown, Electrical an , John Wiley and s	rational Boolean nd sons,		
 Analog Electronics: semiconducto amplifier – principle of operation Digital Electronics: Introduction t expressions and implementation v Reference Books Hughes revised by Mckenzie Electronics Technology, 8th R.J. Smith, R.C. Dorf, Circui 2001. P. S. Dhogal, Basic Electrica 2012. 	or d anc o n vith Edi its I	evices – p-n l application umbers syste logic gates. nith with Joh tion, Pearso Devices and ngineering –	dustry. junction d s – Introdu ems, basic 1 nn Hilcy an n, 2012. Systems, 5 Vol. I & I	iode, Zene ction to U Boolean la d Keith Br th Edition I, 42nd Re	r diode, BJT, oper PS. ws, reduction of I rown, Electrical an John Wiley and s print, McGraw Hi	rational Boolean nd sons,		
 Analog Electronics: semiconducto amplifier – principle of operation Digital Electronics: Introduction t expressions and implementation v Reference Books Hughes revised by Mckenzie Electronics Technology, 8th R.J. Smith, R.C. Dorf, Circui 2001. P. S. Dhogal, Basic Electrica 2012. Malvino, A. P., Leach D. P. a Edition, Tata McGraw Hill, 2 	or d anc o n with Edi its I Il E and 200	evices – p-n l application umbers syste logic gates. nith with Joh tion, Pearso Devices and ngineering – Gowtham S 7.	dustry. junction d s – Introdu ems, basic mn Hilcy an n, 2012. Systems, 5 Vol. I & I Sha, Digital	iode, Zene ction to U Boolean la d Keith Br th Edition I, 42nd Re Principles	r diode, BJT, oper PS. ws, reduction of I rown, Electrical an John Wiley and s print, McGraw Hi and Applications	rational Boolean nd sons,		
 Analog Electronics: semiconducto amplifier – principle of operation Digital Electronics: Introduction t expressions and implementation v Reference Books Hughes revised by Mckenzie Electronics Technology, 8th R.J. Smith, R.C. Dorf, Circui 2001. P. S. Dhogal, Basic Electrica 2012. 4 Malvino, A. P., Leach D. P. a 	or d anc o n with Edi its I Il E and 200	evices – p-n l application umbers syste logic gates. nith with Joh tion, Pearso Devices and ngineering – Gowtham S 7.	dustry. junction d s – Introdu ems, basic mn Hilcy an n, 2012. Systems, 5 Vol. I & I Sha, Digital	iode, Zene ction to U Boolean la d Keith Br th Edition I, 42nd Re Principles	r diode, BJT, oper PS. ws, reduction of I rown, Electrical an John Wiley and s print, McGraw Hi and Applications	rational Boolean nd sons,		
 Analog Electronics: semiconducto amplifier – principle of operation Digital Electronics: Introduction t expressions and implementation v Reference Books Hughes revised by Mckenzie Electronics Technology, 8th R.J. Smith, R.C. Dorf, Circui 2001. P. S. Dhogal, Basic Electrica 2012. Malvino, A. P., Leach D. P. a Edition, Tata McGraw Hill, 2 	or d anc o n with Edi its I Il E and 200	evices – p-n l application umbers syste logic gates. nith with Joh tion, Pearso Devices and ngineering – Gowtham S 7.	dustry. junction d s – Introdu ems, basic mn Hilcy an n, 2012. Systems, 5 Vol. I & I Sha, Digital	iode, Zene ction to U Boolean la d Keith Br th Edition I, 42nd Re Principles	r diode, BJT, oper PS. ws, reduction of I rown, Electrical an John Wiley and s print, McGraw Hi and Applications	rational Boolean nd sons,		

Course Code	:	MEIR12					
Course Title	:	Engineeri	ng Graphi	cs			
Number of Credits		3	-				
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		<mark>0</mark>	<mark>0</mark>	<mark>3</mark>	<mark>3</mark>	<mark>3</mark>	
Prerequisites (Course code)	:	Nil					
Course Type	:	GIR					
Course Learning Objectives							
 Irrespective of engineering disc Graphics. The student is expect operational function in order to Provide neat structure of indus Enables the knowledge about p graphics assemblies. Preparation of machine component 	ted pe tria posi	to possess t erform day to l drawing. ition of the c	he efficient o day activi component	drafting ty.	skill depending on	the	-
Course Content							
Fundamentals Drawing standard -	- BI	S. dimensio	ning, letter	ng, type	of lines, scaling co	nvention	s.
planes inclined to one or both plan perpendicular to VP and axis incli Sectioning of solids Section plane	ineo	d to one and	both plane	s.			
Intersection of surfaces Intersection intersection of prisms.		·	-				
Development of surfaces Develop Isometric and perspective projecti and simple solids, introduction to	ion	Isometric pi	rojection an				
Reference Books							
1 Bhatt, N. D. and Panchal, V.						2010.	
2 Ken Morling, Geometric and	l Er	ngineering D	Drawing, 3rd	d Edition,	Elsevier, 2010		
3 Jolhe, D. A., Engineering dra	awi	ng, Tata Mc	Graw Hill.	2008			
4 Shah, M. B. and Rana, B. C.		Č.			ucation, 2009		
5 K.V. Natarajan, A text boo						hers,	
Course Outcomes		<u> </u>	~ 1			,	
CO1 At the end of the course stud							

Course Code		MAID 01					
Course Code Course Title	:	MAIR21	A	1 D:6		•	
Number of Credits	:	Complex 3	Analysis	and Diff	erential Equat	IONS	
LTPC Breakup		1	т	D		0	
LIFC breakup	:	L	T	P	Contact hours	C	
		3	0	0	3	3	
Prerequisites (Course code)	:	Nil					
Course Type	:	GIR					
Course Learning Objectives							
The course presents							
• An introduction to ana	-		-		1		
• Various Cauchy's the		-	· •		-		
 Various approach to fi Laplace transform tech 		•		•	-		
differential equations					uai equations ra	aitiai	
-	unu	methods to	Tind Solut				
Course Content		onn	no. T : '	ata anal C	an obrita intern 1	these	an 1
Analytic functions; Cauchy-R integral formula (without proc							
proof) and its applications.	n);	Taylor's ser	les and La	urent seri	es; Residue med	orem (wit	nout
proof and its applications.							
Higher order linear differentia	1 ea	uations with	1 constant	coefficie	nts: Second orde	er linear	
differential equations with var							ny
Euler equation; Power series s							
and their properties.							
and their properties.							
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and their properties.				nd integra	ls – Inverse Lap	place tran	sform
and their properties. Laplace Transform of Standar – Convolution theorem – Perio	odic	e functions -	- Applicati	nd integra ion to ord	ıls – Inverse Lap inary differentia	place tran l equatio	sform n.
and their properties. Laplace Transform of Standar – Convolution theorem – Perio Formation of partial differenti	odic al e	e functions - quations by	- Applicati eliminatir	nd integra ion to ord 1g arbitrat	ls – Inverse Lap inary differentia y constants and	blace tran Il equation functions	sform n. s –
and their properties. Laplace Transform of Standar – Convolution theorem – Perio Formation of partial differenti solution of first order partial d	odic al e iffe	e functions - quations by rential equa	- Applicati eliminatir	nd integra ion to ord 1g arbitrat	ls – Inverse Lap inary differentia y constants and	blace tran Il equation functions	sform n. s –
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and their properties. Laplace Transform of Standar - Convolution theorem – Period Formation of partial differentiation of first order partial differentiation of first order partial differentiation of separation of varial Reference Books 1 James Ward Brown, Ruel McGraw-Hill Higher Edu 2 Dennis Zill, Warren S. W Jones & Bartlett Learning 3 Erwin Kreyszig, Advan 4 William E. Boyce, Rich Equations and Boundard 5 Ian N. Sneddon, Element 2013 Course Outcomes At the end of the course, stude CO1 Understand analytic functor CO2 Obtain series representation	odic al e iffe oles Va cati righ righ righ righ righ righ righ rig	c functions - quations by rential equa	- Applicati eliminatir tions – fou ill, Compl R. Cullen, <u>ng Mathe</u> na, Dougl <i>lems</i> , Wil Differenti e to s propertie functions chy's resid	nd integra ion to ord ng arbitran ur standar ex Variab Advance ematics, J as B. Me ey, 2017 ial Equat	lls – Inverse Lap inary differentia y constants and d types – Lagran les and Applica d Engineering M fohn Wiley & S ade, <i>Elementa</i>	blace tran l equation functions nge's equ tions, Aathemat <u>Sons, 20</u> <i>ry Differ</i>	sform n. s – ation. ics, <u>19.</u> <i>cential</i>

CO5	Find the solutions of first and some higher order ordinary differential equations
CO6	Apply properties of special functions in discussion the solution of ODE.
CO7	Find Laplace transform of a given function and its inverse Laplace transform.
CO8	Find solution of first order partial differential equations

Course Code	:	PHIR11					
Course Title	:	Physics					
Number of Credits		3					
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		3	0	0	3	3	
Prerequisites (Course code)	:	Nil					
Course Type	:	GIR					

- To introduce the notions of light matter interaction, fabrication of lasers, light propagation in waveguides, applications of lasers and optical fibers to engineering students.
- To comprehend and explain the concepts of matter waves, wave functions and its interpretation to understand the matter at atomic scale.
- To teach the fundamentals of nuclear forces, models and classification of matter.
- To impart knowledge about the basics of conductors, superconductors, nanomaterials and their applications in science, engineering and technology.

Course Content

Lasers: Introduction to Laser-characteristics of Lasers-spontaneous and stimulated emissions – Einstein's coefficients – population inversion and lasing action – laser systems: He-Ne Laser, semiconductor laser-applications.

Fiber Optics: Snell's law-optical fiber – principle and construction – acceptance cone - numerical aperture –types of fibers - fiber optic communication principle – fiber optic sensors.

Quantum Mechanics: Inadequacy of classical mechanics-black body radiation, photoelectric effect- wave and particle duality of radiation – de Broglie concept of matter waves – electron diffraction –

Heisenberg's uncertainty principle – Schrodinger's wave equation – eigen values and eigen functions – superposition principle – interpretation of wave function – particle confined in one dimensional infinite square well potential.

Nuclear and Particle Physics: Nuclear properties and forces - Nuclear models - Shell model - Nuclear reaction - Radioactivity - types and half-life. Fundamental forces - Particle physics - classification of matter - quark model.

Physics of Advanced Materials: Conductors: classical free electron theory (Lorentz –Drude theory) – electrical conductivity. Superconductors: definition – Meissner effect – type I & II superconductors – BCS theory (qualitative). Nanomaterials: introduction and properties – synthesis – top-down and bottom-up approach – applications.

Ref	erence Books							
1	William T. Silfvast, Laser Fundamentals, 2nd Edition, Cambridge University press, New York,							
	2004.							
2	D. Halliday, R. Resnick and J. Walker, Fundamentals of Physics, 6th Edition, John Wiley and Sons,							
	New York, 2001.							
3	Arthur Beiser, Concepts of Modern Physics, Tata McGraw-Hill, New Delhi, 2010.							
4	R. Shankar, Fundamentals of Physics, Yale University Press, New Haven and London, 2014.							
5	R. Shankar, Fundamentals of Physics II, Yale University Press, New Haven and London, 2016.							
6	C.P. Poole and F.J. Owens, Introduction to Nanotechnology, Wiley, New Delhi, 2007.							
7	Charles Kittel, Introduction to Solid State Physics, 8th Edition, John Wiley & Sons, NJ, USA, 2005.							
Coi	Course Outcomes							
At t	he end of the course, students will be able to							

	know principle, construction and working of lasers and their applications in various science and engineering.
CO2	explain light propagation in optical fibers, types and their applications.
	experience and appreciate the behaviour of matter at atomic scale, and to impart knowledge in solving problems in modern science and engineering.
	understand the role of nuclear and particle physics in applications like radioactivity and nuclear reactions.
	recognize, choose and apply knowledge to develop materials for specific applications for common needs

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	se Code	:	PHIR12							
	se Title	:	Physics L	ab						
	ber of Credits		2			I		. 		
LTP	C Breakup	:	L	Т	Р	Contact hours	C			
			0	0	2	2	2			
Prere	equisites (Course code)	:	Nil							
	se Type	:	GIR							
	se Learning Objectives									
 To introduce the spirit of experiments to verify physics concepts such as reflection, refraction, diffraction and interference on light matter interaction. To perform experiments to estimate the materials properties and to check their suitability in science and engineering. To familiarize physics concepts and to design instruments and experimental set up for better and accurate measurements. To teach and apply knowledge to measure and verify the values of certain constants in physics. Course Content 1. Determination of rigidity modulus of a metallic wire										
	nversion of galvanometer in			voltmeter						
	avelength of laser using diffr									
	spersive power of a prism – S	-								
	dius of curvature of lens-Nev		-							
	merical aperture of an optica									
	eld along the axis of a Circula									
	avelength of white light – Sp									
	libration of Voltmeter – Pote									
	hickness of a thin wire – Air		-							
	pecific rotation of a liquid –			arimeter						
12. P	hotoelectric effect – Planck's	s cc	onstant							
Refe	rence Books									
	Physics Laboratory Manual,	De	partment of	Physics, Na	tional Inst	itute of Technolo	ogy			
	Firuchirappalli, 2018.									
2	R.K. Shukla, Anchal Srivasta	ava	, Practical Pl	nysics, Nev	v age interr	national, 2011.				
	C.L Arora, B.Sc. Practical Pl	nys	ics, S. Chano	1 & Co., 20	12.					
	se Outcomes		11 11							
At the	e end of the course, students	W1	I be able to							
CO1	Know how to calibrate a ga	lva	nometer and	convert it	into a curre	ent and voltmete	rs.			
CO2	To make experimental setu light.	p to	o verify certa	in physics	concepts o	f wave and partie	cle nature o	of		
CO3	Understand the light propag and engineering.	gati	on in fibers,	light matte	r interactio	on and use of lase	ers in scien	ce		
CO4	Acquire knowledge, estima	te a	and suggest 1	naterials fo	r engineer	ing applications.				

Course Code	:	CSIR11	CSIR11						
Course Title	:	Introducti	Introduction to Computer Programming						
Number of Credits		3							
LTPC Breakup	:	L	Т	Р	Contact hours	С			
		<mark>2</mark>	<mark>0</mark>	<mark>2</mark>	<mark>4</mark>	<mark>3</mark>			
Prerequisites (Course code)	:	Nil	•						
Course Type	:	GIR							
Course Learning Objectives									

To learn the fundamentals of computers.

To learn the problem solving techniques using algorithms and procedures

To read, write and execute simple Python Programs

To learn and use Python data structures – lists, tuples and dictionaries

Course Content

Introduction to computers – Computer Organization – Characteristics – Hardware and Software – Modes of operation – Types of programming languages – Developing a program. Algorithms – Characteristics – Flowcharts.

Data types; variables, assignments; immutable variables; numerical types; arithmetic operators and expressions; comments; understanding error messages; Conditions, Boolean logic, logical operators; ranges; Control statements: if-else, loops (for, while); short-circuit (lazy) evaluation. Strings and text files; manipulating files and directories, OS and SYS modules; text files: reading/writing text and numbers from/to a file; creating and reading a formatted file (csv or tab separated). String manipulations: subscript operator, indexing, slicing a string; strings and number system: converting strings to numbers and vice versa. Binary, octal, hexadecimal numbers

Lists, tuples, and dictionaries; basic list operators, replacing, inserting, removing an element; searching and sorting lists; dictionary literals, adding and removing keys, accessing and replacing values; traversing dictionaries.

Design with functions: hiding redundancy, complexity; arguments and return values; formal vs actual arguments, named arguments- Program structure and design- Recursive functions – Introduction to classes and OOP.

List of Programs

- 1. Programs using sequential constructs
- 2. Programs using selection constructs
- 3. Programs using Iterative constructs
- 4. Programs using nested for loops
- 5. Programs using lists
- 6. Programs using tuples and dictionaries
- 7. Simple Python functions
- 8. File input and output
- 9. Sorting and searching programs
- 10. Recursion

Reference Books

1	Kenneth A. Lambert, Fundamentals of Python: First Programs, CENGAGE Learning, 2012.
2	Guido van Rossum and Fred L. Drake Jr, An Introduction to Python – Revised and updated for
	Python 3.2, Network Theory Ltd., 2011.
3	Thareja R, Python Programming using Problem Solving Approach, Oxford University Press, 2017
4	Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2nd edition, Updated
	for Python 3, Shroff/O'Reilly Publishers, 2016.

5	John V Guttag, <i>Introduction to Computation and Programming Using Python</i> , Revised and expanded Edition, MIT Press, 2013.								
Cou	Course Outcomes								
At t	At the end of the course, students will be able to								
COI	Write algorithms for problems								
	Write algorithms for problems								
CO	Use syntax and semantics of Python programming language for problem solving								
002	Ose syntax and semantics of 1 ython programming language for problem solving								
CO3	Code a given logic in Python language								
CO	Appreciate and apply appropriate Data structures available in Python language for								
00-	solving problems								
	solving problems								

	C. J.	_	ODID 11				
	rse Code rse Title	:		Virvil Engin	anina		
	iber of Credits	÷	Basics of C	JVII Engin	eering		
	C Breakup	:	2	т	D	Contract hours	C
	C breakup	•	L	Т	P	Contact hours	C
			2	0	0	2	2
	equisites (Course code)	:	Nil				
	rse Type	:	GIR				
Cour	rse Learning Objectives						-
•	students of all branches	of	Engineerin	g.			
Cour	rse Content						
	erties and uses of constructio	n n	naterials - sto	ones, bricks	, cement.	concrete and steel.	
Road Mark Surve	ck and stone masonry - Plaste ls-Classification of Rural and king-Traffic Signals. eying - Classification-Chain ey equipment.	l ur	ban Roads- I	Pavement N	Aaterials-	Traffic signs and ro	
Intru	ces of Water - Dams- Water sion – Recharge of Ground V	-		of Water-V	Vastewate	er Treatment – Sea	Water
Intrus Refe	sion – Recharge of Ground V rence Books	Vat	er.				
Intrus Refe	sion – Recharge of Ground V	Vat	er.				
Intru: Refe	sion – Recharge of Ground W rence Books Punmia, B.C, Ashok Kumar	Vat Jai	n, Arun Kun	nar Jain, Ba	sic Civil	Engineering, Laksh	
Intru: Refer 1	sion – Recharge of Ground W rence Books Punmia, B.C, Ashok Kumar 2012.	Vat Jai	er. n, Arun Kun ineering, Pea	nar Jain, Ba urson Publis	sic Civil	Engineering, Laksh 9.	nmi Publishers,
Intrus Refer 1 2 3 4	sion – Recharge of Ground W rence Books Punmia, B.C, Ashok Kumar 2012. Satheesh Gopi, Basic Civil E	Jai Ing teri	er. n, Arun Kum ineering, Pea als, Charotai	har Jain, Ba urson Publis Publishing	shers, 200 g House, I	Engineering, Laksh 9. Pvt. Limited, Editio	nmi Publishers,
Intrus Refer 1 2 3 4 5	sion – Recharge of Ground W rence Books Punmia, B.C, Ashok Kumar 2012. Satheesh Gopi, Basic Civil E Rangwala, S.C, Building ma Palanichamy,M.S, Basic Civ Lecture notes prepared by	Vat Jai Ing teri il E	n, Arun Kun ineering, Pea als, Charotar Engineering,	nar Jain, Ba arson Publis Publishing Tata McGr	shers, 200 g House, 1 aw Hill, 2	Engineering, Laksh 9. Pvt. Limited, Editio 2000.	nmi Publishers,
Intrust Refer 1 2 3 4 5 Court	sion – Recharge of Ground W rence Books Punmia, B.C, Ashok Kumar 2012. Satheesh Gopi, Basic Civil E Rangwala, S.C, Building ma Palanichamy,M.S, Basic Civ Lecture notes prepared by rse Outcomes	Jai Jai Eng teri il E De	er. n, Arun Kun ineering, Pea als, Charotar Engineering, epartment of	nar Jain, Ba arson Publis Publishing Tata McGr	shers, 200 g House, 1 aw Hill, 2	Engineering, Laksh 9. Pvt. Limited, Editio 2000.	nmi Publishers,
Intrust Refer 1 2 3 4 5 Court At th	sion – Recharge of Ground W rence Books Punmia, B.C, Ashok Kumar 2012. Satheesh Gopi, Basic Civil E Rangwala, S.C, Building ma Palanichamy,M.S, Basic Civ Lecture notes prepared by rse Outcomes and of the course, students	Jai Jai Eng teri il E De	n, Arun Kum ineering, Pea als, Charotar Engineering, epartment of Il be able to	nar Jain, Ba urson Publis Publishing Tata McGr f Civil Eng	sic Civil I shers, 200 g House, I aw Hill, 2 gineering	Engineering, Laksh 9. Pvt. Limited, Editio 2000. , NITT.	nmi Publishers, on 27, 2009.
Intrust Refer 1 2 3 4 5 Court	sion – Recharge of Ground W rence Books Punmia, B.C, Ashok Kumar 2012. Satheesh Gopi, Basic Civil E Rangwala, S.C, Building ma Palanichamy,M.S, Basic Civ Lecture notes prepared by rse Outcomes the end of the course, students the students will gain kn of buildings, roads and w	Vat Jai Jai Cng teri il E De wi	er. n, Arun Kum ineering, Pea als, Charotan Engineering, epartment o Il be able to ll be able to vledge on si er resources	har Jain, Ba urson Publis Publishing Tata McGr f Civil Eng te selectio	shers, 200 g House, I aw Hill, 2 gineering	Engineering, Laksh 9. Pvt. Limited, Editic 2000. 3, NITT.	on 27, 2009.

Cou	urse Code	:	ENIR12										
	ırse Title	:	Energy an	d Environ	mental E	ngineering							
Nur	mber of Credits		2										
LT	PC Breakup	:	L	Т	Р	Contact hours	С						
			2	0	0	2	2						
Pre	requisites (Course code)	:	Nil										
	ırse Type	:	GIR										
Cou	urse Learning Objectives												
	• To teach the principal ren	lew	able energy s	systems.									
	• To explore the environmental impact of various energy sources and also the effects of												
	different types of pollutants.												
Course Content													
	sent Energy resources in In												
Pla	ntEnergy Demand Scenar	io i	n India-Adv	vantage an	d Disadv	antage of conve	ntional Po	ower					
Pla	nts - Conventional vs Non-	cor	ventional p	ower gene	eration.								
Bas	sics of Solar Energy- Solar	Γhe	rmal Energ	y- Solar P	hotovolta	ic- Advantages	and						
Dis	advantages-Environmental	im	pacts and sa	fety.		_							
	wer and energy from wind t				ergy pote	ntial- Types of v	vind turbi	nes					
	Shore Wind energy- Enviro					71							
	mass Resources-Biomass c					ck preprocessing	g and treat	ment					
	thods- Bioenergy program i												
	othermal Energy resources -												
	0.						r pollutio	n					
				r pollution- Sources, effects, control, air quality standards, air pollution act, air pollution									
me	neasurement. Water Pollution-Sources and impacts, Soil Pollution-Sources and impacts,												
		-80	urces and in					11					
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Course Code	:	PRIR11								
Course Title	:	Engineerin	Engineering Practice							
Number of Credits		2	2							
LTPC Breakup	••	L	Т	Р	Contact hours	С				
		0	0	2	2	2				
Prerequisites (Course code)	:	Nil								
Course Type	:	GIR								

- To use hand tools and machinery in Carpentry, welding shop, Foundry, Fitting shop and Sheet Metal work.
- To manufacture engineering products or prototypes.

Course Content

Foundry: Mould preparation for Flange and Hand Wheel, Plastic moulding / Wax moulding.

Welding: Fabrication of Butt Joint and Fabrication of Lap Joint.

Carpentry: Wood sizing exercise in planning, marking, sawing, chiseling and grooving to make; Tee Through Halving Joint and Dovetail Scarf Joint.

Fitting: Preparation of joints, markings, cutting and filling for making; Semi-circle part with the given work piece, Dovetail part with the given work piece.

Sheet metal: Fabrication of Dust Pan and Fabrication of Corner Tray.

Refe	Reference Books								
1	R.K. Rajput, Workshop Practice, Laxmi Publications (P) Limited, 2009.								
2	Shashi Kant Yadav, Workshop Practice, Discovery Publishing House, New Delhi, 2006.								
Cou	Course Outcomes								
At the end of the course, students will be able to									
CO1	Know to utilize hand tools and machineries in Carpentry, Welding shop, Foundry, Fitting								
	shop and Sheet Metal work.								
CO2	Produce simple engineering products or prototypes								
_									

Course Code	:	MTPC10								
Course Title		Engineerin	Engineering Mechanics and Strength of Materials							
Number of Credits		4	4							
LTPC Breakup	:	L	Т	Р	Contact hours	С				
		3	1	0		4				
Prerequisites (Course code)	:	NIL								
Course Type	:	PC								

To enhance the knowledge in the area of rigid body mechanics. Determine the stresses, strains on various structural object, displacements in various structures and their components under the specific external loads such as axial load, bending, shear load as well as torsion.

Course Content

Engineering Mechanics

Point force and distributed forces- Equivalent systems of Forces – Equilibrium of Rigid Bodies – Free body Diagram – Centroids and Center of Gravity. Dry Friction, Wedge Friction, Disk Friction (thrust bearing), Belt friction, Square of threaded screw, Journal bearings (Axle friction), Wheel friction, Rolling resistance, Moment of Inertia

Concurrent Forces in a Plane and its Equilibrium, Centroids of Composite Plane Figures, General Case of Forces in a Plane.

Moment of Inertia of Plane Figures, Parallel Axis Theorem, Polar M.I., Concept of Mass M.I.,

Strength of Materials:

Simple Stress and Strain, Stresses on Inclined Plane, Two-dimensional Stress Systems, Principal Stress and Principal Planes, Mohr's Circle.

Shearing Force and Bending Moment, Types of Loads, Types of Supports, S.F. and D.M. Diagrams for Cantilever and Simply Supported Beams under Concentrated Loads and under U.D.L.

Flexure formula, Bending Stresses on the above types of Beams and Circular Sections.

Torsion of Circular Shafts, Determination of Shear Stress.

Reference Books

1	S. Timoshenko, Engineering Mechanics, Mc Graw Hill India, 2017									
2	R.K. Bansal, Strength of Materials, Laxmi Publication, 3rd Edition, 2010									
3	S. Ramamrutham, Strength of Materials, Dhanapat Rai, 2008.									
4	Irving H.Shames, Engineering Mechanics – Statics and Dynamics, 4 th Ed, Prentice Hall of India PVT.Ltd Eastern Economy Edition, 2005.									
Course Outcomes										
At t	ne end of the course, students will be able to	PO Correlation								
		Low	Medium	High						
CO	solve problems dealing with forces in plane or in space and equivalent forces systems			1,2,4						
CO2	identify, analyse and solve problems related to rigid body mechanics involving friction.			1,12						
CO3	Understand the different types of material behaviour such have elastic, plastic, ductile and brittle		5	1,3,4						
CO4	Study the fundamental mechanics of solid deformable bodies.			1,2,4						
COS	Use the concept of moment of inertia of lamina for different shapes		5	1						

Cour	se Code	:	HSIR13					
	se Title	:						
		•						
	ber of Credits		3					
LTPO	C Breakup	:	L	Т	Р	Contact ho		
			3	0	0	3	3	
Prere	equisites (Course code)	:	Nil					
Cour	se Type	:	GIR					
Cour	se Learning Objectives							
indivi consist and tr Cour	ovide a thorough understand iduals and the application of stent reasoning about interna rade policy. se Content	tho tio	ose principles nal flows of	s to the wor goods, fact	rld around cors of proc	them and a fiduction, and f	ramework f financial as	or sets,
Foreca propor Marke Types, Produc Institu Introdu Interna Trade, Free T Balanc Regior	nd Analysis and Forecastin asting techniques, Consum- tions, Returns to Scale, Iso t Analysis and game theory. , Location, Efficiency and Fin- ctivity and Capacity Utiliza- tional Investment, Euro Issue actional Investment, Euro Issue actional Trade. Theories - Tern Exchange rate. Trade, Protection and Tariffs, the of Trade and Balance of Pa- nal Economic Groupings an actional Institutions: GAIT, W	er oqu nan ttio es, ttio ms , B ayr ayr	behaviour. ants Analys ace: Mergers n, Shares, I GDR, ADR, nal Trade. of Trade- Co alance of Pa nents. International	Productio is, Product & Amalga Debentures, External C Inter-regio Dincept, Me yments: Fr	n, Cost, ion Funct mations, L Bonds, I Commercia nal and i asurement, ee Trade, ns: BRICS	and Market iqn, Cost Cu cocation of Ind Deposits, Loa I Borrowings international , Types, Facto Protection- Q	structure: irves, Cost dustries and an etc. FD 3. Trade. Pro ors affecting Quotas, Dun	Variable Function, I Theories, I, Foreign oblems of g Terms of nping, etc.
	rence Books	mi	Theory" C	hand & Ca	v 1008			
	Dewett KK, "Modern Economic Theory", Chand & Coy, 1998.							
	Gupta C.B., "Business Organisation and Management", Chand.S & Coy, 1998.							
	Maheswari S. N., "An Introduction to Accountancy", Vikas publishing House Pvt. Ltd, 1999.							
	Ramasamy VS, NamaKumari S., "Marketing Management", MacMillan India Pvt. Ltd, 1996. Aswathappa K., "Organizational behavior", PHI India Pvt. Ltd, 1998.							
	rse Outcomes	Ла			l vi. Liu, 1	<i>))</i> 0.		
	e end of the course, students	wi	ll he able to				PO Correlat	ion
110 010	e end of the course, students	** 11	In be able to			Low	Medium	High
CO1	Demand and supply analysis forecasting Cost analysis, the functions and its theories						2	1,11
CO2	Mergers & Amalgamations efficient use of finance in M			eories and t	ypes and t	he	1	11
CO3	Features of International tra and international trade and						1	11
	and Balance of Payments						1	11
CO5	Regional Economic Groupi Institutions	ng	s and Interna	tional Fina	ncial		1	11

Course Code	:	MTPC11							
Course Title	:	Metallurg	Metallurgical Thermodynamics and kinetics						
Number of Credits		4							
LTPC Breakup	:	L	Т	Р	Contact hours	С			
		3	1	0	4	4			
Prerequisites (Course code)	:	NIL			• •		-		
Course Type	:	PC							
Course Learning Objectives									

To learn the basic principles and concepts of thermodynamics, in terms of various laws pertinent to gaseous, liquids (solutions) and solid systems and their significance in various of metallurgical processes

Course Content

Types of system, state of a system, state properties- First law of thermodynamics; heat of reaction, heat of formation, standard heats, heat of transition; Hess's law of heat summation.

Second law, entropy of irreversible processes, combined statements of 1st and 2nd laws - Maxwell's relations, Clausius- Clapeyron equation, Trouton's rule, Gibb's - Helmholtz relations.

Third law of thermodynamics, relation between C_P and C_V , Nernst heat theorem, equilibrium constant, Van't Hoff equation, concept of fugacity, activity, mole fraction.

Thermodynamics of solutions, Gibb's Duhem equation, partial molar properties of mixing, concept of chemical potential, ideal solution, Raoult's law, Henry's law; nonideal solution, excess functions, regular solutions.

Sievert's law- residual gases in steel-properties and functions of slags, slag compositions, structure of molten slags, molecular theory, concept of basicity index, ionic theory; thermodynamics of slag- metal reactions.

Kinetics: First, Second and third order reactions, Arrhenius equation - activation energy, Determination of order of the reaction, rate constants and rate limiting steps. Numerical problems on the concepts mentioned in all the above units.

1	Tupkary R.H., 'Introduction to Metallurgical Thermodynamics', 1st Ea	lition, TU	Publishers,	1995							
2	Upadhyaya G.S., DubeR.K., 'Problems in Metallurgical Thermodynamics	mics and	Kinetics', l ^s	^t Edition,							
	PergamonPress,1977										
3	3 Ahindra Ghosh, 'Text book of Materials and Metallurgical Thermodynamics', PHI Learning, 2002.										
Cou	rse Outcomes										
At t	ne end of the course, students will be able to	F	O Correlati	ion							
		Low	Medium	High							
CO	Matter, energy, heat- Types of system, state function, first law of thermodynamics, its significance, standard heats of formation, laws of thermochemistry- Numerical examples.			1, 2							
CO2	Nature and second law of thermodynamics-various statements, concept of entropy, Maxwell, Clausius-Clapeyron equations, Trouton's rule, Gibbs Helmholtz relation and their importance - Numerical examples.			1, 2							
CO3	The need for third law of thermodynamics-statement and its relevance to perfectly pure crystalline substances - Numerical examples.			1, 2							

CO4	Thermodynamics of solutions; Gibbs-Duhem relation-partial molar properties-chemical potential Raoult's law, Henry law, on-ideal solutions, excess functions and regular solutions-Numerical examples.		1, 2
CO5	Thermodynamics of gases in metals: Sievert's law and its significance, thermodynamics of slag –metal interactions – numerical examples.	4, 7	12
CO6	Kinetics: order of a reaction, rate constants and rate limiting steps –Numerical examples	4, 5	3, 6, 12

Course Code	:	MTPC12								
Course Title	:	Physical M	Physical Metallurgy							
Number of Credits		4								
LTPC Breakup	:	L	Т	Р	Contact hours	С				
		3	1	0	4	4				
Prerequisites (Course code)	:	NIL								
Course Type	:	PC								

To develop an understanding of the basic principles of physical metallurgy and apply those principles to engineering applications.

Course Content

Crystallography - co-ordination number, effective number of atoms, packing factor, crystal system relevant to metals, indexing of crystal planes and directions in cubic and hexagonal system, linear and planar density, interplanar spacing.

Crystal imperfections and its types; point defects, dislocations - unit dislocation, partial dislocation, motion of dislocations, slip and twin crystal orientation, concept of texture, grain and grain boundaries, methods of grain size determination.

Self-diffusion, diffusion in alloy, diffusion mechanisms, activation energy, laws of diffusion- Fick's I law, II law, inter-diffusion and Kirkendall effect, types of diffusion and examples of diffusion; problems based on diffusion.

Solid solutions and its types and intermediate phases - Hume Rothery's rule - solidification of metals and alloys, cooling curves, concepts of phase diagrams, coring and segregation as applied to various binary systems, ternary systems.

Thermodynamic properties of binary metallurgical systems, free energy- composition curves and their relation to phase diagrams of different types; ternary phase diagram - Gibbs phase triangle.

1	Reza Abbaschian, Reed Hill R.E., 'Physical Metallurgy Principles', 4th Ed, Cengage Learning, 2008
2	<i>R. Balasubramaniam, Callister's Material Science and Engineering: Indian Adaptation, 2nd Ed,</i>
	John Wiley & Sons 2009

- **3** Raghavan V., 'Physical Metallurgy Principles and Practice', PHI Learning Private Limited, 2015
- 4 Donald R. Askeland, Pradeep P. Fulay, Essentials of Materials Science and Engineering, Cengage Lerning, 2013

Cour	rse Outcomes					
At th	e end of the course, students will be able to	PO Correlation				
		Low	Medium	High		
CO1	Understand the geometry and crystallography of crystalline materials; Identify planes and directions in crystal systems.	5	2,4,12	1		
CO2	Recognize the nature of the crystal defects; estimate the grain size	5	2,4	1		
CO3	Apply the concept of diffusion in designing heat treatment	5	2,4	1		
CO4	Understand the concept of phase diagram in recognizing the phase changes during heating/cooling	5	2,4	1		
CO5	Apply thermodynamic concepts in the construction of phase diagrams	5	2,4	1		

Сош	rse Code	•	MTPC13					
	rse Title	•		Electronic	c and Mag	gnetic Mater	ials	
	ber of Credits	•		Lieedom			iuis	
	C Breakup	:	3	Т	р	Contact how		
	Сысакир	•			P	Contact hou		
D	••• (0 1)		3	0	0	3	3	
	equisites (Course code)	:	Nil					
	rse Type rse Learning Objectives	:	PC					
mater	nderstand the basic principles rials and to study the various rse Content		• •	•		v	· ·	ties of
dielec and p Origi Magr earth Conc struct applia Semi mater single techn Princ	omena - concept of polarization ctric breakdown - ferro electro properties. In of Magnetism - Introduction alloys - fine particle magnet ept of superconductivity – B ture and properties – specific cations. conducting materials and typ rials in devices – Production e crystals- zone melting – Cz siques – Lithography piples of photoconductivity, I rials –LCD, LED and diode I 103.	ficiti on ft n s. CS sup pess of s coch	to dia, para nagnetic mat theory of su per conducti ; simple, cor silicon starti malski methe	ectricity and , ferri and the rerials- iron per conducting material npound and ng material od – Epitax photo detect	l pyro elec ferro magr based allo tivity – Ty s – Fabrica l oxide sen s – methoc ial films by ctors – Opt	tricity – BaTi netism – Curi- ys - ferrites ar pes of super c ation and engi niconductors - ls for crystal g y VPE, MBE ical disc and o	O ₃ – structu e temperatu nd garnets – conductors - neering - semicondu growth for b and MOCV	are – rare -YBCO- acting pulk D nic
	rence Books							
1	Electronic, Magnetic, and O	ptie	cal Material	s, Pradeep	Fulay , Ju	ng-Kun Lee,	CRC press,	2016
	Kittel C., 'Introduction to So Publishers, 2004	lid	State Physic	s', 7 th Editi	on, Wiley I	Eastern, New	Internation	al
	Ed. Kasap and Capper, hand					erials, 2006, N	VY.	
	Dekker. A.J, Solid state Phys					-1		
	Van Vlack L.H, Elements of			-	-			
	Raghavan V, Materials Scier	ice	and Enginee	ering – A Fi	erst Course	e, Prentice Ha	II India, 20	04.
	rse Outcomes		1 1 1.1 (~	0.0 1 -!	
At th	e end of the course, students	W1	ii be able to				O Correlati Medium	
CO1	Understand various electr	ice	l nhenomor	on such a	e hand a	Low ap 5	3	High 1
01	theory, ferro electricity, pie with dielectric behaviour of	zo f m	electricity an aterials	nd pyro elec	ctricity alo	ng		1
CO2	materials exhibiting magne industry with recent advance	tisn	n and their d		• •	in	3	1
CO3	To study the theory of superconducting materials advancements						3	1

CO4	Understand the fundamentals of semiconducting materials and operational principles of solid-state devices made of these semiconducting materials. To learn various methods of producing semiconductors and their processing methods used in the semiconducting materials industry.	3	2	1
CO5	To learn about photoconduction phenomenon, optical materials and various optical devices and their performances.	5	3	1

Сош	rse Code	:	MTPC14						
	rse Title	:	Polymers, Composites and Ceramics						
			-	, composi					
	ber of Credits C Breakup	:	3	Т	р	Contact	h	C	
	Сысакир	•			P			<u>C</u>	
			3	0	0	3		3	
	equisites (Course code)	:	Nil						
	rse Type	:	PC						
	rse Learning Objectives evelop the basic knowledge of	..				1	1		
	entional metals and alloys to								
Cour	rse Content								
	duction - as a material, classi		• •	•					oach,
	ysts in polymerization, molec	cula	ar weight det	ermination	, methods	s of molect	ular weigl	nt	
chara	acterization								
impo	ic compounding of plastics n rtant engineering plastics - L lose, elastomers								e to
	ication technology and polym plastic fibers, elastomers, adhe								
polyr	mers			11			1		
		, ue	neral proper		mics: and		-	amic	
Intro	mers duction to ceramic materials; rials; Bonding and structure (ties of cera		classificat	-	amic	
Intro mater	duction to ceramic materials;	of c ng;	oxide and no Structure-pr	ties of ceran	amic mate	classificat erials;	ion of cer		ion of
Intro mate: Intro ceran	duction to ceramic materials; rials; Bonding and structure of duction to ceramics processin nic materials for different ap rence Books	of c ng; plic	oxide and no Structure–pr cations	ties of cera n-oxide cer roperty corr	amic mate	classificat erials; ceramic n	ion of cer		ion of
Intromate: Introcerant Refe 1	duction to ceramic materials; rials; Bonding and structure of duction to ceramics processin nic materials for different ap rence Books Billmeyer F., 'Textbook of P	of c ng; plic	oxide and no Structure–pr cations mer Science	ties of ceran n-oxide cer roperty corn	amic mater relation in	classificat erials; ceramic n	ion of cer naterials;	Selecti	
Intromate Introcerant Refe 1	duction to ceramic materials; rials; Bonding and structure of duction to ceramics processin nic materials for different ap rence Books Billmeyer F., 'Textbook of Po Richerson D. W., 'Modern C	of c ng; plic olyn Cera	oxide and no Structure–pr cations mer Science	ties of ceran n-oxide cer roperty corn	amic mater relation in	classificat erials; ceramic n	ion of cer naterials;	Selecti	
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Course Code	:	MTLR30							
Course Title	:	Process M	Process Metallurgy Laboratory						
Number of Credits		2							
LTPC Breakup	:	L	Т	Р	Contact hours	С			
		0	0	2	2	2			
Prerequisites (Course code)	:	NIL			·		•		
Course Type	:	ELR							

To learn about the properties of minerals; to become familiar with equipment used in mineral processing, by means of experiments / demonstration of laboratory scale equipment

Course Content

List of experiments:

- 1. Determination of Flash and fire point
- 2. Viscosity Measurement
- 3. Proximate analysis of coal
- 4. Determination of calorific value using Bomb Colorimeter
- 5. Sieve analysis and determination of size distribution in sample
- 6. Estimation of screening efficiency
- 7. Sedimentation and decantation
- 8. Jaw crusher
- 9. Demonstration of Froth floatation
- 10. Observations of mineral samples
- 11. Observations of furnaces and temperature calibration

Reference Books

1	Gupta O. P., ' Elements of Fuels, Furnaces and Refractories', 2 nd Edition, Khanna Publishers, 1990
2	Barry A. Wills, Tim Napier-Munn, Mineral Processing Technology: An Introduction to the

Practical Aspects of Ore Treatment and Mineral Recovery, Elsevier Science & Technology, 2006
 Process Metallurgy Laboratory Manual, NIT Tiruchirappalli, 2019.

Cour	se Outcomes			
At th	e end of the course, students will be able to	P	O Correlati	on
		Low	Medium	High
CO1	Analyse the various properties of solid and liquid fuels		3	1,2,4
CO2	Perform sieve analysis to determine the particle size distribution of any given sample.		4	1,2
CO3	Understand the principle of settling velocity and sedimentation of solid particles in a vertical column of fluid		3	1,2
CO4	Reduce the particles size using jaw crusher and determine the screening efficiency		4	1,2
CO5	Understand the working of different type of furnaces and the temperature calibration		4	1,2

Course Code	:	MTLR31					
Course Title	:	Polymers,	Polymers, Composites and Ceramics Laboratory				
Number of Credits		2					
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		0	0	2	3	2	
Corequisites (Course code)	:	MTPC14					
Course Type	:	ELR					

To become familiar with the synthesis and various testing and characterization techniques used for polymer, composite and ceramic materials

Course Content

- 1. Determination of molecular weight and density of polymers
- 2. Synthesis of polymer
- 3. Melt flow index of polymer
- 4. Environmental stress cracking resistance of polymer
- 5. Fabrication of polymer composites
- 6. Hardness of polymer/composite materials/ceramics
- 7. Tensile strength of the polymer composites
- 8. Flexural testing of polymer composites/ceramics
- 9. Impact strength of polymer composites
- 10. Synthesis of nanostructured ceramic particles
- 11. Fabrication of ceramic coatings on metals by plasma electrolytic oxidation
- 12. Structural parameters/ Functional groups analysis of ceramic materials
- 13. Band gap measurement of ceramic materials/coatings

Ittit	A CHEC DOOKS							
1	G.M. Swallowe, Mechanical Properties and Testing of Polymers: An	A–Z Ref	erence, Spri	nger				
	Netherlands, 1999							
2	2 W. Grellmann, S. Seidler, Polymer Testing, Carl Hanser Verlag, Munich 2007							
3	Polymers, composites and ceramics laboratory manual, NIT Tiruchir	appalli, 20)19.					
Cou	rse Outcomes							
At th	he end of the course, students will be able to	F	PO Correlati	on				
		Low	Medium	High				
CO1	Determine the molecular weight of the polymer materials		2	1,4				
CO2	Synthesize and characterize different polymeric materials	9	3	1,2				
CO3	Fabricate particulate/fiber reinforced polymer matrix composite materials	9	3	1,4				
CO4	Test and characterize the mechanical properties of polymer and composite materials		2,4	1,3				
CO5	Synthesize and characterize ceramic powders and coatings		2,3	1,4				

Cour	rse Code	:	MAIRYY				
	rse Title	:		fferential	Equations	s and Numerical N	Methods
Num	ber of Credits		4				
LTPO	C Breakup	:	L	Т	Р	Contact hours	С
			3	1	0	4	4
	equisites (Course code)	:	MAIR21				
	rse Type	:	GIR				
	se Learning Objectives						
1. 2. 3. 4.	discuss various approach to construct mathematical mo introduce various numerica validate numerical solution	ode al a	l and solution lgorithm to f	n of some p ind numer	physical price	roblem	equation.
Cour	rse Content						
Class Lapla	er series in complex form – ification of second order line ace equation; Solutions of on	ear ie d	partial differ imensional h	rential equa leat and wa	ve equation		
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Course Code	:	MTPC15					
Course Title	:	Phase Tra	Phase Transformation and Heat Treatment				
Number of Credits		4					
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		3	1	0	4	4	
Prerequisites (Course code)	:	MTPC12					
Course Type	:	PC	PC				

To study the phase changes that occurs during both thermal and thermo mechanical treatments.

Course Content

Introduction and classification of phase transformations. Diffusion in solids: phenomenological approach and atomistic approach. Nucleation and growth theories of vapour to liquid, liquid to solid, and solid to solid transformations; homogeneous and heterogeneous strain energy effect during nucleation; interface-controlled growth and diffusion controlled growth; overall transformation kinetics.

Principles of solidification, evolution of microstructures in pure metals and alloys. Precipitation from solid solution: types of precipitation reactions, crystallographic description of precipitates, precipitation sequence and age hardening, spinoidal decomposition.

Iron-carbon alloy system: iron-carbon diagram, nucleation and growth of pearlite, cooling of hypoeutectoid, eutectoid, and hyper-eutectoid steels, development of microstructures in cast irons. Heat treatment of steels: TTT and CCT diagrams, bainitic transformation, martensitic transformation, hardenability, role of alloying elements in steels

Conventional heat treatment of steels. Massive transformation. Order-disorder transformation. Phase transformations in and heat treatment of some common non-ferrous metals and alloys

Types of furnaces and furnace atmospheres; quenching media; types of quenching, mechanism of quenching, quenching characteristics, choice of quenchants; surface hardening of steels- carburizing, nitriding, carbonitriding and others.. Various thermo-mechanical treatments; Designing for heat treatment, defects in heat treated parts, causes for the defects in heat-treated parts and remedies

Ref	erence Books			
1	Porter, D.A, Easterling, K.E., and Sherif, M.A., Phase transformations	s in metal	s and alloys	s, 3 rd Ed,
	CRC press, 2017.			
2	Reza Abbaschian, Robert E. Reed-Hill, Physical Metallurgy Principle	s, Cengag	ge Learning	, 2008
3	Lakhtin Y., 'Engineering Physical Metallurgy', 2 nd Edition, Universit	ty Press c	of the Pacifi	c, 2000
4	Prabhu Dev K. H., 'Handbook of Heat Treatment of Steel', McGraw H	Hill Educa	ation, 2003	
Cou	irse Outcomes			
At t	he end of the course, students will be able to	Р	O Correlati	on
		Low	Medium	High
CO	I Understand the liquid –Solid transformational with respect to their	8,11	43,	1,2
	nucleation and growth phenomena			
CO2	2 Study the kinetics and mechanism of solid-solid phase	8	3	1,3
	transformation and understand the structureproperty relation			

CO3	Comprehensive understanding on Fe-Fe ₃ C Phase diagram and Time		2,4	1,2,3
	-Temperature -Transformation diagram and study their structural			
	transformation with varying temperature			
CO4	Know the different heat treatment processes and understand their	9	7	1,5
	industrial practice and applications			
CO5	Demonstrate the various surface thermal and chemical processing;	9	5	7
	thermo-mechanical treatment and understand the heat treatment			
	issues and remedial measures			

Course Code	:	MTPC16					
Course Title	:	Transport	Fransport Phenomena				
Number of Credits		3					
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		3	0	0	3	3	
Prerequisites (Course code)	:	NIL					
Course Type	:	PC					

To understand basic concepts related to heat flow, fluid flow, mass transfer, in the context of metallurgical processes; to become familiar with the mathematical treatment and equations related to above transport phenomena; to comprehend the science behind process modelling.

Course Content

Fluid Flow - Viscosity – differential mass and momentum balances –overall momentum balance – mechanical energy balance – applications

Heat Transfer – heat conduction equation – applications – steady and transient heat conduction. Two dimensional heat conduction

Convective heat transfer –concept of heat transfer coefficient – forced and free convection; Radiation – view factor - radiative heat exchange between surfaces

Mass Transfer - Diffusion: Diffusivity in gases, liquids, solids – convective mass transfer –concept of mass transfer coefficient

Dimensionless analysis – Rayleigh's method, Buckingham method – use of differential equations – similarity criteria – applications in physical modeling

Reference Books

1 A.K. Mohanty, "Rate Processes in Metallurgy", PH India Ltd., 2000

- 2 B.R.Bird, Stewart, Lightfoot, 'Transport Phenomena', John Wiley, New York, 1994
- 3 Poirier D.R. and Geiger G.H., 'Transport Phenomena in Materials Processing', Springer International Publishers, Switzerland, 2016

Cour	se Outcomes				
At th	e end of the course, students will be able to	PO Correlation			
		Low	Medium	High	
CO1	Solve mass and energy balance calculations involved in fluid flow	12	4	1,2,3	
CO2	Use the heat conduction equations in solving 1D and 2D heat transfer in real time situations	12	5	1,2,3	
CO3	Differentiate the forced and free convection and perform calculations on convective and radiative heat transfer	5, 12	4	1,2,3	
CO4	Understand the concepts of diffusion, diffusivity in different materials and mass transfer coefficient	12	4	1,2	
CO5	Model any processes by converting actual (descriptive) processes into appropriate equations and then attempt to solve the same	11	5	3,4,12	

Course Code	:	MTPC17					
Course Title	:	Mechanica	al Behavio	our and To	esting of Materi	als	
Number of Credits		4					
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		3	1	0	4	0	
Prerequisites (Course code)	:	MTPC12					
Course Type	:	PC					

To know the fundamental concepts of mechanical behavior of materials, various mechanical testing practices and to apply them to design the materials for various load-bearing structural engineering applications.

Course Content

Elastic and plastic deformation, stress-strain relationship; plastic deformation of metallic materials, Mohr's circle, Yielding criterion- Von Misses, and maximum-shear-stress/Tresca yielding criterion, failure criteria under combined stresses

Elements of theory of plasticity, dislocation theory, properties of dislocation, stress fields around dislocations, elementary dislocation interactions; application of dislocation theory to work hardening and strengthening mechanisms.

Engineering stress-strain curve, true stress-strain curve, instability in tension, stress distribution at the neck, ductility measurement, effect of strain rate and temperature on flow properties, testing machines, Tensile properties of important materials.

Introduction, Brinell, Vickers and Rock well hardness tests, Meyer hardness, analysis of indendation by an indenter, relationship between hardness and the flow curve, microhardness tests, hardness conversion; hardness at elevated temperatures. Introduction to torsion, torsional stresses for large plastic strains, types of torsion failures torsion test vs. tension test, hot torsion testing.

Introduction to fatigue testing, practice and evaluation; fatigue crack growth; low cycle, high cycle fatigue; Introduction to creep; stress rupture testing; creep data extrapolation; fatigue-creep interactions; superplasticity.

Refe	Reference Books								
1	Dieter G. E., 'Mechanical Metallurgy', 3 rd Edition, McGraw Hill Pul	olications,	2004						
2	2 Dowling NE, Mechanical Behaviour of Materials, 4 th Ed, Pearson, 2013								
3	Hull, D., Bacon, D.J., Introduction to Dislocations, 5th Ed., Butterwork	th-Heiner	nann, 2011						
4	Suryanarayana, AVK., 'Testing of Metallic Materials', BS Publicatio	ns, 2018							
Cou	rse Outcomes								
At t	he end of the course, students will be able to	F	O Correlati	ion					
		Low	Medium	High					
COI	Understand the basics of elastic and plastic deformation behaviour of materials		2	1					
CO2	Analyse the plasticity, dislocation and strengthening mechanisms		2	1					
CO3	Understand and analyse the tensile behaviour of materials and correlating with microstructures		2	1					
CO4	Understand and analyse various other mechanical testing practices		2	1					
COS	Understand fatigue and creep behaviour and evaluate & design materials for better creep and fatigue resistance	4	2,3	1					

Course Code	:	MTLR32					
Course Title	:	Metallogra	Metallography and Heat Treatment Laboratory				
Number of Credits		2					
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		0	0	2	2	2	
Co-requisites (Course code)	:	MTPC15			•		
Course Type	:	ELR					

- To learn and to gain experience in the preparation of metallographic specimens.
- To examine and analyse the microstructures of carbons steels, alloy steels, cast irons and other ferrous materials.
- To understand the basic principles of optical microscopy to measure the grain size of materials

Course Content

- 1. Specimen preparation for metallographic observation -working of metallurgical microscope, Grain size measurements
- 2. Microstructure cast iron -gray, nodular and malleable iron -unetched & etched
- 3. Microstructure of gray, nodular and white iron –etched
- 4. Microstructure of steels (Carbon steels & Alloy steels)
- 5. Microstructure of stainless steels and high speed steels
- 6. Conduct of different heat treatment processes such as annealing and normalising and study their microstructure
- 7. Perform the hardening and tempering and assess the hardening characteristics using hardness test
- 8. Heat treatment of non-ferrous alloys (Precipitation hardening) and understand the effect of parameters
- 9. Experiment on Jominey End Quench test
- 10. Heat treatment of various alloy steels and understand their microstructure

Cour	se outcomes			
At th	e end of the course, students will be able to	P	O Correlati	on
		Low	Medium	High
CO1	Understand the basic metallographic practices and know the microscopic facilities		2	1
CO2	Analyse the structural features of ferrous alloys: carbon steels, cast iron, alloy steels		2,3	1,4
CO3	Perform the various basic heat treatment processes and know their effect on structural transformation		2,3	1,4
CO4	Conduct the precipitation hardening heat treatment and correlate structure-property		2	1,4
CO5	Learn the heat treatment practices for various speciality steel and understand their importance		2,3	1

Course Code	:	MTLR33					
Course Title	:	Materials	Testing ar	nd Inspecti	ion Laboratory		
Number of Credits		2					
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		0	0	2	2	2	
Co-requisites (Course code)	:	MTPC17			·		
Course Type	:	ELR					

To know the concepts of mechanical testing and to apply them for the destructive and nondestructive testing of various structural engineering applications.

Course Content

List of Experiments

- 1. Tensile testing using UTM
- 2. Tensile testing using Hounsfield tensometer
- 3. Hardness testing using Brinell and Rockwell methods
- 4. Hardness testing using Vickers method and microhardness testing
- 5. Impact testing of metals Izod/Charpy
- 6. Compression testing
- 7. Creep and torsion testing
- 8. Liquid penetrant testing
- 9. Magnetic particle testing
- 10. Ultrasonic testing Defect location and wear estimation

Course Outcomes								
At the	e end of the course, students will be able to	F	PO Correlati	on				
		Low	Medium	High				
CO1	Classify the different destructive and nondestructive testing methods with their inherent merits and limitations			1				
CO2	Analyse the test sample by different destructive testing methods of testing	5	9	2				
CO3	Differentiate between testing and inspection			1				
CO4	Analyse the test sample by different nondestructive testing methods of testing	5	9	2				
CO5	Conduct Investigations of engineering components	4						

Сош	rse Code	•	MTPC18						
	rse Title	:		ing and St	eel Maki	ng			
Num	ber of Credits		4	0		0			
	C Breakup	:	4 L	Т	Р	C	ontact hour	rs C	
	e Di cunup		3	1	0		4	4	
Dror	equisites (Course code)	:		_	0		4	4	
	rse Type	•	PC	MIFCIO					
	rse Learning Objectives	•	10						
To k	now the importance of the Iroution feasibilities in steel Ind			•	· · ·				
Cou	rse Content								
Class	sification of furnaces; differen	nt k	inds of furna	aces; heat b	alance, en	ergy	conservati	on and en	ergy audi
parts	, construction and design asp	ect	s of blast fur	nace, ancill	ary equip	ment	; blast furn	ace instru	mentatior
	t furnace reactions; Gruner's t ron and the slag; reactions in			.	-		U U		
failu	t furnace (B/F) operations; B re, modern trends in (B/F) uction of DRI (HBI/ Sponge	tecl	hnology ove						
Revi slag	iew of traditional steel makin metal interaction, role of sla		-	-	-				
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Course Code	:	MTPC 19						
Course Title	:	Metal Cas	sting Tech	nology				
Number of Credits		3						
LTPC Breakup	:	L	Т	Р	Contact ho	ours	С	
-		3	0	0	3		3	
Prerequisites (Course code	e) :	NIL						
Course Type	:	PC						
Course Learning Objective To know the basic concept materials		tal casting t	echnology	and to a	oply them to	produc	ce of	new
Course Content Introduction to casting and to foundry operations; patterns testing; different moulding	s; mouldi	ng practice; i				•		and
Types of furnaces used in fo alloys, copper alloys and ma Sand casting, permanent mo	agnesium	alloys; safe	ty consider	ations; flu	xing, degassii	ng and	inocul	
investment casting, continue Overview of pouring and se systems, functions of riser, visualization of mould fillin	, types of	riser, botto	m pouring			-	-	-
Overview of pouring and se	, types of ag (model directiona culation a	riser, botto ing), method l solidificati nd modificati	m pouring ling on, role of tion – with	and top	pouring, yield iltration of liq	d calcu	lations	5,
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Course Code	:	MTPC20						
Course Title	:	Materials	Joining T	echnology	1			
Number of Credits		3						
LTPC Breakup	:	L	Т	Р	Contact hours	С		
		3	0	0	3	3		
Prerequisites (Course code)	:	NIL						
Course Type	:	PC						

To know the concepts of different materials joining technology and emphasis on underlying science and engineering principle of every processes.

Course Content

Classification of welding processes, arc physics, power sources, working principle, advantages, limitations of arc welding processes –MMAW, GTAW, GMAW, SAW, ESW & EGW

Working principle, advantages and limitations of solid state welding processes. - Friction, friction stir, explosive, diffusion and ultrasonic welding.

Working principle, advantages and limitations of power beam processes: Plasma arc welding, electron beam & laser beam welding.

Principles of operation, process characteristics, types and applications – Resistance welding, Gas welding, brazing, soldering and joining of non-metallic materials.

Welding metallurgy: Introduction, thermal cycles, prediction of peak temperature, pre heat and cooling rate, PWHT. Weldability of carbon steel, stainless steel & aluminum. Hot & cold cracking phenomenon, weld defects, causes and their remedies

wer	d dereets, eduses and then remedies
Ref	erence Books
1	Parmer R. S., 'Welding processes'', Khanna Publishers, 1997
2	Robert W Messler, Jr. "Principles of welding, Processes, physics, chemistry and metallurgy",
	Wiley,2004.
3	Larry Jeffus, "Welding Principles and Applications" Fifth edition, Thomson, 2002

Course Outcomes At the end of the course, students will be able to PO Correlation Low Medium High CO1 Learn the working principle, merits and demerits of fusion welding 6, 7 3 1, 2, 9 processes CO2 Learn the working principle, merits and demerits of solid welding 6,7 3 1, 2, 9 processes 6.7 CO3 3 1.2.9 Understand the working principle and importance of welding allied processes 2 1, 3, 4, CO4 Solve welding heat flow related problems 5 Learn weldability and welding related problems of different 5.6 3, 7, 12 1, 2, 4, CO5 materials

Cour	rse Code		MTPC21					
	se Title	•		ming Tech	nology			
	ber of Credits	•			morogy			
	C Breakup	:	3	Т	D	Contact how	C	
	Сысакир	•	L 3	0	P	Contact ho	urs C 3	
Duon	equisites (Course code)		MTPC17	0	0	3	3	
	rse Type	:	PC					
	se Learning Objectives	•	10					
	now the concepts of metal for	rmi	ng and assoc	ciate techno	ologies and	apply them t	to the conve	ntional
	dvanced materials manufact		-		-			
	rse Content						_	
	sification of metal forming pr				-	-		
	mperature, strain rate and in theories; processing map		rostructural	variables;	residual s	tresses, exper	imental tec	hniques;
•					1.0	1		
	sification of forging processes die forging and close die for					plane strain f	orging analy	/\$1\$,
	sification of rolling processes es, defects in rolled products,							ts and
	s of extrusion, process variab cation processes	oles	, extrusion d	efects, forc	e calculati	on, wire, rod,	and tube dr	awing,
Shear	ring, blanking, bending, stre		•	•	•		products, ex	plosive
	ing, electro-hydraulic and m	Ũ			, formabil	ity diagrams		
Sever	re Plastic Deformation techn	iqu	es – Brief in	troduction				
	ler Consolidation : Cold com ding, high velocity compacti				powder rol	lling & extrus	ion, Powde	r injectior
Hot C	Compaction – Vacuum hot pr	ress	ing, spark p	lasma sinte	ring, high	velocity com	paction	
Refe	rence Books							
	Dieter G. E, 'Mechanical Me		0.			Education, In	dian Editior	n, 2017
2	Higgins R.A, 'Engineering N	/leta	allurgy', Vol	ume II, EL	BS, 1975			
3	Harris J.N, 'Mechanical Wor	·kin	g of Metals-	Theory and	d Practice'	, Pergamon P	ress, 1983	
	Mahmood Aliofkhazraei (Ed		<u> </u>					H Verlag
	GmbH & Co, Germany, 201	5				_		
Cour	rse Outcomes					r		
At th	e end of the course, students	wil	ll be able to				PO Correlati	1
001			<u> </u>		1 11	Low	Medium	High
CO1	Apply the concept of plastic convert them in to useful shapplications				•	0		1
CO2	Differentiate the various bu choose the appropriate one					s 5	2	1
CO3	Analyze various operationa the metal forming quality	ıl aı	nd materials	parameters	influenci	ng 3		1

CO4	Differentiate the various sheet metal forming technology and choose the appropriate one for required engineering applications	5	2	1
CO5	Acquire knowledge about powder consolidation techniques		3	1, 2, 4

Course Code	:	MTLR34						
Course Title	:	Foundry a	Foundry and Welding Laboratory					
Number of Credits		2						
LTPC Breakup	:	L	Т	Р	Contact hours	С		
		0	0	2	2	2		
Co-requisites (Course code)	:	MTPC19, MTPC20						
Course Type	:	ELR						

To know the concepts of sand casting and materials joining technology and to apply them for the advanced manufacturing processing for various engineering applications.

Course Content

List of Experiments

Foundry

- 1. Determination of permeability, shear strength and compression strength of the given foundry sand
- 2. Determination of clay content for the given moulding sand sample and also to study the variation of compression strength for various moisture contents
- 3. Determination of the grain fineness of the given foundry sand
- 4. Prepare the mould for the given pattern with core using two boxes and three box moulding process
- 5. Determination of flowability for the given foundry sand
- 6. Foundry melting practice demonstration

Welding

- 1. Arc striking practice
- 2. Bead-on-plate welding
- 3. Effect of welding parameters on weld bead
- 4. GTA welding (Demonstration)
- 5. Microstructural observation of weldments
 - Carbon steel
 - Stainless steel
 - Aluminium alloy
 - Titanium alloy
 - Dissimilar joints

Cour									
At th	e end of the course, students will be able to	F	O Correlati	on					
		Low	Medium	High					
CO1	Determine the properties of foundry sand		2,3	1,4					
CO2	Understand the foundry melting practice		4	1,2,3					
CO3	Develop basic welding skills in manual arc welding processes 1,2,11,12	9, 11	4	1,2,3					
CO4	Analysis the weldment microstructure 2,7,9	9, 11	4, 5	1,2,3					
CO5	Analyze the various metallurgical factors affecting mechanical properties of different metals and alloys 2, 1, 11	9, 11	4, 5	1,2,3					

Course Code	:	MTLR35					
Course Title	:	Metal Form	ning and H	Particulate	Processing Lab	oratory	
Number of Credits		2					
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		0	0	2	2	2	
Co-requisites (Course code)	:	MTPC21					
Course Type	:	ELR					

To familiarize the calibration of load cells and LVDT

To perform simple metal forming and powder metallurgy experiments

Course Content

- 1. Calibration of load cells
- 2. Calibration of LVDT
- 3. Upsetting / Forging of a cylinder
- 4. Rolling, extrusion
- 5. Cupping test
- 6. V- and U-Bending
- 7. Surface Strain prediction and Estimation of Forming Limit Curve
- 8. Powder characteristics such as metal powder size and shape, Apparent density and tap density, Flow rate
- 9. Compressibility of different powders and Green density of powder preform
- 10. Sintering (Conventional and Micro-wave) of powder preforms
- 11. Demonstration on Atomization
- 12. Demonstration of hot pressing (Vacuum hot pressing & Spark Plasma Sintering)

Cour	se Outcomes			
At th	e end of the course, students will be able to	PO Correlation		
		Low	Medium	High
CO1	Calibrate the load cells and LVDT		1,5	2,4
CO2	Perform forging, rolling, extrusion, bending and cupping test		1	2,4
CO3	Predict surface train and determine forming limit curve		1,3	2,4
CO4	Understand the powder characteristics by using standard procedure		4	1,2
CO5	Learn the density measurements and sintering procedures of various powder preforms		2	1

Сош	rse Code	•	HSIR14					
	rse Title	•	Profession	al Ethics	(Non Circ	uit)		
		•				uit <i>j</i>		
	ber of Credits		3			1	-1	
LTP	C Breakup	:	L	Т	Р	Contact hours		
			3	0	0	3	3	
Prer	equisites (Course code)	:	Nil					
Cou	rse Type	:	GIR					
Cou	rse Learning Objectives							
Ident	ify the core values that shap	e th	ne ethical bel	navior of a	n engineer.	To create an a	wareness	on
profe	essional ethics and Human Va	alue	es and to app	reciate the	rights of ot	hers		
	rse Content							
	als, Values and Ethics - Integ							
	s - Living peacefully - Carin							
	mitment - Empathy - Self-			Character -	Spirituali	ty - The role	of engin	eers in
	ern society - social expectation							
	e of 'Engineering Ethics' - Va							
	nomy - Kohlberg's theory - G							
	s & Professionalism - theorie al theories.	s a	bout right ac	uon - Sen-	interest - ci	ustoms and ren	gion - use	es of
	neering as experimentation -	end	vineers as res	nonsible e	vnerimente	rs - Research e	thics -Co	des of
	s - Industrial Standard - Bala							
CHIC								Court
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Course Code	:	MTPC22					
Course Title	:	Non-Ferro	Non-Ferrous Metallurgy				
Number of Credits		4					
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		3	1	0	4	4	
Prerequisites (Course code)	:	MTPC12					
Course Type	:	PC					
Course Learning Objectives							

To comprehend the basic principles of non-ferrous materials and apply those principles to demanding engineering applications.

Course Content

Brief introduction to extraction of aluminium; Aluminium and its alloys; physical. chemical and mechanical properties, classifications, heat treatable and non-heat-treatable types – structural features corrosion behaviour; cladding and other methods of corrosion protection.

Brief introduction to extraction of titanium; Titanium and its alloys; physical, chemical and mechanical properties of titanium, effect of other elements on its properties, types of titanium alloys, microstructural features, properties and applications.

Brief introduction to extraction of magnesium; Magnesium and its alloys; structure, properties and applications of magnesium and some its alloys; metallurgy of magnesium castings; Brief introduction to extraction of copper; copper and its alloys, electrical conductivity as influenced by other elements, alloys for high conductivity.

Lead, tin, zinc, zirconium, other non-ferrous alloys, relevant phase diagrams and microstructural features, properties and applications

Creep resistant materials, structure-property relationship, high temperature applications, superalloys, applications based on structure and properties, Intermetallics.

Ref	erence Books			
1	Polmear I. J., Light Alloys: From Traditional Alloys to Nanocrystals, Heinemann, 2006	, 4 th Editio	on, Butterwo	orth-
2	Alan Russell and, Kok Loong Lee ., Structure-Property Relations in N Interscience, 2005.	lonferrou	s Metals, Wi	iley-
3	ASM Handbook: Properties and Selection: Nonferrous Alloys and Spe edition, ASM International, 1990	ecial-Pur	pose Materi	al, 10 th
4	Joseph R. Davis, Alloying: Understanding the Basics, ASM Internation	onal, 2001		
5	Angelo P C and Ravisankar B"Non Ferrous Alloys: Structures, Prope Applications", Cengage publishers, 2018	erties and	Engineering	7
Cou	irse Outcomes			
At t	he end of the course, students will be able to	F	PO Correlati	on
		Low	Medium	High
CO	Understand the structure and properties of nonferrous metals and alloys			1
CO	2 Identify the phases present in different alloy systems by analyzing the phase diagrams		2	1
CO	Apply the basic principles of non-ferrous physical metallurgy for recommending materials for specific applications		3	1

Cour	rse Code	•	MTPC	123						
	rse Title	•			Characteriz	vation				
		·		ui (ation				
	nber of Credits PC Breakup		3		т			1	C	
	C breakup	:	L		T	P	Contact		C	
-			3		0	0	3		3	
	requisites (Course code)	:	Nil							
	rse Type	:	PC							
	rse Learning Objectives		:			diffue etie			-1i	
	amiliarize the various micros niques used for material chara				opic, x-ray	diffractio	n and ther	mai an	alysis	
	rse Content		11Zation.							
	timen preparation techniques	for	optical r	nicr	oscopy, Pri	nciples of	optical m	icrosco	py, brig	ht
	dark field illumination, polari illography.	zed	and inte	rfer	ence contra	st micros	copy; quai	ntitativo	e	
	raction of electron beam with	ma	aterials: t	rans	mission ele	ectron mic	croscopy -	bright	and darl	c field
	ging and diffraction technique		,				1.4	\mathcal{C}		
Scar	nning electron microscopy –	con	struction							8,
	ications; EDS and WDS, EPN			~	11.00	-				
	y diffraction - construction and									
	action pattern in powder metl es, order- disorder transforma									
-	n; residual stress measuremer		II, deterii	IIIIa		us mie, es	Sumation	n cryst		e allu
	duction to spectroscopic tech		ues: Opt	ical	emission s	pectrosco	py (OES).	ICP-O	ES, ator	nic
	rption spectroscopy (AAS), U									
	oduction to thermal analytical									
	ysis (DTA), differential scanr									
	ning probe microscopy - Ato	omi	c force n	nicro	oscopy (AF	M), scan	ning tunne	lling n	nicrosco	pe
(STN Refe	M). Field ion microscopy erence Books									
	B.D. Cullity, S.R. Stock, Ele	me	nts of X-	rav	Diffraction	3 rd Fd F	Pearson 20	001		
	P.J. Goodhew, J. Humphreys								¹ Ed Ta	vlor &
	Francis, New York, 2001.	, 1	. Douina	10, 1		leroseopy	und i mui	515, 5	Lu, Iu	$101 \mathrm{cc}$
3	Vander Voort, G.F., Metallo	ara	nhy. Prir	cin	e and pract	ice ASM	Internatio	nal 10	00	
	P.C. Angelo, Material Chara	- /		-	-			mai, 15		
	Leng, Y., Materials Characte					-		rtrosco	nic Meth	ods John
	Wiley & Sons (Asia) Pte Ltd					leroscopi	e una spec			.5 u 5, 30111
	rse Outcomes	, ~	-0-10-010	, _0						
	ne end of the course, students	wil	ll be able	to						
Atth								PO	Correlat	on
Att	,						Lo		Correlat Iedium	
CO1					y and perfo	orm	Lo		Correlat Iedium	High
		otic	al micros	scop	y and perfo	orm	Lo			
	Explain the principles of op quantitative analysis of mic	otic	al micros tructures	scop						High
CO1	Explain the principles of op quantitative analysis of mic	otic cros	al micros tructures	scop				w N 3		High 1,2
CO1 CO2	Explain the principles of op quantitative analysis of mic Prepare samples and analysis transmission electron micro	otic cros se n osco	al micros tructures nicrostru opes.	scop cture	e using sca	nning and		w N 3 1	ledium	High 1,2 2,3,4
CO1	 Explain the principles of op quantitative analysis of mic Prepare samples and analysis transmission electron micro Demonstrate the various approximation 	otic cros se n osco	al micros tructures nicrostruc opes. cation the	scop cture	e using sca	nning and		w N 3	ledium	High 1,2
CO1 CO2 CO3	 Explain the principles of op quantitative analysis of mid Prepare samples and analysis transmission electron micro Demonstrate the various ap techniques for material characterial 	otic cros se n osco oplic ract	al micros tructures nicrostru- opes. cation the terization	cture e x-1	e using sca ray diffract	nning and		w N 3 1 3,4	ledium	High 1,2 2,3,4 1,2
CO1 CO2 CO3	 Explain the principles of op quantitative analysis of mid Prepare samples and analysis transmission electron micro Demonstrate the various ap techniques for material cha Understand working princi 	otic cros se n osco oplic ract	al micros tructures nicrostru- opes. cation the terization	cture e x-1	e using sca ray diffract	nning and		w N 3 1	ledium	High 1,2 2,3,4
CO1 CO2 CO3	 Explain the principles of op quantitative analysis of mid Prepare samples and analysis transmission electron micro Demonstrate the various ap techniques for material chains Understand working principate 	ptic cross se n pscc pplic ract	al micros tructures nicrostru- opes. cation the terization	scop cture e x-n n ous s	e using sca ray diffract	nning and ion ic		w N 3 1 3,4	ledium	High 1,2 2,3,4 1,2 1,2
CO1 CO2 CO3	 Explain the principles of op quantitative analysis of mid Prepare samples and analysis transmission electron micro Demonstrate the various ap techniques for material chains Understand working princi- techniques Analyse and characterize the 	ptic crossen posco oplio ract ples	al micros tructures nicrostru- opes. cation the terization s of vario	cture e x-1 n ous s	e using sca ray diffract	nning and ion ic		w N 3 1 3,4	1edium	High 1,2 2,3,4 1,2
CO1 CO2 CO3 CO4	 Explain the principles of op quantitative analysis of mid Prepare samples and analysis transmission electron micro Demonstrate the various ap techniques for material chains Understand working principate 	ptic crossen posco oplio ract ples	al micros tructures nicrostru- opes. cation the terization s of vario	cture e x-1 n ous s	e using sca ray diffract	nning and ion ic		w N 3 1 3,4 5	1edium	High 1,2 2,3,4 1,2 1,2

Course Numb LTPC Prerect Course To acq	e Code e Title er of Credits E Breakup	:		Engineeri	ng			
Numb LTPC Prerec Course To acq	er of Credits			Engineeri	ng			
LTPC Prerect Course To acq								
Prerect Course Course To acq	² Breakup		3					-
Course Course To acq		:	L	Т	Р	Contact hou		
Course Course To acq			3	0	0	3	3	
Course To acq	quisites (Course code)	:	NIL					
To acq	е Туре	:	PC					
-	e Learning Objectives							
. 1	uire knowledge on principl	les,	various form	ns, testing,	monitoring	g and prevention	on of corro	osion
-	menon.							
	be Content ochemical and thermodynar	nio	nringinlag	Normat aqua	tion and a	astrada notan	tials of	
	, EMF and galvanic series,		• •	-		-		rtance to
	luminium and magnesium r			onis, ongn		in diagram a	la its impo	
	nge current density, polariz ity, electrochemical behavio						-	-
	pheric, pitting, dealloying, g corrosion and high temper						, corrosior	ı fatigue,
crackir	se of testing, laboratory, se ng and pitting, sequential pr ng and corrosion map of Ind	roce						
inorgan	sion prevention by design in nic coatings, mechanical an ence Books aj Narayan, 'An Introductio BH, 1983	id c	hemical met	hods and va	arious corr	osion inhibito	rs	
	ontana M. G., Greene N.D.	, '(CorrosionEn	gineering ',2	2nd Edition	n, McGrawHi	ll,1983	
3 D	Denny Jones, "Principles an	d P	Prevention of	^c Corrosion	" Prentice	Hall of India	1996	
	e Outcomes		<u>rerennen oj</u>	corrosion	, 1 / 0/11/00	inter of interes	,17701	
	end of the course, students	wil	ll be able to			P	O Correlat	ion
	,					Low	Medium	High
	basic principles related to phenomenon in metals and		•	feasibility	of corrosio	on		1, 2
	basics of kinetics of electr and equations.	ocł	nemical corr	osion, relev	ant theori	es		1, 2
	manifestations of corrosid mechanisms and remedies.		phenomeno	n through	their origi	in,		1, 2
	origin and causes of high kinetics, governing equation				nrough the	eir		1, 2
	Different methods of co corrosion auditing and map			g, suscepti	bility tes	ts,	4, 7	1, 2
	Various corrosion prevent		methods th ic protection		-	-	4, 5	3, 6, 12

Course Code	:	MTLR36						
Course Title	:		Non-Ferrous Metallography and Characterization Laboratory					
Number of Credits		2						
LTPC Breakup	:	L	Т	Р	Contact hours	С		
		0	0	2	2	2		
Pre-/Co-requisites (Course	:	MTPC22,	MTPC23					
Course Type	:	ELR						

- To evaluate the various microstructure of the non-ferrous metals and alloys using microscope and apply the concepts to make tailor made materials for given engineering design and applications.
- To develop the knowledge of heat treatment and associated procedure of various non-ferrous engineering materials and apply them to study how it influences the microstructure and results in different mechanical behavior.

Course Content

List of Experiments

- 1. Electrochemical polishing/etching for metallography
- 2. Microstructure of copper alloys
- 3. Microstructure of aluminium alloys (as received and Heat-treated conditions: Solutionizing and Ageing)
- 4. Microstructure of lead alloys
- 5. Microstructure of magnesium alloys (as received and Heat-treated conditions: Solutionizing and Ageing)
- 6. Heat treatment of titanium alloys
- 7. Microstructure of superalloys
- 8. Heat treatment of super alloys
- 9. Stereographic projection
- 10. Indexing of x-ray diffraction pattern

Cour	se outcomes	-		
At the	e end of the course, students will be able to	F	O Correlati	ion
		Low	Medium	High
CO1	Differentiate variety of microstructure of non- ferrous materials (Al, Mg, Ti etc) using microscope		1	2,3
CO2	Provide the comprehensive metallography procedure for a given non-ferrous metal or alloy		1	2,3
CO3	Analyze the microstructure of the given non-ferrous metal or alloy using microscope		1	2,4
CO4	Classify different heat treated microstructure of non-ferrous metals and alloys		1	2,3
CO5	Index the x-ray diffraction pattern of BCC and FCC materials and estimate lattice parameter.		1,5	2,4

Course Code	:	MTLR37						
Course Title	:	Corrosion	Corrosion and Surface Engineering Laboratory					
Number of Credits		2						
LTPC Breakup	:	L	Т	Р	Contact hours	С		
		0	0	2	2	2		
Co-requisites (Course code)	:	MTPC24						
Course Type	:	ELR						

To provide practical knowledge and hands on experience in experiments related to plating, various forms of corrosion and remedies through different coating methods thus covering broad spectrum of corrosion and surface engineering.

Course Content

- 1. Copper electroplating, electroless plating, anodizing of aluminum, and corrosion rate determination by weight loss method (with and without inhibitor)
- 2. Corrosion rate by electrical resistance method, corrosion rate by potentiostatic polarization experiment(a) Tafel method and (b) LPR method
- 3. Atmospheric/environmental corrosion (using colour indicator method)
- 4. Galvanic corrosion, pitting corrosion, stress corrosion cracking
- 5. IGC susceptibility tests for stainless steels, salt spray test, coating thickness measurement
- 6. Metallic coating on a substrate using wire-arc spray process
- 7. CERMET coating on a substrate using HVOF process
- 8. Testing of coated samples using salt-spray chamber

Cour	rse Outcomes			
At th	e end of the course, students will be able to	P	O Correlati	on
		Low	Medium	High
CO1	Acquire hands on experience in conducting electroless plating of copper and anodizing of aluminium		7	1, 2
CO2	Familiarize with electrochemical and non-electro chemical methods for corrosion rate measurements		7	1, 2
CO3	To gain practical knowledge in conducting susceptibility tests for IGC and salt spray and their assessment		7	1, 2, 4
CO4	To perform coatings through thermal spray coating process and their assessment		7	1, 2, 4
CO5	From the above experiments to acquire comprehensive knowledge on industrial corrosion problem and contemplate possible remedial measures.		7	1, 2, 4, 12

Course Code	:	MTPE01					
Course Title	:	Mineral P	rocessing	and Metal	lurgical analy	ysis	
Number of Credits		3					
LTPC Breakup	:	L	Т	Р	Contact hour	rs C	
		3	0	0	3	3	
Prerequisites (Course code)	:	NIL		1	I		ľ
Course Type	:	PE					
Course Learning Objectives Theoretical aspects of common mining and pre-extraction pract		ral processi	ng techniqu	les and the a	associated equ	ipment use	ed in
Course Content							
Principles of combustion, testir properties -typical energy cons (including fluxes) in metals pro Physical properties of minerals	umpt ocess s, phy	ion in metal ing ysical and c	lurgical pro	bcesses, ove	erview of diffe	erent raw n al minerals	such as
magnetite, haematite, galena, c and ilmenite Mineral Processing: economics	s of o	ore processi	ng; Comm	inution – F	Principle, com	minution (theories,
Crushing and grinding – equipt Classification: Principles of a concentration - Jigs and Tables	classi	fication - s	settling vel	•		0	
introduction to common analys	of flo ometa s - ore	w sheets (sp illurgy. es, metals, a	ecific exan lloys, detai	nples from ils of specif	metals proces	ssing), wet	and dry
thickening and filtering. Use of sampling. Introduction to hydro Principles of chemical analysis introduction to common analys Reference Books	of flo ometa s - ore is tec	w sheets (sp ullurgy. es, metals, a hniques use	ecific exan lloys, detai d in metallu	nples from Is of specif argical indu	metals proces ic chemical a stries.	ssing), wet	and dry
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Course Code	:	MTPE02					
Course Title	:	Instrument	nstrumentation and Control Engineering				
Number of Credits		3	3				
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		3	0	0	3	3	
Prerequisites (Course code)	:	NIL					
Course Type	:	PE					

To develop the basic understanding of measurements using different tools and skills to implement knowledge of techniques to control the systems.

Course Content

General concepts of measurements, static and dynamic characteristics, Introduction to calibration, calibration standards.

Temperature measurements: Measurement using expansion thermometers, thermocouples, Resistance temperature detectors, thermistors and optical pyrometers.

Measurement using strain gauges, Capacitive transducers, inductive transducers and Piezoelectric transducers. Introduction to pressure, level and flow measurements.

Basics of open loop and closed loop system, classification of variables, ON/OFF, P, PI, PID controllers and their applications.

Introduction to Micro Processor and its architecture. Instruction sets. Introduction Programmable logic controllers and instruction sets.

Refe	erence Books						
1	John P. Bentley., "Principles of Measurement Systems" 3rd E, Addiso	n Wesley	Longman I	Ltd., UK.			
2	Neubert H.K.P., "Instrument Transducers: An Introduction to their pe	rformanc	e and Desig	n, 2 nd			
	Edition Oxford University Press, Cambridge, 1999.						
3	Ramesh Goankar, "Microprocessor architecture, Programming and ap	oplication	s, with the				
4	Patranabis, "Sensors and Transducers", Wheeler Publishing, 1999.						
5	5 Doebelin E.O, "Measurement system-applications and design", 4 th E McGraw Hill New York,2003						
Cou	rse Outcomes						
At th	At the end of the course, students will be able to		PO Correlat	ion			
		Low	Medium	High			
CO1	Differentiate static and dynamic characteristics and calibration		2	1			
	standards for measurements.						
CO2	1	6		1,2,3			
	suitable condition.						
CO3	Application of various transducers for direct contact and non-		1	2,4			
	contact measurements.						
		6	2	2.4			
CO4	Design and measurements of PC based methods, construction of interface devices.	6	2	3,4			
			0.4	1.0			
CO5	1 11		3,4	1,2,			
	in various situations.						
L		1	1	1			

Course Code		MTDEA2						
Course Title	:	MTPE03	roop and I	Frantura N	Inchanica			
	•	Fatigue, C	reep and r	racture N	rechanics			
Number of Credits		3			1			
LTPC Breakup	:	L	Т	Р	Contact	hours	С	
		3	0	0	3		3	
Prerequisites (Course code)	:	MTPC17						
Course Type	:	PE						
Course Learning Objectives								
To develop the knowledge about as fracture, fatigue and creep and structural engineering application	to a			•	U	U		
Course Content								
Characteristics of fatigue failure, i fatigue behaviour, fatigue testing; crack propagation, corrosion fatigu Introduction to creep - creep mech	anal Je, c anis	lysis of fatig case studies sms, creep cu	ue data, fra urve, Prese	cture mec	hanics of f 1 practical	atigue applica	ation of	creep
data; accelerated creep testing, tin resistant alloys, creep testing, stres		·	parameter	rs for con	version of	creep	data; cre	ep
Introduction, types of fracture in n fracture, fracture of single crystals combined stresses.								
temperature curve, metallurgical fa scale tests, fracture analysis diagra Introduction, strain energy release strain toughness testing, plasticity of materials.	ım, rate	e, stress inter	nsity factor	, fracture t	oughness a	and des	ign, K _{IC}	plane
Reference Books								
1 T.H. Courtney, Mechanical	Dah	aviour of M	stariala 2nd	Ed Wow	land Drog	2005		
2 Dieter G. E., 'Mechanical M								
		0,						
3 Suryanarayana, 'Testing of	Met	allıc Materia	ils', Prenti	ce Hall Ind	dia, 1979			
4								
Course Outcomes								
At the end of the course, students	wil	l be able to					Correlati	
					Lov	v M	ledium	High
CO1 Describe basic mechanis engineering materials and t					ous	2		1
CO2 Understand and analyse microstructure for the life temperatures						2		1
CO3 Understand and analyse influencing the fracture be	havi	iour at differ	ent temper	atures.		2		1
CO4 Understand, evaluate and a	naly	vse the impac	t properties	s of materi	als	2		1
CO5 Understand, evaluate and materials						2		1

Course Code	:	MTPE04					
Course Title	:	Special St	eels and C	ast Irons			
Number of Credits		3					
LTPC Breakup	:	L	Т	Р	Contact ho	ours	С
		3	0	0	3		3
Prerequisites (Course cod	de) :	-	Ť				-
Course Type	:	PE					
Course Learning Objecti							
To become familiar with a Cast-iron	wide arra	y of ferrous	alloys inclu	ding carb	oon steels, spe	cial stee	ls and
Course Content							
Phase diagrams, composit and precipitation hardenal Dual phase steels, TRIP st	ble stainle teels, TWI	ss steels IP steels, UH	-				-
Tool steels; classification, special problems in heat tre Types of cast irons - grey, S silicon cast irons, heat rest applications	eatment of SG, white, istant cast <u>ysical Met</u> . Propertia	tion, and ap f tool steels malleable; a irons- high tallurgy of St es and Select	ustempered chrome cas eels', McG tion: Irons,	l ductile in st iron- st <u>Fraw Hill,</u> Steels, an	ron; alloy cass ructure, prope <u>1982</u> nd High-Perfe	t irons, N erty and	Vi hard, high engineering Alloys, 199
 Tool steels; classification, special problems in heat trees applications Reference Books 1 Leslie W. C., 'The Phy 2 ASM Hanbook, Vol 1. 3 Pickering P. B., 'Phy 1983 	eatment of SG, white, istant cast <u>ysical Met</u> . Propertia	tion, and ap f tool steels malleable; a irons- high tallurgy of St es and Select	ustempered chrome cas eels', McG tion: Irons,	l ductile in st iron- st <u>Fraw Hill,</u> Steels, an	ron; alloy cass ructure, prope <u>1982</u> nd High-Perfe	t irons, N erty and	Vi hard, high engineering Alloys, 199
Tool steels; classification, special problems in heat tree Types of cast irons - grey, S silicon cast irons, heat rest applications Reference Books 1 Leslie W. C., 'The Phy 2 ASM Hanbook, Vol 1. 3 Pickering P. B., 'Phy 1983 Course Outcomes	eatment of SG, white, istant cast <u>ysical Met</u> ysical Met	tion, and ap f tool steels malleable; a irons- high tallurgy of St es and Select allurgy and t	ustempered chrome cas eels', McG tion: Irons,	l ductile in st iron- st <u>Fraw Hill,</u> Steels, an	ron; alloy cas ructure, prope 1982 nd High-Perfe , Applied Scie	t irons, N erty and ormance ence Pub	Ni hard, high engineering <u>Alloys, 199</u> Dishers,
Reference Books1Leslie W. C., 'The Phy2ASM Hanbook, Vol 1.3Pickering P. B., 'Phy	eatment of SG, white, istant cast <u>ysical Met</u> ysical Met	tion, and ap f tool steels malleable; a irons- high tallurgy of St es and Select allurgy and t	ustempered chrome cas eels', McG tion: Irons,	l ductile in st iron- st <u>Fraw Hill,</u> Steels, an	ron; alloy cass ructure, prope 1982 nd High-Perfe 7, Applied Scie	t irons, N erty and ormance ence Pub	Vi hard, high engineering Alloys, 199 Polishers, elation
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u	rse Code	:	MTPE05						
Cou	rse Title	:	Special Ca	asting Tec	hniques				
Num	ber of Credits		3						
	C Breakup	:	L	Т	Р	Cont	act hours	s C	
	•		3	0	0		3	3	
Prer	equisites (Course code)	:	MTPC19	Ū	Ŭ		5	5	
	rse Type	:	PE						
	rse Learning Objectives								
• • •	To know the raw materia processes. To gain knowledge on dest To gain knowledge on usin To develop components of and casting techniques.	igni ng e	ing appropri	ate process lesign to gi	es to prod ve better d	uce for a	different astings	applicat	ions
Cou	rse Content								
Shell	, moulding : Process details	type	es, character	ristics and	process va	riables.	types of	sand use	ed
	additives, application	~ 1	,			. ,	~ 1		
Inve: appli	stment casting: Pattern mater stment, Pattern removal and cation casting: Process details, gravi	firi	ng , pouring	and casting	g, process	s variabl	es and cl	haracteri	
					, equipment	nt and d	e details	s, casting	
techr	niques, characteristics of the	pro			, equipinei	nt and d	e details	s, casting	,
Cent	rifugal casting : Process detail	ils,	cess, applica centrifugal f	ation Force calcul	lations, pr	oductio	n technic	ques- Tri	
Cent centr	rifugal casting : Process deta ifugal and centrifuging proce	ils, esse	cess, applica centrifugal f s, process v	ation Force calcul ariables an	lations , pr d characte	oductio ristics,	n technic applicati	ques- Tru	ue, semi
Cent centr Sque	rifugal casting : Process deta rifugal and centrifuging proce eze casting, Low pressure d	ils, esse lie o	cess, applica centrifugal f s, process v casting, thix	ation Force calcul ariables an o and rheo	lations , pr d characte casting , f	roductio pristics, a full mole	n technic applicati 1 process	ques- Tru on s , electro	ue, semi
Cent centr Sque casti	rifugal casting : Process deta ifugal and centrifuging proce eze casting, Low pressure d ng, Magnetic casting, No ba	ils, esse lie o	cess, applica centrifugal f s, process v casting, thix	ation Force calcul ariables an o and rheo	lations , pr d characte casting , f	roductio pristics, a full mole	n technic applicati 1 process	ques- Tru on s , electro	ue, semi
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Cent centr Sque castin Refe 1	rifugal casting : Process deta rifugal and centrifuging proce reze casting , Low pressure d ng , Magnetic casting , No ba rence Books <i>Heine R., Loper C.R., Rosen</i>	ils, esse lie o ake	cess, applica centrifugal f es, process v casting, thix or pepset mo	ation Force calcul variables an o and rheo bulding, ca aciples of n	lations , pr d characte casting , f sting proce	roductio eristics, a full mole ess for r ng . 2 nd	n technic applicati l process eactive r edition ,	ques- Tru ion s , electro metals. <i>Tata M</i> a	ue, semi o slag
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Course Code	:	MTPE06					
Course Title	:	Special To	Special Topics in Metal Forming				
Number of Credits		3					
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		3	0	0	3	3	
Prerequisites (Course code)	:	MTPC21					•
Course Type	:	PE					

To become familiar with forming processes apart from the conventional forming techniques.

Course Content

High velocity forming – comparison with conventional forming – Explosive forming - explosives – detonation velocity of explosives – energy transfer media – safety circuit – process parameters – application of explosive forming

Petro forge system – rubber pad forming – electro magnetic forming coil requirements – effect of work piece dimensions and conductivity - applications – electro hydraulic forming – types of electrodes – applications

Superplastic forming – superplasticity – definition - components – mechanism of superplastic deformation – diffusion bonding – superplastic forming and diffusion bonding – methods of forming

Severe plastic deformation – ECAP -types- microstructural variations with processing route – cryo rolling – process- types – stress strain distribution

Severe plastic deformation by mechanical alloying – types – equipment – compaction – sintering – mechanism of sintering

1	Hosford W.F and Caddell, 'Metal forming mechanics and metallurgy	" Prentic	e Hall, 198.	3				
2	Explosive forming process and techniques – A.A.Ezra, Prentice Hall,	1980						
3	ASM metals Handbook, Volume 5, 1984							
4	Padmanabhan KA and G.J.Davis, Superplasticity, Springer Verlag,	Berlin He	idberg, NY,	1980.				
5	Mahmood Aliofkhazraei (Editor) "Handbook of Mechanical Nanostru GmbH & Co, Germany, 2015	icturing"	Wiley-VCH	I Verlag				
Cou	rse Outcomes							
At th	he end of the course, students will be able to	P	O Correlati	on				
		Low	Medium	High				
CO1	Understand the non-conventional metal forming methods			1				
CO2	Select the appropriate technique for forming components		3					
CO3	Understand superplastic forming techniques		1					
CO4	Understand top down approaches in severe plastic deformation			1				
CO5	Understand bottom up approaches in severe plastic deformation			1				

Cou	rse Code	:	MTPE07					
Cou	rse Title	:	Economic	s of Metal	Productio	on Processes		
Num	nber of Credits		3					
	PC Breakup	:	L	Т	Р	Contact hours	C C	
	Ĩ		3	0	0	3	3	
Prer	requisites (Course code)	:	MTPC18	Ũ	0	0		
	rse Type	:	PE					
Cou	rse Learning Objectives							
To u	inderstand the role of metallu	ırgi	cal industrie	es in the ec	onomy; to	understand how	v metallu	gical
	panies come up with innova	tive	e practices w	vith respect	to raw m	aterials, proces	ses, cost,	yield
	market conditions.							
	rse Content							
	nage production, range of						n the me	tals
	materials sector; Input on m			e	•			
	ical approaches to cost estimatives the structure of the							
	ngs and profits, such as ROI a			the metall	urgicai uol	nam, approache	5 to couili	au011 01
	ural resources required for 1			gical indust	ries: trend	ls in mining a	nd public	policy
	e frame required for moving	•				•	1	1 - 5
Nee	d for developing new grades	or	new varietie	s of produc	ts, related	investment requ	uirements,	related
tech	nological initiatives and impa	act	on profitabil	ity				
ucch								
Sust	tainability in the production							
Sust gene	eration, losses and disposal; ta							
Sust gene								
Sust gene gree	eration, losses and disposal; ta en manufacturing erence Books	arg	ets with resp	ect to emis	sions and 1	related penalties	s; Concept	of
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Course Code	:	MTPE08					
Course Title	:	Particulate	Technolo	ogy			
Number of Credits		3					
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		3	0	0	3	3	
Prerequisites (Course code)	:	NIL					
Course Type	:	PE					

To introduce the importance non-conventional processing routes for different materials and its importance for advanced materials manufacturing.

Course Content

Introduction – Historical background, important steps in powder metallurgy (P/M) process - Advantage and Limitations of powder metallurgy process and Applications

Methods – Production of ceramic powders - powder production by newer methods such as electron beam rotating electrode, rotating electrode process, electron beam rotating disc and the rotating rod process, automation, rapid solidification technique. Characteristics: sampling – chemical composition, particle shape and size analysis, Surface area, packing and flow characteristics, Porosity and density, compressibility, Strength properties. Blending and mixing of metal powders; Compaction of powders, pressure less and pressure compaction techniques - single action and double action compaction, Cold Isostatic compaction, powder rolling, continuous compaction, explosive compaction, Hot temperature compaction – Uni axial hot pressing, Hot extrusion, Spark sintering, Hot isostatic pressing, Injection moulding – Sintering – Types – Theory of sintering – process variables, Effects of sintering – Sintering atmospheres – metallographic technique for sintered products.

Post sintering operations – Sizing, coining, repressing and resintering, impregnation, infiltration, Heat treatment, steam treatment, machining, joining, plating and other coatings. Products: Porous parts, sintered carbides, cermets, dispersion strengthened materials, electrical applications, sintered friction materials

Atomisation, Mechanical alloying, Metal Injection moulding, Microwave sintering and self- propagating high temperature synthesis.

Ref	erence Books						
1	Angelo.P.C. and R.Subramanian 'Powder metallurgy – science, Technology and applications',						
	Prentice hall Publishers, 2008						
2	Kuhn H. A., 'Powder Metallurgy Processing - New Techniques and Analysis', Oxford & IBH, New						
	Delhi, 1978.						
3	Randel German, 'Powder Metallurgy Sciene', 2 nd ed., MPIF, 1994						
4	Fritz.V. Lenel 'Powder metallurgy – Principles and Applications" Me	etal powde	er Industries				
	federation, New Jersey, 1980						
Cou	Course Outcomes						
At t	he end of the course, students will be able to	P	O Correlati	on			
		Low	Medium	High			
CO	Describe the basic mechanism of powder production for variety of	5	4	1,2			
	materials to meet the demand of the research and industrial needs						

CO2	Characterize the various powders (materials) based on the engineering applications	5	1,3
CO3	Differentiate the processing routes for various powders (materials) and associated technology		1,2,5
CO5	Apply the powder metallurgy concepts to design new materials for advanced engineering materials		1,3
CO6	Apply the concepts of particulate processing to produce non- conventional materials which are difficult to produce other techniques		1

Course Code	:	MTPE09							
Course Title	:	Additive M	Additive Manufacturing						
Number of Credits		3							
LTPC Breakup	:	L	Т	Р	Contact hours	С			
		3	0	0	3	3			
Prerequisites (Course code)	:	NIL					•		
Course Type	:	PE							

To know the principle methods, areas of usage, possibilities and limitations as well as environmental effects of the Additive Manufacturing technologies

Course Content

Overview – History – Need-Classification - Additive Manufacturing Technology in product development-Materials for Additive Manufacturing Technology – Tooling – Applications.

Reverse Engineering: Basic Concept – Digitization techniques – Model Reconstruction – Data Processing for Additive Manufacturing Technology: CAD model preparation – Part Orientation and support generation – Model Slicing –Tool path Generation – Softwares for Additive Manufacturing Technology: MIMICS, MAGICS.

Classification – Liquid based system – Stereo lithography Apparatus (SLA)- Principle, process, advantages and applications - Solid based system –Fused Deposition Modeling - Principle, process, advantages and applications, Laminated Object Manufacturing

Selective Laser Sintering – Principles of SLS process - Process, advantages and applications, Three Dimensional Printing - Principle, process, advantages and applications- Laser Engineered Net Shaping (LENS), Electron Beam Melting.

Customized implants and prosthesis: Design and production. Bio-Additive Manufacturing- Computer Aided Tissue Engineering (CATE) – Case studies

Reference Books

KU	erence books										
1	Brent Stucker, DavidRosen, and Ian Gibso, Additive Manufacturing Te	chnologie	es, Springer	, 2010							
2	Chua C.K., Leong K.F., and Lim C.S., Rapid prototyping: Principles and applications, Third Edition, World Scientific Publishers, 2010										
3	Gebhardt A., Rapid prototyping, Hanser Gardener Publications, 2003.										
4	Kamrani A.K. and Nasr E.A., Rapid Prototyping: Theory and practice, Springer, 2006.										
Cou	rse Outcomes										
At t	ne end of the course, students will be able to	P	O Correlati	on							
		Low	Medium	High							
CO	Describe the need and applications of additive manufacturing		2	1							
CO2	Prepare CAD model, model slicing, tool path using different software		5	2,3							
CO3	Classify and evaluate the relative merits and demerits of liquid and solid based additive manufacturing system		4	1,2							
CO4	Understand the laser based additive manufacturing techniques			1,2							
CO	Fabricate the 3D printed bio products			3,5							

LTPC Prereq Course Course To un length model Course Introdu proced Electro	e Title er of Credits Breakup uisites (Course code)	: : co atio	onal technic e packages.	T 0	P 0	Contact ho 3 and engin	3 discrete and the second seco	
Number LTPC	er of Credits Breakup uisites (Course code) e Type e Learning Objectives derstand basic concepts and time scale computa ing and simulation softw e Content uction to computational lures. Introduction to ICM ponic structure methods	: : co atio	3 L 3 NIL PE omputationa onal technic e packages.	T 0	P 0	Contact ho 3 and engin	3 discrete and the second seco	
LTPC Prereq Course Course To un length model Course Introdu proced Electro	Breakup uisites (Course code) e Type e Learning Objectives derstand basic concepts and time scale computation ing and simulation softw e Content uction to computational lures. Introduction to ICM ponic structure methods	co atio vare	L 3 NIL PE omputationa onal technic e packages.	0 al materia	0 ls science	3 and engin	3 discrete and the second seco	
Prereq Course To un length model Course Introdu proced	uisites (Course code) e Type e Learning Objectives derstand basic concepts and time scale computation ing and simulation softw e Content uction to computational lures. Introduction to ICN ponic structure methods	co atio vare	3 NIL PE omputationa onal technic e packages.	0 al materia	0 ls science	3 and engin	3 discrete and the second seco	
Course To un length model Course Introdu proced	e Type e Learning Objectives derstand basic concepts and time scale computa- ing and simulation softw e Content uction to computational lures. Introduction to ICM ponic structure methods	co atio vare	NIL PE omputationa onal technic e packages.	al materia	ls science	and engin	neering, di	
Course To un length model Course Introdu proced	e Type e Learning Objectives derstand basic concepts and time scale computa- ing and simulation softw e Content uction to computational lures. Introduction to ICM ponic structure methods	co atio vare	PE omputationa onal technic e packages.					
Course To un length model Course Introdu proced	e Learning Objectives derstand basic concepts and time scale computa- ing and simulation softw e Content uction to computational lures. Introduction to ICM ponic structure methods	co atio vare	omputationa onal technic e packages.					
To un length model Course Introdu proced	derstand basic concepts and time scale comput- ing and simulation softw e Content uction to computational lures. Introduction to ICN ponic structure methods	atio vare	onal technic e packages.					
Introdu procect Electro	uction to computational lures. Introduction to ICM onic structure methods							
proceci Electro	lures. Introduction to ICM onic structure methods							
			, multi-scal	e modelin	g, applica	tions		
	, information to software			-			nsity func	tional
	c scale methods – Int uction to software packag				•			hods;
	copic methods – Introd re package OpenCalphac					d methods,	introducti	on to
						athada M	a dalina of	-4
	nuum simulation methods rature distribution during					iethous, wi	odening of	stress and
Refere	nce Books							
	esar, R., Introduction to cor ambridge University Press,			erials scien	ce: Fundar	nentals to ap	oplications,	
2 Le	ee, J.G., Computational Ma	ter	ials Science:	An Introdu	ction, CR	C Press, Boc	a Raton, 20	17
	orstemeyer, M.F., Integrate 'iley & Sons, Inc., New Jer			al Materials	s Engineeri	ng (ICME)	for Metals, .	lohn
	SM Metals Handbook Vol. ternational, 2009	22	A-Fundame	ntals of mo	deling for 1	netal proces	sing, ASM	
Course	e Outcomes							
At the	end of the course, students	wil	ll be able to]	PO Correlat	ion
						Low	Medium	High
	Understand basic proce science and engineering	du	res of con	nputationa	l materia	ls 1	3, 1	5, 2
	Classify different scale m and materials engineering		eling techn	iques in m	etallurgic	al	3, 2	5, 1
	Perform simple modeling atomic scale methods	g a	nd simulati	ons in ele	ctronic an	ld	3, 1	5, 4, 2
	Understand thermodyna microstructures using cor			-	olution o	of 1	4, 2	5, 3
	Choose modeling as computationally solve an	nd y n	simulation simula		1	to 1	4, 2	5, 3, 12

:	MTPE11							
:	Materials	Materials for New and Renewable Energy						
	3							
:	L	Т	Р	Contact hours	С			
	3	0	0	3	3]		
:	NIL							
:	PE							
	:	: Materials 3 : : L 3 : : NIL	: Materials for New and3: L 3: D :NIL	: Materials for New and Renew3: L TP30:NIL	Image: Constraint of the system Image: Constraint of the system 3 Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint of the system Image: Constraint o	Image: Contract hold by the second		

Main objective of this subject to create an awareness on energy and its sources. It is also for connecting materials engineering subject in the field of energy generation and harvesting

Course Content

Introduction – Energy demand in India and sources – Renewable energy sources – Wind energy (Principles & types) – Solar energy (PV cells & Solar cells), Electrochemical energy storage and conversion (Batteries, Fuel cells & Supercapacitors) – Hydrogen energy & harvesting (Production, Storage & Energy Conversion) – Thermoelectric materials & energy harvesting.

Solar energy & materials – Nanomaterials for Photovoltaic solar energy conversion systems – Principles of photovoltaic energy conversion (PV) – Types of photovoltics Cells – Physics of photovoltaic cells – Organic photovoltaic cell cells – Thin film Dye Sensitized Solar Cells – Quntum dot (QD) Sensitized Solar Cells (QD-SSC) – Organic-Inorganic Hybrid Bulk Hetero Junction (BHJ-SC) Solar cells – Current status & future trends.

Nanomaterials for Energy Storage (Batteries & Supercapaitors): Systems Issues and Challenges of functional Nanostructured Materials for electrochemical Energy Storage systems – Primary and Secondary Batteries (Lithium ion, Sodium ion, Redox flow, Ni-MH & Metal-Air Batteries) – Cathode & anode materials – Nanostructured Carbon based materials & Nano-Oxides materials (Batteries & Redox capacitors) – Novel hybrid electrode materials (Batteries) – Electrochemical supercapacitors – Electrical double layer model – Principles & materials design – Conducting polymers based materials (Supercapacitors) – Current status & future trends.

Hydrogen storage methods & Materials – Metal hydrides –Carbon based materials, Alantes, etc. Processing and performance Nanomaterials for energy conversion (Fuel cell) systems: Issues & challenges of functional nanostructured materials for electrochemical energy conversion systems – Fuel Cells: Principles & materials for different fuel cells

Thermoelectric (TE): Principles & effects (Seebeck, Peltier effect & Thomson Effect) – Electronic & thermal transport of TE materials – Inter-relation of thermoelectric properties (Seebeck coefficient, ZT, Electrical conductivity, Thermal conductivity & Power factor) – Classification of Thermoelectric materials – Types of materials (Low, Medium & High Temperature) – Processing of thermoelectric materials – Applications – Fabrication & assembly of Thermoelectric devices – Current status and future trends.

Reference Books								
1	J. Twidell and T. Weir, Renewable Energy Resources, E & F N Spon Ltd, London, 1986.							
2	Electrochemical methods: Fundamentals and Applications, Allen J.Bard and Larry R. Faulkner,							
	2ndEdition John Wiley & Sons. Inc (2004)							
3	Fuel cell technology handbook. Hoogers. CRC Press, 2003							
4	Handbook of Nanomaterials for Hydrogen Storage - Mieczyslaw Jurc	zyk						
Course Outcomes								
At the end of the course, students will be able to PO Corr			O Correlati	on				
		Low	Medium	High				

CO1	To learn the energy demands and their sources for harvesting	9	6, 7	1, 3, 4
CO2	To understand the solar energy and its efficiency with respect to materials aspects	8,9	2, 6	1, 3, 4
CO3	To study the batteries engineering and their future demand	8	2, 6,7	1, 3, 4, 5
CO4	To learn the technology related to hydrogen storage via materials and applications	8,9	2, 7	1, 3, 4, 5
CO5	To understand the energy harvesting engineering, in specific Thermo-electrics	8,9	2,6	1, 3, 4,5

Course Code	:	MTPE12	MTPE12						
Course Title	:	Non-Ferro	Non-Ferrous Extraction						
Number of Credits		3							
LTPC Breakup	:	L	Т	Р	Contact hours	С			
		3	0	0	3	3			
Prerequisites (Course code)	:	NIL							
Course Type	:	PE							

To understand the nature's resources in terms of minerals for non-ferrous metals available on the earth crust, familiarize with principles and extraction of the same and their significance to the mankind.

Course Content

Principles of pyrometallurgy, chemistry of roasting, drying and calcination; classification of pyrometallurgical processes, use of Ellingham diagram in pyrometallurgy

Metallic oxide reduction by C, CO, hydrogen and metals; principles of metallothermic reduction and halide metallurgy; physicochemical principles of fused salt electrolysis

Principles of hydro metallurgy; properties of good solvent, leaching and precipitation, solvent extraction, ion exchange and pressure leaching gaseous reduction of aqueous solutions, bacterial leaching

Extraction schemes for copper, nickel, titanium, aluminium, magnesium, indium, gold and silver

Extraction of metals from secondary sources, energetics of non-ferrous extraction, extraction schemes of zinc, lead, zirconium and tantalum; prospects of non-ferrous industries in India

Refe	erence Books											
1	RayH. S., SridharR., AbrahamK.P, 'Extraction of Non-ferrous Metals', WestPress, 1987	, 1 st Editio	n, Affiliatec	l East								
2	Rosenquist T., 'PrinciplesofExtractiveMetallurgy',2 nd EditionMcGrawHill,1983											
3	Raghavan R., 'Extractive Metallurgy of Non-Ferrous Metals', Vijay N	Vicole Imp	orints, 2015									
Cou	rse Outcomes											
At th	he end of the course, students will be able to	F	O Correlati	ion								
		Low	Medium	High								
CO	Basic principles of pyrometallurgy, different types, Ellingham diagram and its significance			1, 2								
CO2	Principles of metallothermic reduction, halide metallurgy and fused salt electrolysis			1, 2								
CO3	Principles of hydrometallurgy, properties of good solvent leaching and precipitation			1, 2								
CO4	Extraction schemes for Cu. Ni, Ti, Al, Mg, In, Au and Ag metals			1, 2								
COS	Principles and practice of extraction of secondary metals		4, 7	12								
COe	Energetics involved in extraction of non-ferrous metals and prospects of non-ferrous industries in India		4, 5	3, 6, 12								

Course Code	:	MTPE13						
Course Title	:	Metallurgi	Metallurgical Waste Management					
Number of Credits		3	3					
LTPC Breakup	:	L	Т	Р	Contact hours	С		
		3	0	0	3	3		
Prerequisites (Course code)	:	NIL						
Course Type	:	PE						
Course Learning Objectives								

To become familiarize with the waste produced in mining, ore beneficiation, metallurgical operations, e-waste; utilization of waste and their management.

Course Content

Environmental and health impacts of Mining and Metallurgical waste. Various kind of wastes: Mining and Beneficiation waste production. Ferrous metal waste production. Ferroalloys waste production. Hydrometallurgical waste production. Metal manufacturing and finishing waste production. Post-consumer waste production. E-waste and recovery of metals and useful things from e-waste.

Utilization of mine overburden and waste rock. Potential utilization of mineral beneficiation tailings. Prevention and mitigation of acid mine drainage.

Recycling and reuse of blast furnace ironmaking slags, steel making dusts and sludges. Utilization of steel making dusts – Plasma based processing, hydrometallurgical processing, solidification and stabilization. Recycling and reuse of steelmaking slags

Utilization of Jarosite, goethite produced during extraction of zinc, Utilization of red mud produced in Bayer process: metallurgical utilization through metal recovery, utilization in building and construction, Glass-ceramics and Pigments. Recycling and utilization of surface oxide scale produced during metal forming operation. Metal recovery from pickling and plating sludges.

Waste management and utilization options: zero waste process approach, synergy between residue produces and residue end users. Process integration to mineral waste utilization. Process intensification.

Reference Books

1	Ndlovu, S., G.S. Simate and E. Matinde, Waste production and utilization in the Metal
	Extraction Industry, CRC Press, 2017

- 2 Ramachandra Rao, Resource recovery and recycling from metallurgical wastes, Elsevier, 2006
- 3 K. Hieronymi, R. Kahhat, E. Williams, E-waste Management: From waste to resource, Routledge, New York,2013

Course Outcomes										
At th	e end of the course, students will be able to	PO Correlation								
		Low	Medium	High						
CO1	Identify the various kinds of wastes produced during mining, beneficiation, manufacturing, finishing operations and e-wastes		1,2	7						
CO2	Understand the utilization of waste produced during mining and mineral beneficiation.		1,2	7						
	Classify the wastes produced from iron making, steel making, plasma processing, hydrometallurgical processing.		2	7						
CO4	Select a suitable methods to recycle the wastes produced during extraction of non-ferrous metals		5	3,7						
CO5	Provide a solution for waste management through process integration and intensification		5	3, 7						

Course Code									
Course Code	:	MTPE14							
Course Title	:	Non-destructive Testing							
Number of Credits		3							
LTPC Breakup	:	L	Т	Р	Contact hours	С			
		3	0	0	3	0			
Prerequisites (Course code)	:	NIL							
Course Type	:	PE							
Course Learning Objectives									
To introduce the various non-des	truc	tive techniqu	ues for test	ing and ins	spection of materi	als to dete	ect		
surface, sub-surface and internal	defe	ects produce	d during th	e fabricatio	on process withou	ıt destroyi	ing		
them.		_	-		_		-		
Course Content									
Visual examination; Liquid po	enet	rant inspecti	on: Princip	ole, applica	tions, advantages	and limi	tations,		
Dyes, developers and cleaners, F	luor	escent penet	rant test.						
Magnetic particle inspection: Pr	inci	ples, applica	tions, mag	netisation	methods, magnet	ic particle	es, Dry		
technique and Wet technique, der	mag	netization, A	dvantages	and limita	tions.				
Radiography - basic principle, e	elect	romagnetic	radiation s	ources, typ	bes and use of fil	ters and s	screens,		
geometric factors, Inverse sq	uare	e law, film	ns charact	eristics, I	Penetrameters, E	Exposure	charts,		
Radiographic equivalence, radio	gra	ohic imaging	g, inspectio	on techniq	ues, applications	, limitatio	ons and		
safety. Fluoroscopy- Xero-Radio	ogra	phy. Industri	al compute	ed tomogra	aphy (ICT).				
Ultrasonic testing - Types of	Ultr	asonic wave	es, princip	les of way	ve propagation,	characteri	stics of		
ultrasonic waves, Attenuation, co	oupl	ants. Inspec	tion metho	ods - pulse	echo, Transmissi	on and rea	sonance		
techniques, flaw characterization	n t	echnique, in	nmersion (esting, Th	ickness measure	ment. T	ypes of		
scanning, Test block, IIW - refer		-		-					
testing			C			-			
		1	1		, ,	, . .	• •		

Eddy current testing - principle, application, limitation; acoustic emission testing-principles, applications, merits and demerits; Leak testing, Holography and Thermography - principles, procedures and applications, Comparison and selection of NDT methods; defects in casting, forging, rolling and others. Introduction to ASNT codes and certification of NDT personnel.

Refe	erence Books									
1	Barry Hull and Vernon John, Non Destructive Testing, ELBS / Mac	cmillan, 20	001.							
2	Baldev Raj, Jayakumar T. Thavasimuthu M, Practical Non-Destructi	ve testing	, Narosa Pu	blishing						
	House, New Delhi, 1997.									
3	Louis Cartz, Non-Destructive Testing, ASM International, Metals Park Ohio, US, 1995.									
4	ASM Handbook, Vol.17: Nondestructive Evaluation and Quality Control, ASM International,									
	Metals Park, Ohio, USA, 1992.									
Cou	rse Outcomes									
At th	PO Correlat	ion								
		Low	Medium	High						
C01	Perform liquid penetrant testing to identify the surface defects		1	2						
CO2	Demonstrate suitability, merits and demerits of magnetic particle testing method for material characterization		3	1,2						
CO3	Understand principles, inspections techniques and process variables in radiographic testing.		4	1,2,3						
CO4	Choose an appropriate ultrasonic inspection and scanning method to detect the internal defects in the materials	5	4	2,3						
CO5	Select a suitable non-destructive testing technique to identify the defect in the products.		4	3						

о т ч	:	MTPE15					
Course Title	:	Welding N	1 etallurgy				
Number of Credits		3				_	
LTPC Breakup	:	L	Т	Р	Contact hou	urs	С
		3	0	0	3		3
Prerequisites (Course code)	:	MTPC20				•	
Course Type	:	PE					
 Course Learning Objectives To gain understanding of hea weld geometry To understand the solidificati welding parameters Study phase transformations i Gain knowledge of process, some specific alloys such as O eliminate the occurrence of we Course Content Heat flow - temperature distribut thickness, preheat, significance of Weld metal solidification - Epitax welding parameters - Gas/metal a Weldability of Carbon steels, low Welding of Non-ferrous alloys: All defects and remedial measures Origin of defects, - significance - 	tion n w dif Cu, eld tion f the tial nd a l, T ren	low and tem structure an reld joints wi fficulties, an Al, Ti and N defects. -cooling rate growth - col slag/metal re loy steels, w i, Mg and Ni medial measu	d growth r th aid of C d microstr i alloys and es - influen y number umnar struc- actions elding of st alloys – pr	norpholog CT, Schaft uctures for I the remed ce of heat ctures and ainless ste rocesses, d	y on weld jo fler and Delor ormed during dial measures input, joint growth morp els and cast in ifficulties, mi	ins in re ng diagra g weldin to minin geometry hology- rons icrostruct	lation to the ms g of nize or y, plate effect of
reheat cracking - weldability tests	S -	effect of n				-lamellar	tearing -
	urg of V	y', 2 nd Editic Velding Meta	netallurgica on, Wiley In allurgy', Ja	l paramete terscience ico Publis	ers. 2, 2002 hing House, I	1994	
Reference Books1Sindo Kou., 'Welding Metall2Granjon H., 'Fundamentals3Kenneth Easterling, 'Introdu Heinmann, 1992	urg of V uctio	y', 2 nd Editic Velding Metc on to Physicc	netallurgica on, Wiley In allurgy', Ja al Metallur	ll paramete aterscience ico Publis gy of Weld	ers. 2, 2002 hing House, I ding ', 2nd Ed	1994	
Reference Books1Sindo Kou., 'Welding Metall2Granjon H., 'Fundamentals3Kenneth Easterling, 'Introdu Heinmann, 19924Saferian D., 'The Metallurgy5Jackson M. D., 'Welding Metall	urg of V uctio	y', 2 nd Editic Velding Meta on to Physica Welding', C	netallurgica on, Wiley In allurgy', Ja al Metallur Chapman an	ll paramete terscience ico Publis gy of Weld nd Hall, 1	ers. 2, 2002 hing House, I ding', 2nd Ed. 985	1994	
Reference Books1Sindo Kou., 'Welding Metall2Granjon H., 'Fundamentals3Kenneth Easterling, 'Introdu Heinmann, 19924Saferian D., 'The Metallurgy5Jackson M. D., 'Welding MeCourse Outcomes	urg of V uctio v of tho	y', 2 nd Editic Velding Mete on to Physice Welding', C ds and Meta	netallurgica on, Wiley In allurgy', Ja al Metallur Chapman an	ll paramete terscience ico Publis gy of Weld nd Hall, 1	ers. 2, 2002 hing House, 1 ding', 2nd Ed. 985 m, 1967	1994 ition, Bu	tterworth
 Granjon H., 'Fundamentals' Kenneth Easterling, 'Introdu Heinmann, 1992 Saferian D., 'The Metallurgy 	urg of V uctio v of tho	y', 2 nd Editic Velding Mete on to Physice Welding', C ds and Meta	netallurgica on, Wiley In allurgy', Ja al Metallur Chapman an	ll paramete terscience ico Publis gy of Weld nd Hall, 1	ers. 2, 2002 hing House, H ding', 2nd Ed. 985 200, 1967 F	1994 ition, Bu	tterworth
 Reference Books 1 Sindo Kou., 'Welding Metall 2 Granjon H., 'Fundamentals' 3 Kenneth Easterling, 'Introdu Heinmann, 1992 4 Saferian D., 'The Metallurgy 5 Jackson M. D., 'Welding Me Course Outcomes At the end of the course, students 	urg of V oction v of tho will e (y', 2 nd Editic Velding Meta on to Physica Welding', C ds and Meta Il be able to of heat ing structure bas	netallurgica on, Wiley In allurgy', Ja al Metallur, Chapman an Ilurgy', Grj	Il paramete iterscience ico Publis gy of Weld id Hall, 1 fin, Londo emperature	ers. 2, 2002 hing House, I ding ', 2nd Ed. 985 m, 1967 F Low e 10	1994 ition, Bu	tterworth
Reference Books 1 Sindo Kou., 'Welding Metall 2 Granjon H., 'Fundamentals' 3 Kenneth Easterling, 'Introduce 4 Saferian D., 'The Metallurgy 5 Jackson M. D., 'Welding Metall Course Outcomes At the end of the course, students CO1 Understand the influence distribution across a welded	urg of V ection v of tho will e (ed s ng	y', 2 nd Editic Welding Meta on to Physica Welding', C ds and Meta Il be able to of heat inp structure bas and PWHT.	netallurgica on, Wiley In allurgy', Ja al Metallur, Chapman an Ilurgy', Grj	Il paramete iterscience ico Publis gy of Weld id Hall, 1 fin, Londo emperature	ers. 2, 2002 hing House, I ding ', 2nd Ed. 985 m, 1967 F Low e 10	1994 ition, Bu PO Corre Mediu	tterworth lation m High
Reference Books 1 Sindo Kou., 'Welding Metall 2 Granjon H., 'Fundamentals' 3 Kenneth Easterling, 'Introduce 4 Saferian D., 'The Metallurgy 5 Jackson M. D., 'Welding Metall Course Outcomes Substant States At the end of the course, students Substant States CO1 Understand the influence distribution across a welder and importance of preheating	<i>urg</i> of V action <i>y</i> of tho will e (ed s ng ng	y', 2 nd Editic Velding Meta on to Physica Welding', C ds and Meta Il be able to of heat inp structure bas and PWHT.	netallurgica on, Wiley In allurgy', Ja al Metallur, Chapman an Ilurgy', Grj	Il paramete iterscience ico Publis gy of Weld id Hall, 1 fin, Londo emperature	ers. 2, 2002 hing House, I ding', 2nd Ed. 985 pn, 1967 F Low e 10 y	1994 ition, Bu O Corre Mediu 4, 5,	lation m High 1,2,3,
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Course Code	:	MTPE16							
Course Title	:	Materials f	Materials for extreme environments						
Number of Credits		3							
LTPC Breakup	:	L	Т	Р	Contact hours	С			
		3	0	0	3	3			
Prerequisites (Course code)	:	NIL							
Course Type	:	PE							

Student should be capable of understand various extreme environment conditions and choose suitable materials for various conditions.

Course Content

Fundamentals of high temperature deformation, creep - Mechanism - Deformation Mechanism Maps - Superplasticity - Engineering materials applied in extreme environments: structural materials at high temperatures such as gas turbine applications

Introduction radiation resistance materials; radiation damage - half life period - irradiation damage resistance - BCC structures and ferritic grade steels for radiation damage resistance applications - Liquid sodium storage materials in nuclear industry - nuclear waste disposal.

Space environment - anomalous behavior of materials in space - Engineering materials applied in extreme environments: spacecraft materials - reusable space vehicles - carbon-carbon composites (CCC).

Understanding high strain rate deformation - Elastic wave propagation - Materials under thermomechanical extremes (static vs dynamic; high-pressure phases; shock; detonation; cavitation; supercooled liquids and glasses) - Shock resistant materials - armor grade materials.

Materials for cryogenic applications - DBTT - FCC structures - Deformation behavior in cryogenic temperatures - cryorolling.

Refe	rence Books									
1	G.E. Dieter, "Mechanical Metallurgy", Mc Graw Hill Publishers, NY	,2002								
2	Vincenzo Schettino and Roberto Bini, Materials Under Extreme Cond	litions, In	perial Coll	ege						
	Press, winter 2012.									
Course Outcomes										
At th	e end of the course, students will be able to	P	O Correlat	ion						
		Low	Medium	High						
C01	Can understand the behaviour of high temperature materials		2	1						
CO2	Capable of assessing behaviour of various irradiation damage resistance materials		3	1,2						
CO3	Can understand the space environment and choosing materials for space applications		2	1						
CO4	Analyse the high strain rate deformation behaviour and capable of choosing or fabricating materials		1	2,3						
CO5	Capable of understanding deformation at cryogenic temperatures		2	1						

Course Code	:	MTPE17						
Course Title	:	Thermody	namics of	Solidifica	ation			
Number of Credits		3						
LTPC Breakup	:	L	Т	Р	Contact h	ours	С	
		3	0	0	3		3	
Prerequisites (Course code)	:	MTPC11,	MTPC19					
Course Type	:	PE						
Course Learning Objectives								
 A study of important them involving the characteristics other functions. To analyze solidification pro transport, and interface pl transformations. Course Content Introduction and important therm capacity, applications of first law 	of ces nen nod	liquid-solid sing of engi omena gove ynamic func	phase trans neering ma erning mic	sformation terials in t rostructure vs of therm	terms of the developm	hermody e phase e ent in -enthalpy	namio quilit liquid 7, hea	cs and prium, I-solid t
entropy, free energy and their inter Thermodynamics of solidification Constitutional undercooling, Mu Dendritic growth; Multiphase solidification Heterogeneous systems –equilib diagrams, principles of free energy chemical potential, Raoult /Henry	; N allin sol oriu ergy	ucleation and ns-Sekerka idification: m constants minimizati	instability; eutectic, , Ellingha ion; energy	Single pl peritectic m-Richard / balance	hase solidit and mono son diagram of industri	fication: tectic; ms, pred al syster	Cellu Mode lomin	ular and lling of ant area olutions-
Evolution of Phase diagrams retrograde solidus; determination thermodynamic analysis of ternar Principles of applications- princip methods and applications, aqueou interfaces; solid electrolytes; Ef crystalline solids.	of y ai ples s sy	activity and nd multi com s of applicat stems; Inter	other therm ponent systems to mo faces-energ	odynamic tems, inter lten slags y, shape, s	parameters raction para and silicate egregation	from ph meters melts; e at extern	ase di lectro al and	agrams,; ochemica 1 interna
Reference Books								
1 Fleming, M.C., Solidification	n Pi	ocessing: M	cGraw-Hil	l, N.Y 19	074			
2 Kurz, W. and Fishe Publications, Switzerland, 198	r, 1	D.J., Fundan				rans-Tec	h	
Course Outcomes		11 11				DC C	1.	
At the end of the course, students	wil	I be able to			т	PO Cor		
CO1 Decollect the thermody		min ain las sel	avont to co	lidification	Low	Medi	um	High
CO1Recollect the thermodynamCO2Model solidification proce knowledge gained on nucl multi-phase solidification	ss o	of metals and	d alloys ba	sed on the		4,5	2	2,3
CO3 Understand the thermodynamic energy minimization and quarters				s of free]	1,2
CO4 Analyse the binary, ternary determine various thermody	nan	nic paramete	rs.		to	4		2,3
CO5 Demonstrate the importanc	e o	f interface er	nergy and s	hape on		3	1	1,2

Course Code	:	MTPE18							
Course Title	:	Design asp	Design aspects of Welding and Casting						
Number of Credits		3							
LTPC Breakup	:	L	L T P Contact hours C						
		3	0	0		3			
Prerequisites (Course code)	:	MTPC19, MTPC20							
Course Type	:	PE							

To select the proper design for various casting techniques and to minimize the defects. Knowledge of the various welding codes used in industry parlance.

Course Content

Designing for economical moulding – designing for sand moulding – investment castings. Design for economical coring – general rules for designing cored holes.Design problems involving thin sections, uniform sections unequal sections. Considering metal flow, riser location, feed path, mould-metal temperature effect.

Design problems involving junctions, distortion – possible design remedies. Dimensional variations and tolerances – influence of cores – influence of location of cores. Dimensions for inspection and machining. Surface finish ISI specification, effect of mould material, parting line, fillet influences. Design of gating and risering for ferrous and non-ferrous metals

Types of joints, joint efficiency, edge preparation, types of loads, design for static lading, design for cyclic loading, rigid structures, primary and secondary welds, treating a weld as a line, structural tubular connections, influence of specifications on design, symbols for welding and inspection, estimating and control of welding costs.Residual stresses, causes and effects, methods to measure residual stresses, weld distortion.

Boiler and pressure vessel codes, structural welding codes, pipelines codes.

Welding procedure specifications, welding procedure qualifications, welder performance qualifications, welding variables, filler metal qualifications, qualification of welding inspectors, welding supervisors and welding engineers, qualification of NDT personnel.

Ref	Reference Books									
1	"Casting.Design Hand Book", American Society for Metals,1962									
2	Matousek R., "Enginering Design"., Blackwell Scientific Publications	.,1962								
3	Heine, Loper and Rosenthal, "Principles of Metal Casting", Tata McGraw Hill Publishing									
4	Harry Peck, "Designing for Manufacture", Pitman Publications, 1983.									
5	O.W. Blodgett, Design of weldments, James F. Lincoln Arc Welding Foundation, 1963									
Cou	rse Outcomes									
At t	At the end of the course, students will be able to PO Correlation									
		Low	Medium	High						
CO	Select the appropriate design for the particular casting process.		1	2,3						
CO2	Minimize the defects by proper selection of casting systems		1	2,3						
CO3	Select an appropriate joint design to reduce weld distortion and residual stresses.		1	2,3						
CO4			1	2,3						
COS	Categorize welding procedures for different applications		1,10	2,3						

Cour	rse Code	:	MTPE19					
Cour	rse Title	:	Alloy Dev	elopment				
Num	iber of Credits		3					
LTP	C Breakup	:	L	Т	Р	Contact hou	rs C	
	-		3	0	0		3	
Prer	requisites (Course code)	•	NIL	0	Ŭ			
	rse Type	:	PE					
	rse Learning Objectives	•	12					
To s	study the fundamentals, class	sifi	cation, prop	perties of a	pplications	s of various f	errous and	l non-
Cour	rse Content							
Ferro heat	position, structure and proper ous systems – Effect of speci treatment ous systems – Highly alloy formations; development of r s, DP steels and Duplex stain	ific ved nov	alloying ele steels; spec el grades of	ments; allo fic examp steels such	y grades c bles; Effec as maragir	f cast irons, c t of alloying	arbon steel elements	on phas
steels Non- effec	Ferrous systems based on A ets; relevant phase diagrams;	lur Inp	ninium, Tita ut on heat tre	nium and (eatment	Copper; Ty			
steels Non- effec Use c cases	-Ferrous systems based on A	Alur Inp n re	ninium, Tita ut on heat tro finement; In	nium and (eatment clusion eng	Copper; Ty			
steels Non- effec Use c cases Refe 1	Ferrous systems based on A ets; relevant phase diagrams; of alloying elements for grain s such as High Entropy Alloy rence Books Alloying: Understanding the	Alur Inp n re $\frac{1}{2}Ba$	ninium, Tita ut on heat tro finement; In nd Bulk meta sics Edited b	nium and (eatment clusion eng allic glasses by Joseph R	Copper; Ty gineering; o s 2. Davis, A	concept of OD	OS alloys; s nal	pecial
steels Non- effec Use o cases Refe 1 2	Ferrous systems based on A ets; relevant phase diagrams; of alloying elements for grain s such as High Entropy Alloy rence Books	Alur Inp n re $\frac{1}{2}Ba$	ninium, Tita ut on heat tro finement; In nd Bulk meta sics Edited b	nium and (eatment clusion eng allic glasses by Joseph R	Copper; Ty gineering; o s 2. Davis, A	concept of OD	OS alloys; s nal	pecial
steels Non- effec Use of cases Refe 1 2	Ferrous systems based on A ets; relevant phase diagrams; of alloying elements for grain s such as High Entropy Alloy erence Books Alloying: Understanding the Phase Transformations in Ma	Alur Inp n re ys an <u>Ba</u> etal	ninium, Tita ut on heat tro finement; In nd Bulk meta sics Edited I s and Alloys	nium and (eatment clusion eng allic glasses by Joseph R s, Third Edi	Copper; Ty gineering; o s 2. <i>Davis, A</i> tion by Da	concept of OD SM Internation vid A. Porter,	OS alloys; s nal Kenneth E	pecial
steels Non- effec Use of cases Refe 1 2 3	Ferrous systems based on A ets; relevant phase diagrams; of alloying elements for grain s such as High Entropy Alloy rence Books Alloying: Understanding the Phase Transformations in Me Easterling, CRC Press	Alur Inp n re <u>Ba</u> etal	ninium, Tita ut on heat tro finement; In nd Bulk meta sics Edited l s and Alloys loying Eleme	nium and (eatment clusion eng allic glasses by Joseph R s, Third Edi ents in Stee	Copper; Ty gineering; o s <u>R. Davis, A</u> tion by Da <i>ls, ASM,M</i>	concept of OD SM Internation vid A. Porter, etal Park, Ohi	PS alloys; s nal Kenneth E	pecial
steels Non- effec Use of cases Refe 1 2 3 4	Ferrous systems based on A ets; relevant phase diagrams; of alloying elements for grain s such as High Entropy Alloy rence Books Alloying: Understanding the Phase Transformations in Me Easterling, CRC Press Bain, E.C. and Paxton, H.W. Lakhtin, Yu, M., Engineering	Alur Inp n re <u>Ba</u> etal	ninium, Tita ut on heat tro finement; In nd Bulk meta sics Edited l s and Alloys loying Eleme	nium and (eatment clusion eng allic glasses by Joseph R s, Third Edi ents in Stee	Copper; Ty gineering; o s <u>R. Davis, A</u> tion by Da <i>ls, ASM,M</i>	concept of OD SM Internation vid A. Porter, etal Park, Ohi	PS alloys; s nal Kenneth E	pecial
steels Non- effec Use of cases Refe 1 2 3 4 Cou	Ferrous systems based on A ets; relevant phase diagrams; of alloying elements for grain s such as High Entropy Alloy rence Books Alloying: Understanding the Phase Transformations in Me Easterling, CRC Press Bain, E.C. and Paxton, H.W. Lakhtin, Yu, M., Engineering rse Outcomes	Alur Inp n re <u>s Ba</u> etal	ninium, Tita ut on heat tro finement; In nd Bulk meta sics Edited I s and Alloys loying Eleme hysical Meta	nium and (eatment clusion eng allic glasses by Joseph R s, Third Edi ents in Stee	Copper; Ty gineering; o s <u>R. Davis, A</u> tion by Da <i>ls, ASM,M</i>	concept of OD SM Internation vid A. Porter, etal Park, Ohi ment, Mir Pul	PS alloys; s nal Kenneth E	pecial
steels Non- effec Use of cases Refe 1 2 3 4 Cou	Ferrous systems based on A ets; relevant phase diagrams; of alloying elements for grain s such as High Entropy Alloy rence Books Alloying: Understanding the Phase Transformations in Me Easterling, CRC Press Bain, E.C. and Paxton, H.W. Lakhtin, Yu, M., Engineering	Alur Inp n re <u>s Ba</u> etal	ninium, Tita ut on heat tro finement; In nd Bulk meta sics Edited I s and Alloys loying Eleme hysical Meta	nium and (eatment clusion eng allic glasses by Joseph R s, Third Edi ents in Stee	Copper; Ty gineering; o s <u>R. Davis, A</u> tion by Da <i>ls, ASM,M</i>	concept of OD SM Internation vid A. Porter, etal Park, Ohi ment, Mir Pul	PS alloys; s nal Kenneth E o blishers, M	pecial
steels Non- effec Use of cases Refe 1 2 3 4 Court	Ferrous systems based on A ets; relevant phase diagrams; of alloying elements for grain s such as High Entropy Alloy erence Books Alloying: Understanding the Phase Transformations in Me Easterling, CRC Press Bain, E.C. and Paxton, H.W. Lakhtin, Yu, M., Engineering rse Outcomes he end of the course, students	Alur Inp n re s an Ba etal . All g Pl wii	ninium, Tita ut on heat tro finement; In nd Bulk meta sics Edited l s and Alloys loying Eleme hysical Meta Il be able to	nium and (eatment clusion eng allic glasses by Joseph R s, Third Edi ents in Stee llurgy and	Copper; Ty gineering; o s 2. <i>Davis, A</i> tion by Da <i>ls, ASM,M</i> <i>Heat Treat</i>	concept of OD SM Internation vid A. Porter, etal Park, Ohi ment, Mir Pul	PS alloys; s nal Kenneth E o blishers, M	pecial
steels Non- effec Use of cases Refe 1 2 3 4 Coun At th	Ferrous systems based on A ets; relevant phase diagrams; of alloying elements for grain s such as High Entropy Alloy erence Books Alloying: Understanding the Phase Transformations in Me Easterling, CRC Press Bain, E.C. and Paxton, H.W. Lakhtin, Yu, M., Engineering rse Outcomes ne end of the course, students Understand the strategies of	Alur Inp n re \overline{Ba} etal \overline{Ba} etal \overline{Ba} etal \overline{Ba} etal \overline{Ba} etal	ninium, Tita ut on heat tro finement; In nd Bulk meta sics Edited I s and Alloys loying Elema hysical Meta ll be able to lloying, effea	nium and (eatment clusion eng allic glasses by Joseph R s, Third Edi ents in Stee llurgy and	Copper; Ty gineering; o s 2. Davis, A tion by Da ls, ASM,M Heat Treat	concept of OD SM Internation vid A. Porter, etal Park, Ohi ment, Mir Pul	PS alloys; s nal Kenneth E o blishers, M	pecial
steels Non- effec Use of cases Refe 1 2 3 4 Cour At th CO1	Ferrous systems based on A ets; relevant phase diagrams; of alloying elements for grain s such as High Entropy Alloy rence Books Alloying: Understanding the Phase Transformations in Me Easterling, CRC Press Bain, E.C. and Paxton, H.W. Lakhtin, Yu, M., Engineering rse Outcomes ne end of the course, students Understand the strategies of thermodynamics of alloyin Describe the carbon steels, alloying elements and heat	Alur Inp n re 2 $Baetal\overline{Ba}etal\overline{Ba}etal\overline{Ba}etal\overline{Ba}etal\overline{Ba}etal\overline{Ba}etal$	ninium, Tita ut on heat tro finement; In nd Bulk meta sics Edited l s and Alloys loying Eleme hysical Meta ll be able to lloying, effect st iron and th atment	nium and (eatment clusion eng allic glasses by Joseph R s, Third Edi ents in Stee llurgy and cts of alloy eir grading	Copper; Ty gineering; o s <u>R. Davis, A</u> tion by Da <i>Is, ASM,M</i> <i>Heat Treat</i> ing and , role of	concept of OD <u>SM Internation</u> vid A. Porter, <u>etal Park, Ohi</u> <u>ment, Mir Pul</u> <u>Pul</u> Low	PS alloys; s nal Kenneth E o blishers, M	pecial 2. <i>Toscow</i> . ion High
steels Non- effec Use of cases Refe 1 2 3 4 Coun At th	Ferrous systems based on A ets; relevant phase diagrams; of alloying elements for grain s such as High Entropy Alloy rence Books <u>Alloying: Understanding the</u> Phase Transformations in Me Easterling, <i>CRC Press</i> <u>Bain, E.C. and Paxton, H.W.</u> Lakhtin, Yu, M., Engineering rse Outcomes the end of the course, students Understand the strategies of thermodynamics of alloyin Describe the carbon steels, alloying elements and heat Choose a suitable alloying steels with specific propert	Alur Inp n re Ba etal Al Ba etal Al Ba etal a a Ba etal a a a a a a b a a a a a a a a a a	ninium, Tita ut on heat tro finement; In nd Bulk meta sics Edited l s and Alloys loying Eleme hysical Meta ll be able to lloying, effect at iron and the atment ments to dev	clusion eng allic glasses by Joseph R s, Third Edi ents in Stee llurgy and cts of alloy reir grading	Copper; Ty gineering; o s 2. Davis, A tion by Da ls, ASM,M Heat Treat ing and , role of hly alloyed	concept of OD SM Internation vid A. Porter, etal Park, Ohi ment, Mir Pul Low I	PS alloys; s	pecial 2. <i>Toscow</i> . High 1 1,2

Course Code	:	MTPE20								
Course Title	:	Ceramic M	Ceramic Materials							
Number of Credits		3								
LTPC Breakup	:	L	L T P Contact hours C							
		3	0	0	3	3				
Prerequisites (Course code)	:	NIL								
Course Type	:	PE								

To study the fundamentals (structure, properties and processing) of ceramic materials to understand its advantages and limitations and to apply those fundamentals for selecting and developing ceramic materials for different engineering applications.

Course Content

Ceramics as a class of engineering materials; general characteristics of ceramics; classification of ceramics; production of ceramic powders; bonding in ceramic Materials, variations in properties as a function of bonding; concept of co-ordination number, ratio of ionic radii and corresponding crystal structures of oxides, silicates, other non-oxide ceramics, theoretical density of ceramics, polymorphism in ceramics.

Defects in crystalline ceramics, non-stoichiometry, Kgroger-Vink notations, significance of defects with respect to applications; Glasses: types, structure, bridging and non-bridging oxygen, significance of oxygen to silicon ratio, commercial oxide glasses, devitrification; Introduction to glass–ceramics and tempering of glasses.

Introduction to ceramics processing, densification methods, theory of sintering, crystalline and noncrystalline phases in ceramic microstructures; mechanical properties of ceramic materials and testing of ceramic materials; Toughening Mechanisms.

Electrical, magnetic and optical properties of important ceramic systems, correlation of properties with structure

Classification of refractories, characteristics of refractories. Production of refractories, properties and applications of various refractories. Ceramics for sensor applications, Introduction to bio-ceramics and bio-glass. Applications of bioceramics.

Ref	Reference Books									
1	<i>Richerson D. W., 'Modern Ceramic Engineering – Properties, Processing and Use in Design', 3rd</i>									
	edition, CRC press, 2006									
2	2 Yet-Ming Chiang, Dunbar P. Birnie and W. David Kingery, Physical Ceramics: Principles for									
	Ceramic Science and Engineering John Wiley & Sons, 1996									
3	Carter, C. Barry, Norton, M. Grant, Ceramic Materials: Science and Engineering, 2 nd Ed,									
	Springer,2013									
4	Kingery W. D., Bowen, H. K. and Ulhmen D. R., 'Introduction to Cere	amics', 2 ⁿ	^d E, John W	'iley,						
Cou	urse Outcomes									
At t	he end of the course, students will be able to	Р	O Correlati	on						
		Low	Medium	High						
CO	Know the structure and properties of different ceramic materials	5	3	1						

CO2	Understand the phase diagrams and comprehend the phase transformations in ceramic materials	5	3	1
CO3	Understand the testing methods for evaluating the mechanical properties of ceramic materials	5	3	1
CO4	Understand and design the electrical, magnetic and optical properties of ceramic systems	5	2,3	1
CO5	Select ceramic materials and to develop new ceramics for different engineering applications	5	2,3	1

	se Code	•	MTPE21					
	se Title	:		Processing				
Num	ber of Credits		3	-				
	C Breakup	:	L	Т	Р	Contact hou	rs C	
	-		3	0	0	3	3	
Prero	equisites (Course code)	:	NIL		-	_	_	
	se Type	:						
Cour	se Learning Objectives							
To k	now manufacture of different	ent	type of Ce	ramic mate	rials and c	levelop for s	pecific	
Ū	eering							
	rse Content							
	ce and interfaces, grain bou			υ.		U	quilibria in	ceramic
syste	m - single component SiO2	trai	nsformation	s in silica; t	wo compor	ient systems		
Over	view of coromic processing	017	nhasis on n	owdor prog	assing rout	o orushing (rinding si	zina pro
	view of ceramic processing - blidation by pressing, casting							
	anisms, solid state sintering,				ioining a	ing spraying	Sinterill	o suiges,
				C				
	pressing - reaction sintering							
	n cast ceramics - slurry cast	-	- overview	of refracto	ry processi	ng - sol-gel p	processing -	- ceramic
coatii	ngs - manufacture of glasses							
	• • • • •							
Princ	iples properties application	ns	and process	sing for im	portant sv	stems such a	s · silicon	carbide
	iples, properties, applicatio n nitride, boron carbide, boro							
silico Princ	n nitride, boron carbide, bor iples, properties, application	on i is ai	nitride, cerm nd processin	ets, molybo g of import	denum di-si	ilicide and cer s such as: zirc	camic fibres	slized
silico Princ zirco	n nitride, boron carbide, bor iples, properties, application nia, sialons, magnetic ceram	on i is ai	nitride, cerm nd processin	ets, molybo g of import	denum di-si	ilicide and cer s such as: zirc	camic fibres	slized
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silico Princ zirco ceran Refe	n nitride, boron carbide, bor iples, properties, application nia, sialons, magnetic ceram- nics rence Books	on i is ai ics,	nitride, cerm nd processin supercondu	g of import	denum di-si ant system nics, semico	ilicide and cer s such as: zirc onductors, gla	camic fibres	slized
silico Princ zircon ceran Refe 1	n nitride, boron carbide, bor iples, properties, application nia, sialons, magnetic ceraminics rence Books McColm J., 'Ceramic Science	on the set of the set	nitride, cerm nd processin supercondu	ets, molybo g of import cting ceram Technolog	denum di-si tant systema nics, semico y', Leonard	ilicide and centric s such as: ziro conductors, gla	conia, stabil ss ceramics	s lized s, bio
silico Princ zircon ceran Refer 1 1 2 1	n nitride, boron carbide, bor iples, properties, application nia, sialons, magnetic ceram- nics rence Books	on the set of the set	nitride, cerm nd processin supercondu	ets, molybo g of import cting ceram Technolog	denum di-si tant systema nics, semico y', Leonard	ilicide and centric s such as: ziro conductors, gla	conia, stabil ss ceramics	s lized s, bio
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silico Princ zircon ceran Refer 1 / 2 /	n nitride, boron carbide, bor iples, properties, application nia, sialons, magnetic ceram nics rence Books McColm J., 'Ceramic Science Richerson D. W., 'Modern	on a lis an ics, $\frac{1}{ce fc}$	nitride, cerm nd processin supercondu or Materials gramic Engi	ets, molybo g of import cting ceram <u>Technolog</u> neering -	denum di-si tant system nics, semico y', Leonard Properties	ilicide and cer s such as: zirconductors, gla d Hill, 1983 Processing	conia, stabil ss ceramics and Use	ized s, bio
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Num	iber of Credits			3					
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Prer	equisites (Course code)	:	N	MTPC12					
	rse Type	:	P	PE					
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Course Code	:	MTPE23					
Course Title	:	Emerging	Materials				
Number of Credits		3					
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		3	0	0	3	3	
Prerequisites (Course code)	:	NIL			•		
Course Type	:	PE					

To define new engineering materials and apply for multi-functional areas.

Course Content

Techniques of rapid solidification. production of metallic glasses, atomic arrangement, comparison with crystalline alloys - mechanical, electrical, magnetic, superconducting and chemical properties and applications

Phase diagrams of ferritic, martensitic and austenitic stainless steels, duplex stainless steels, precipitation hardenable stainless steels, mechanical and metallurgical properties of stainless steels, HSLA steels, micro-alloyed steels

Aluminium alloys, magnesium alloys and titanium alloys; metallurgical aspects, mechanical properties and applications

Development of super alloys-iron base, nickel base and cobalt base - properties and their applications; materials for cryogenic service, materials in nuclear field, materials used in space

Carbonaceous materials - including nano tubes and fullerenes; shape memory alloys, functionally gradient materials, high temperature super conductors - bio materials

Reference Books

1	Sukh Dev Sehgal, Lindberg R.A.,	'Materials,	their Nature,	Properties an	nd Fabrication',	S
	Chand, 1973					

2 Polmear I. J. 'Light alloys: Metallurgy of Light Metals', 3rd Edition, Arnold, 1995

Cour	rse Outcomes			
At th	e end of the course, students will be able to	P	O Correlati	on
		Low	Medium	High
CO1	Describe the processing route, mechanical, electrical, magnetic and chemical properties of metallic glasses.			1
CO2	Analyse the Phase diagram and Microstructure of different type of stainless steel materials.		1	2
	Demonstrate the metallurgical aspects and applications of aluminium, magnesium and titanium alloys.			1
CO4	Describe the materials used for cryogenic, nuclear and space applications		3	1,2
CO5	Understand the effect of structures on the properties of functional materials like carbon nanotubes, fullerenes, shape memory alloy, biomaterials, etc.		3	1

Course Code	:	MTPE24					
Course Title	:	Automotive	e Material	S			
Number of Credits		3					
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		3	0	0	3	3]
Prerequisites (Course code)	:	MTPC12					
Course Type	:	PE					

To understand the working principles of automobiles, different systems in automobiles and materials used in automobile components fabrication

Course Content

Reciprocating engines, Otto cycle, Diesel cycle, four stroke and two stroke engines, working principle and constructional details of two stroke and four stroke engine, engine components, automobile construction, recent trends in automobile technology.

Engine cylinder: Structure and functions, types, cylinder blocks materials and manufacturing processes, improving engine components with surface modifications, Piston: Structures and functions, types, piston materials, piston manufacturing processes

Structure, function and materials for piston rings, camshaft, valves and valve seats, valve springs, connecting rod, crankshafts, turbocharger and exhaust manifold; tailor welds.

Types of chassis layout and chassis materials, vehicle frames, materials used for car body, front axle and steering system, drive line, propeller shaft, universal joints, wheels and suspension system. Types of tires, applications of polymers in automobiles, environmental impact of emissions from IC engines and its control.

Working principle of electric vehicles, fundamental of drives and DC machine, drives and Control of EV Using DC Machines, materials used in electric cars.

Refe	erence Books			
1	Ganesan.V, Internal Combustion Engines, Tata-McGraw Hill Publish	ing Co.,	New Delhi,	1994.
2	Hiroshi Yamagata, The Science and Technology of Materials in Autor Publishing in Materials, 2005.	notive Er	ıgines, Woo	dhead
3	Sheldon S. Williamson, Energy Management Strategies for Elec Electric Vehicles, Springer, 2013	ctric and	Plug-in H	ybrid
Cou	rse Outcomes			
At th	he end of the course, students will be able to	I	PO Correlat	ion
		Low	Medium	High
CO1	To understand air standard cycles and to estimate efficiencies of air standard cycles		3	1,2
CO2	To understand the functions of engine block and materials for engine block		3,5	1,2
CO3	To study various components used in automobile and selection of materials		5	2,3
CO4	To understand the functioning of electric vehicles		9,11	5,8

Course (Code	:	MTPE25					
Course 7		:	Metallurgi	cal Failur	e Analysi	S		
Number	of Credits		3		5			
LTPC B		:	L	Т	Р	Contact hou	ırs C	
	Сакир	•	<u> </u>	0	P 0	3	<u>118 C</u> 3	
Duono cur	ritar (Commo anda)		-	0	0	5	5	
Course 7	sites (Course code)		NIL PE					
	Learning Objectives	•	ΓĽ					
To introd	uce various types of failu measures.	ure	s involved ir	ı metallurgi	cal operat	ions, their ide	ntification	and
Course (Content							
Characteri Fatigue fa Stress Ru Gas Turb Wear failu Analyzing Corrosion Analyzi Causes of Processing Failure of Microstruc	mechanics concept. Due stics Revealed by Mic ilure - Factors affecting pture, Elevated Temp ine Components And P re - types of Wear, Rol Wear Failure. Corrosio Failures, Stress Corr ng Stress Corrosion failure in forging like g, Fabrication or Deterio Firon and Steel Casting cture, Improper Comp Conditions. Failure of	eros Fa era Petr e c con cosi Ci e r cosi cosi gs, cosi	acopy atigue Life ture Fatigu oleum Refi of friction i Failures- 1 on Crackin racking, va naterial cha tion resultin effect of Su tion, Impr	Some Case nery Comp n wear, Lu Factors In ng - Source rious type racteristics ng from so oper Heat	Studies ed Tempo ponents. Ibricated fluencing s. Chara es of Hy , deficie ervice con continuitie Treatmen	of Fatigue erature Effe and Non-Lub Corrosion F cteristics, Pro- drogen Dam ncies in desi nditions, s, Internal t, Stress Co	Failures; ects on C pricated V Failures, An cedure for age Failure ign, Impro Discontinu	Pertain Vear, nalysis of or es. oper nities, n and
Analysis.			Junients	iteusons	ior runur			unure
Reference							****	9
	ngelo, V.J., and F.A. He New York, USA, 1974		r, Analysis	of Metallu	rgical Fa	ilures, John	Wiley and	Sons
Pub	rlie R Brooks, Ashok Cl lishing Co. USA, 1993		•	0		•		
	A Handbook, Vol. 10: Fa	ilu	re Analysis	and Preven	ntion, AS	M Metals Pa	rk, Ohio,	1995.
	Dutcomes		1 ha -1.1 ·					
At the en	d of the course, students	W1	ii be able to			Low	O Correlat Medium	1
	scribe the sources, types bes of fracture	an	d microscop	ic features	of differen		2	High 1
CO2 An	alyse the factors influence ir remedial measures	ce t	he fatigue a	nd creep fai	lures and		1	2
	stinguish the role of vario	ous	factors on the	he wear and	l corrosior	1	2,3	1
	entify the causes for failu ldments	res	in castings,	forgings ar	ıd		1	2,3

Cour	rse Code	:	MTPE26					
Cour	rse Title	:	Biomateria	als				
Num	ber of Credits		3					
LTP	C Breakup	:	L	Т	Р	Contact hour	s C	
			3	0	0		3	
Prer	equisites (Course code)	:	NIL					
	rse Type	:	PE					
Cour	rse Learning Objectives							
The o	objective of this course is to	pro	vide students	s a fundame	ental under	standing of dif	ferent	
mate	rials for biomedical-applicat	ions	s and their <i>in</i>	-vitro and a	<i>in-vivo</i> cha	racteristics.		
Cour	rse Content							
Need	for biomaterials; Salient pr	ope	rties of imp	ortant mat	erial classe	es for differen	t bio-imp	lant
Appl	ications. Introduction biodeg	grad	able implant	materials.				
Proce	essing and properties of diff	eret	nt hiomateria	ls Nanom	aterials and	1 nanocomposi	ites for me	dical
	cations; Nanostructured coat				activities and	. nunocomposi		aivui
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	nanical property evaluation <i>vo</i> evaluation of biomaterials		phyisco-che	emical chai	racterizatio	n of biomateri	als; In-vit	ro and
in-vi	vo evaluation of biomatemais	5.						
	structure and composition				. .		sue engine	ering;
Appl	ications of tissue engineering	g; B	iomaterials f	for drug de	livery appli	ications.		
				-				
Riom	aterials worldwide market	tec	hnology trar	sfer and e	thical issue		for bioma	terials
	naterials worldwide market,	tec	hnology trar	nsfer and e	ethical issue		for bioma	terials
	naterials worldwide market, levices.	tec	hnology trar	nsfer and e	ethical issue		for bioma	terials
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and d Refer 1 2 3 4	levices. rence Books Hench L. Larry, and Jones Engineering, Woodhead Pul Hench L. Larry, & Wilson J. oon Park, Bioceramics, Prop Buddy D. Ratner et al., Bioma	s J., blisl ., (E pert ater	(Editors), hing Limited, Editors), An I ties, Charact	Biomateria , 2005. Introduction erizations,	els, Artificion n to Bio cer and Applic	es; Standards al organs and ramics, World rations, Spring	Tissue Scientific, e, 2008	1994.
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Course Code	:	MTPE27					
Course Title	:	Stainless s	teels and A	Advanced	Ferrous Alloys		
Number of Credits		3					
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		3	0	0	3	3	
Prerequisites (Course code)	:	Nil					
Course Type	:	PE					
Course Learning Objectives							
To understand the processing, phy	ysic	al metallurg	y, corrosion	behaviou	r and applications	of stainles	S

To understand the processing, physical metallurgy, corrosion behaviour and applications of stainless steels.

Course Content

Overview of Stainless Steel: Types of stainless steels, Alloying elements in Stainless Steel and their effect on microstructure and properties, Major grades of Stainless Steel: Austenitic, Ferritic, Martensitic stainless steels and precipitation hardening grades, Recent and advanced grades of stainless steels: superferritic, superaustenitic, duplex, Lean Duplex (high Mn and high N), Superduplex and Hyperduplex Stainless Steels, Cost implications of alloy addition and substitutes. Applications of Stainless Steel in various Segments: Automotive, Railways & Transport, Architecture, Building & Construction, Reinforcement bars, Roofing sheets, Material Handling applications, Process Industries, Life Cycle Cost Analysis, Physical, Mechanical and Surface Properties required for different applications

Physical metallurgy of Stainless Steel : Relevance of Nickel equivalent and Chromium equivalent, Why FeC diagram is inadequate for Stainless Steel?, Role of alloying elements in ferrite and austenite stabilization, Precipitation in stainless steel (M_7C_3 , $M_{23}C_6$, Cr_2N , sigma, chi etc.) and their effect on properties, Deformation behaviour of stainless steels. Role of stacking fault energy and the deformation induced transformation

Stainless Steel (SS) making and processing : Complete overview covering Electric Arc Furnace, Argon oxygen decarburisation, Ladle Refining, Vacuum Oxygen Decarburisation, Vacuum degassing, Ingot casting, Continuous casting, Hot Rolling, Annealing & amp; Pickling, Cold Rolling, Final Annealing and Pickling, Skin Pass Mill, Strip Grinding Line, Inclusion control in stainless steel, Stainless Steel fabrication: Cold roll forming (CRF) process mechanism, Welding of Stainless Steel, Effect of alloying elements on weldability of SS, Schaeffler De Long diagram and the modified versions. Sensitization/Weld decay: Causes, mechanisms, remedies, High temperature sensitization, 475 C embrittlement, σ -phase transformation, Issues faced during fabrication of stainless steel and their solutions: Distortion and Ridging: Causes, mechanisms, remedies, Hot Cracking, Edge cracking, Sliver (surface crack)

Corrosion in Stainless Steel : Major types of corrosion, Galvanic corrosion: Mechanism and prevention, Pitting Corrosion: Mechanism and prevention, Interpretation of PREN, Crack propagation mechanisms, Intergranular, Transgranular

Advanced Ferrous Alloys: Maraging steels, Steels for power plants and nuclear reactors including ODS alloys, Advanced high strength automotive steels, High strength, high toughness steels for strategic application, High silicon steels for electrical application, High Ni steels (1%, 3%, 9%) for cryogenic application, FeCrAl alloys for high temperature application

Reference Books Joseph R. Davis, Stainless Steels, ASM International, 1994 1 2 Jonathan Carl Beddoes, Jonathan Beddoes, James Gordon Parr, Introduction to Stainless Steels, ASM International, 1999. 3 Mårten Görnerup, Studies of Slag Metallurgy in Stainless Steelmaking, KTH, 1997 4 A. John Sedriks, Corrosion of Stainless Steels, Wiley, 1996 **Course Outcomes** At the end of the course, students will be able to PO Correlation Low Medium High

CO1	Explain the various types of stainless steels and their engineering applications		3	1,2
CO2	Understand the influence of various alloying elements on microstructure, precipitation, mechanical properties and deformation mechanisms of stainless steels.	12	3	1,4
CO3	Understand the manufacturing and processing of stainless steels for various applications.		3	1,2
CO4	Analyse and interpret the various types of corrosion in stainless steels and their prevention.	3	7	1,6
CO5	Understand the physical metallurgy of various advanced ferrous alloys like, maraging steels, high N steels, high Si steels, etc.	12	3	1,2

Cour	rse Code	:	Μ	ITOE10					
Cour	rse Title	:	N	anomate	rials and A	Applicatio	ons		
Num	ber of Credits		3						
LTP	C Breakup	:		L	Т	Р	Contact hou	urs C	
				3	0	0	3	3	
Prer	equisites (Course code)	:	N	IL					
Cour	rse Type	:	O	E					
Stude and a	rse Learning Objectives ents who complete this cours applications of nanomaterials					methods f	or production	, characteri	zation
	rse Content								
reduc Meth	duction: Concept of nanoma ction on various properties, a ods to produce nanomaterial sition, ball milling, severe pla	dva ls: F	anta Plas	iges and li sma archin	imitations a	at the nanc	o level.		
	acterization of nanomaterial , TEM, STM, AFM, XRD, e		and	nanostru	ctures: Sa	lient featu	ires and work	king princi	ples of
nanon Healt pollu Impli	ications: Fullerenes, carbo medicines, etc. th Issues: Understanding the tion. Environmental issues: I ications of nanoscience and t rence Books B.S. Murty, P. Shankar, B	tox Effe ech	ticit ect nol	ty of nano on the en logy in so	oparticls and vironmenta ciety, gove	d fibers, e il and othe rnment re	xposure to qua r species. Soc gulations, etc.	artz, asbesto vietal implic	os, air cations:
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Course Code	:	MTOE11					
Course Title	:		cal Tachn	iques in N	Materials Resear	roh	
				iques in N	viateriais Resea		
Number of Credits		3			~ .	~	Т
LTPC Breakup	:	L	Т	Р	Contact hours	С	_
		3	0	0	3	3	
Prerequisites (Course code)	:	NIL					
Course Type	:	OE					
Course Learning Objectives							
To understand how mathematics i	s b	eing used to	advance re	esearch wo	rk in materials; t	o prepare t	the
student for a career in materials			become far	niliar with	n some specific	mathemati	ical
techniques used in materials resea	rch						
Course Content							
(Actual coverage will depend or	n tl	ne class and	the draft	course pla	an (prepared wit	h input fro	om the
students))							
(Course involves limited number			al lectures	, considera	able self – learni	ing, and a	ctive
series of student seminars on selec				····1· ···		1	6
Review of certain topics from pr differential equations in metallurg			s courses (such as ex	xamples on the a	application	IS OI
Fundamental input on the mathem		· ·	nhysical m	etallurov	metallurgical the	rmodynam	nics
(such as the mathematics behind c				etanai gy,	inclandigical the	modynan	nes
Indicative input on use of technica	•			omain (suc	h as Mathematic	a, Matlab)	
Discussion of the basic principles							
selected topics (from this list):			•		2		
Mathematical Techniques in Crys							
Stereographic Projection – Conce			ions				
Mathematics of Diffusion in Mate							
Group Theory Applications in Sol							
Dislocation modeling to study fail Studies on Fractal Geometry for the				Astarials			
Fundamentals of Density Function			Auvanceu I	viaterials			
Solidification Dynamics of Binary		•					
Kapoor and Frohberg Model for n		•	slags				
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Markov Chains and Processes	0						
Pseudopotential lattice Boltzman					ds		
Vector Calculus and the Behaviou		-	g Materials	6			
Constitutive Modeling of Enginee							
Weibull Distributions and their Ap	ppl	ications					
Basics of Tensor Analysis							
Reference Books							
1 OCW Lecture Notes on Math	nem	natics for Ma	terials Scie	entists and	Engineers, MIT,	USA (ava	ilable
version)							
2 Lecture Notes on Constitut Technology, Goteborg (availa			of Engin	eering Ma	aterials, Chalme	rs Univer	sity of
3 Mathematical Techniques in C Verlag, 1994	Crys	stallography	and Materi	als Science	e, Edward Prince	, Springer	
4 Current Literature in related	top	ics / reading	materials c	ited in the	class		
Course Outcomes							
At the end of the course, students	wil	ll be able to			POO	Correlation	1
					Low M		

ſ	CO1	apply concepts of higher mathematics in studying and developing	4,5,9	1,2,3
		advanced materials and processes; and work in inter-disciplinary		
		research teams		

Cour	rse Code	:	MTOE12					
Cour	rse Title	:	Design and	I Selection	of Mater	rials		
Num	ber of Credits		3					
LTP	C Breakup	:	L	Т	Р	Contact ho	ours C	
			3	0	0	3	3	
Prer	equisites (Course code)	:	NIL					
	rse Type	:	OE					
	rse Learning Objectives							
	now different types of mat cations	teria	als and prop	perties and	to select	better mater	ials for diff	erent
Cour	rse Content							
stren; Type struct indic	conmental and electrical prop gth-density, fracture toughne es of design, Design tools and tural shape factors – limit to es – case studies ice, Fabrication and econom rials – Collection of data on	ess-a l ma sha	strength, aterials data ape efficiency requirements	– Materials 7 Comparis 5 for the co	and shape on of strue	e – microscop ctural sections	bic and micro s and materia	al ction of
the si Class studie influe Select and n Refe	ituations – case studies sifying processsystematic es – Influence of manufactu ence on selection of material ction of materials for automo nining industries. rence Books <i>M.F.Ashby, " Materials Se</i> <i>Oxford, 2005.</i>	sele tring s. bile	ection of pro- g aspects an e, nuclear, po- tion in Mech	cess – Sele d processin ower genera hanical De	ction char ng route o ation, aeros	ts – Ranking n properties o space, petrocl <i>Third edition,</i>	of processes of materials hemical, elec <i>Elsevier p</i>	a – case and its etronic ublishers
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Cou	irse Code	:	MTOE13					
Cou	ırse Title	:	New Produ	uct Develo	opment			
Nur	nber of Credits		3					
LTI	PC Breakup	:	L	Т	Р	Contact hours	С	
	-		3	0	0	3	3	
Pre	requisites (Course code)	:	NIL					
	irse Type	:	OE					
	rse Learning Objectives	•	0L					
	ose students to the structured	Nev	w Product D	evelopmen	t (NPD) N	Aethodology and h	eln them	
_	erstand the methodology; and			_			ionp unonn	
Cou	irse Content							
Fun	damentals of Product Develop	ome	nt - Global 7	Frends Ana	lysis and	Product decision -	Types of	
	ous trends affecting product d				•			
	hnical Trends (Technology, A							- / 7
	nomy, GDP, Income Levels, S							
	vironmental Regulations and (•	÷	•				nario
	rends and Company Policies)		·		-			
	luct Development Methodolo				verview of	Products and Serv	vices	
(Coi	nsumer product, Industrial pro	du	ct, Specialty	products e	tc.,) - Typ	es of Product Dev	elopment	
(NP	D/ Re-Engineering (Enhancer	nen	ts, Cost Imp	rovements) / Reverse	e Engineering/ De	sign Porti	ng &
Hon	nologation) - Overview of Pro	oduc	ct Developm	ent method	lologies -	Product Life Cycle	e (S-Curv	e,
Rev	erse Bathtub Curve) - Product	t De	evelopment I	Planning ar	nd Manage	ement		
	uirement Engineering and Ma							
	sical, Regulatory, Economical							
	cific, Internal-Company Speci							
	ceability Matrix and Analysis							
	oduction to System Modeling	- S	ystem Optim	ization - S	ystem Spe	ecification - Sub-S	ystem De	sign -
	rface Design	_						
	ign and Testing-Conceptualiz							
	cept generation Techniques -			0		1 0		
	rdware Schematics and simul			÷	-	U		
	ing - Hardware Testing – Pro							ent
	otype, Alpha, Beta, Gama) - I			·	••••	•	•	
•	em Integration and Business	•		•				~~~
	ufacturing/Purchase and Asse							
•	ems - Product verification pro		•		• •			
	dation processes and stages -							
	ing/ Performance Testing / Co							
	stry specific - Product Docum						LoL) Supp	ort –
	ntenance and Support - Obsol							1
	L Disposal; Business Dynami							
	us Academia - vertical specifi fidentiality	ic p	roduct dever	opment pro	Jeesses - I	interfectual Propert	ty Rights a	anu
Ref	erence Books							
1	Kevin Otto, Kristin Wood, "I	Pro	duct design	techniques	in reverse	e engineering and	new nrodi	uct
-	development", Pearson, Indi		0	ques		ing and ing and		
2				a duat Dar	ion and D	analonmant" 2.1	Edition.	
4	Ulrich, Karl T. and Eppinger		ieven D, Pi	oauct Desi	ign ana D	evelopment, sra	Eamon,	
	McGraw-Hill, New York, 20	04						

3 Ullman, David G., "The Mechanical Design Process", McGraw-Hill, 4th edition, 2009

	Kenneth B. Kahn, George Castellion, Abbie Griffin, The PDMA Hand Development, 2005, John Wiley & Sons , Inc. Hoboken, New Jersey, V		New Produc	rt
	Merle Crawford, Anthony Di Benedetto, New Products Management, McGraw Hill Companies Inc. New York, USA	ninth edi	tion, 2008,	
6	A.K.Chitale, R.C.Gupta, 'Product Design and manufacturing'			
7	Hand outs provided by industrial experts			
8	Resource Materials / 'BoK' provided by NASSCOM, related to NPD			
Cou	rse Outcomes	r		
At th	e end of the course, students will be able to		PO Correlat	1
		Low	Medium	High
CO1	Clear understanding of the NPD Methodology		6	1,3
CO2	Clear understanding of the influence of STEEP Factors for the success of New Product		6	1,3
CO3	Clear understanding of the importance of Customer study, requirement gathering and analysis, Patent Study and analysis and Concept Generation		6	1,3
CO4	Execute Pilot NPD Project		4,6	3
CO5	apply individual Creative skills, work as a team to achieve the results and present the project outcome to management review team		6	3,9

Course Cod	le	:	MTOE14						
Course Titl	e	:	Introducti	on to Qual	ity Mana	gement	t		
Number of	Credits		3						
LTPC Brea	lkup	:	L	Т	Р	Conta	act hours	C	
			3	0	0		3	3	
Prerequisit	es (Course code)	:	NIL						
Course Typ)e	:	OE						
Course Lea	rning Objectives								
• To le	arn important concep arn about quality phil arn about statistical to	loso	ophy; and	ality					
Course Cor		0010	, abea in qui	unty					
	ntroduction; philosop	hica	al approach	; cost of q	uality; ov	verview	of the v	works of	Juran,
- •	osby, Taguchi; PDCA		· •	-	•				·
X 7 · · ·	1				1		1		
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capability an Inspection; multiple san Reliability – failure distri Reference H 1 J.M.Jun Edition 2 B.L. H	nalysis; statistical pro inspection by sampl npling plans. - concept; difference l butions; MTBF. Books ran and F.M.Gryna,	cess ling: betv 'Qı	s control. ; acceptance veen reliabil uality Plann uality Contr	e sampling lity and qua ning and A	ity; differ	al appro rent mea <i>McGraw</i>	aches; s asures of <i>Fill, N</i>	ingle, de reliabili wew Yo	buble an ty; time t rk, 2nd
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	rse Code	:	MTOE15						
Cou	rse Title	:	Surface En	gineering					
Num	ber of Credits		3						
LTP	C Breakup	:	L	Т	Р	Con	tact hours	C	
			3	0	0		3	3	
	equisites (Course code)	:	NIL						
	rse Type	:	OE						
	rse Learning Objectives								
	et exposed to various concep					d attai	n comprel	nensive	
	vledge in offering suitable so	luti	ons to indus	trial proble	ems.				
	rse Content	.1				C			·
	duction to tribology, surface ative, corrosive, erosive and	_			• -				
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	nical and electrochemical po	list	ing, signific	ance. spec	ific exampl	les, ch	emical co	nversion	coating
	phating, chromating, chemica								
	istrial practices		6,	6					•
	ace pre-treatment, deposition								
-	ng, electro composite plating,	, pro	operties of el	lectrodepos	sits, electro	less, el	lectroless	composi	te plating
. .	cation areas, properties.	_							
	nitions and concepts, physica								
	na nitriding, process capabili ted CVD.	ties	, chemical v	apour depo	osition (CV	D), m	etal organ	ic CVD,	plasma
	mal spraying, techniques, adv	van	ced spraving	· · · · 1· · · · · · · · ·		c ·		, .	
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	city oxy-fuel processes, laser ssessment of wear and corros	sur	face alloying						
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for a Refe	city oxy-fuel processes, laser ssessment of wear and corros rence Books	sur sion	face alloying	g, laser clao	dding, spec	ific in	dustrial ap	oplication	ns, tests
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Num	iber of Credits		3	}								
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Prer	requisites (Course code)	:	N	NIL								
	rse Type	:	0	DE								
	rse Learning Objectives											
proce	e completion of this course, ess modelling; to get hands of	on e	expe	erience in	some aspe	ects of						
	elling of complex industrial	scal	le n	netallurgi	cal process	ses						
	rse Content	1 .	1	1		1.1.	••			1		
	nematical modeling, physical umentation and data acquisit				vantages an	ia lim	ntatio	ns; proc	cess cont	rol,		
conc	ew of transport phenomena, ept of physical domain and c ions, introduction to FEM &	com	ipu	tational d	-							
Intro	duction to software packag	es -	– 11	iseful we	hsites and	aene	ric in		1 /	diffo	rent	
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Course Code	:	MTOE17					
Course Title	:	Intellectua	l Property	Rights			
Number of Credits		3					
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		3	0	0	3	3	
Prerequisites (Course code)	:	NIL			·		
Course Type	:	OE					

To impart the knowledge in IPR and related areas with case studies.

Course Content

Introduction to IPR; Overview & Importance; IPR in India and IPR abroad; Introduction to Intellectual Property Law. Patents; their definition; granting; infringement; searching & filing; patent landscaping

Industrial Designs; Designs; scope; protection; filing; infringement; difference between Designs & Patents, Introduction to Trademark – Trademark Registration Process – Post registration Procedures – Trade mark maintenance - Transfer of Rights - Infringement – Dilution Ownership of Trademark – Likelihood of confusion - Trademarks claims – Trademarks Litigations – International Trademark Law

Introduction to Copyrights – Principles of Copyright Principles -The subjects Matter of Copyright – The Rights Afforded by Copyright Law – Copyright Ownership, Transfer, and duration – Right to prepare Derivative works – Rights of Distribution – Rights of Perform the work Publicity Copyright Formalities and Registrations – Copyright disputes and International Copyright Law

Introduction to Trade Secret – Maintaining Trade Secret – Physical Security – Employee Limitation -Employee confidentiality agreement - Trade Secret Law - Unfair Competition – Trade Secret Litigation – Breach of Contract. Geographic indication; Meaning, process of securing GI, Well-known GIs in India and abroad, benefits of securing GI

International environment of IPR: World Intellectual Property Organization, Paris Convention, Berne Convention, WTO & TRIPS agreement, Managing intellectual property in a knowledge-based society. IPR and technology transfer, case studies.

Reference Books

1	Deborah Bouchoux: "	Intellectual Pr	operty"	. Third E	dition,	Cengage	learni	ng Inc	e Pub,	Clifton	Park,
	Fourth Edition, 2012.										
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- 2 Deborah E. Bouchoux, —Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets, Cengage Learning, Third Edition, 2012.
- **3** Prabuddha Ganguli,Intellectual Property Rights: Unleashing the Knowledge Economy, McGraw Hill Education, 2011.
- 4 Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013

Course Outcomes

Cour	se Outcomes			
At th	e end of the course, students will be able to	Р	O Correlati	on
		Low	Medium	High
CO1	Understand the relevance and importance of IPR for			3,4,6
	engineers and for business			
CO2	Understand the scope of patents, designs, trademark,			4,6
	copyright, geographical indications and trade secrets			
	Study the fundamentals of IPR law, including the process of securing the various types of IPR			12

Course Code	:	MTOE18							
Course Title	:	Business a	nd Entrep	reneurshij	o for Engineers				
Number of Credits		3							
LTPC Breakup	:	L	Т	Р	Contact hours	С			
		3	0	0	3	3			
Prerequisites (Course code)	:	NIL					·		
Course Type	:	OE							
Course Learning Objectives									

• Introduce students to the world of Business, Management and Entrepreneurship

- To understand how start-ups take their ideas to implementation
- To sensitize the engineer to the broader world in which his or her professional work is carried out

Course Content

Introduction to the course, objectives, deliverables, experiential learning component, team formation, ideation, refinement and project presentation. Business Fundamentals: basic aspects of various topics, including macro economics, micro economics, marketing, accounting, business law, technology innovation, intellectual property rights, technology forecasting, organizational behaviour, war for talent.

The Startup Journey: class sessions; mini-lectures; workshops - format; meetings to mark progress; business idea; obtaining feedback from peers and instructors; refining the thought process and evolving the business idea; liaising with mentors offline (between class sessions); understanding customer need; partnering for success

Business Model Canvas: Startup basics; Ideation and Refinement; Team Formation; Startup Mechanics; and Business Plan

Out of the Building experiential learning: Customer Discovery, Customer Creation and Business Plan Refinement (each student team may need to travel outside the campus for two or three days, for this hands on learning experience)

Validation: Present Business Plan to Peers and Faculty; and then to the External Panel; feedback from the final session

Reference Books

1	Capsules of reading materials and videos shall be made available, as an		repository of	f course
	knowledge; and the usage of this repository by students shall be tracke	d		
2	Reading materials on business fundamentals – as prescribed by the fac	ulty, durii	ng lectures;	selected
	chapters from certain books			
3	edX Courses on Entrepreneurship (Free access) https://www.edx.org/le	earn/entre	preneurship	
4	edX course by Tarun Khanna, HBS, Entrepreneurship in Emerging Ec	onomies (Free access),
	https://www.edx.org/course/entrepreneurship-emerging-economies			
5	Steve Blank - Lean Startup methodology, https://steveblank.com/tools	-and-blog	s-for-entreg	oreneurs
6	MIT Open Courseware: Managing Innovation and Entrepreneurship (F	Free acces	s)	
	https://ocw.mit.edu/courses/sloan-school-of-management/15-351-management/15-3	aging-inne	ovation-	
	andentrepreneurship-spring-2008/			
7	Harvard Course on Innovation, Entrepreneurship and Business Transfo	ormation,		
	https://canvas.harvard.edu/courses/4156/assignments/syllabus			
Co	urse Outcomes			
At	the end of the course, students will be able to	Р	O Correlati	on
		Low	Medium	High

CO1	Understand the world of business and markets; and how these institutions are shaped and regulated by the political, legal and economic environment; and how companies are founded, grown and developed into profit-maximizing entities	8	2,6
CO2	Learn how to develop a business plan that determines the commercial viability of a product or service in a selected market and geographic location	12	7
CO3	Actually "get out of the building" to interact with prospective customers, generate data, discover customers, and progressively iterate the features of the product or service through a process of hypothesis testing	5	9,10
CO4	Learn how to pitch (sell) the business plan to prospective investors, advisers and other stakeholders	9	10,11

Cour	rse Code	:	MTMI10					
Cou	rse Title	:	Materials T	Technolog	у			
Num	ber of Credits		3					
LTP	C Breakup	:	L	Т	Р	Contact hou	rs C	
			3	0	0	3	3	
Prer	equisites (Course code)	:	NIL			I		
Cou	rse Type	:	MINOR					
Cour	rse Learning Objectives	•						
To ir	npart knowledge in material	pro	perties and n	nanufacturi	ing metho	ds. Students wi	ill be able t	0
unde	rstand various material and in	ts p	roperties and	l manufacti	uring metl	nods.		
	rse Content							
	RODUCTION Selection crit		-					-
	stries. Properties: Mechanical							
	erties. Processing of metals a	nd	alloys-Castir	ng-hot and	cold rollin	ng forging- extr	rusion-deep	2
draw		TIC	METATOI	Duno incre	oct incr	nild staal state	loss start-	
	ROUS AND NON-FERRO al alloy steels- iron and iron							
-	s.Manufacturing methods of		·	•		•		.
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	YMERS, COMPOSITES,	CE	RAMICS A	ND INOR	GANIC M	MATERIALS		
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(1) II	ndustrial polymerization met	nod	s. crystallini	tv and stere	eo isomers	s- Thermosettir	ng and The	rmo
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plast (ii) F mixtu enam	ics. RP-Fiber Reinforced Plastics ures; wood. (iii) Ceramic cry nels-properties. (iv) Cement a	s (F stal ınd	RP), different and silicate its properties	nt types of structures-	manufactu processing	uring methods; g of ceramics-	asphalt and cements-gl	d asphal
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Cour	se Code	:	MTMI11					
Cour	rse Title	:	Fundamen	tals of Me	tallurgy			
Num	ber of Credits		3					
LTP	C Breakup	:	L	Т	Р	Contact hou	rs C	
			3	0	0	3	3	
Prere	equisites (Course code)	:	NIL			1		
Cour	se Type	:	MINOR					
Cour	se Learning Objectives							
To gi	ve basic ideas about alloys c	lass	sification, ma	aterial chara	acterizatio	on and protection	on of mater	ials
	rse Content							
Туре	of steels; Plain carbon steel,	all	oy steels, too	ol steels, Sta	ainless ste	el		
-		. ~						
Type	s of cast iron; Grey, White, S	SG,	Malleable an	nd alloy cas	st iron			
Indu	trially important C A1 T	М	and N: Lass	d nor fam				
indus	strially important Cu, Al, Ti,	wg	, and ini dase	u non-terro	ous alloys			
Introd	duction to materials characte	riza	tion - Optics	al and Elect	ron micro	scopy and X-1	rav diffract	ion
muot		1120	uion optici			, seopy, and 11	ay annual	
Degra	adation of Materials; Corrosi	ion	and protectiv	ve methods				
			•					
	rence Books			. 11 . 0	101.	T . M C	11:11 100	7
	Sidney H Avner, Introduction			0.				7
2	William D. Callister, Materia	als i	Science and	Engineerin	g, 2nd Ed	lition, Wiley, 20)14	
3	V. Raghavan, Physical Meta	llur	gy: Principle	es and prac	tice, 2nd	Edition, PHI, 2	2006	
	rse Outcomes		-	-				
At the	e end of the course, students	wil	ll be able to			P	O Correlati	on
						Low	Medium	High
CO1	Understand the basic classi	fica	tion and pro	perties of st	eels and			1
	cast iron							
CO2	Describe the structure, prop	pert	ies and appli	cations of a	non-ferrou	ıs		1
	alloys							
CO3	Characterize the materials b	ov r	nicroscopy a				4	
205	Characterize the materials (<i>y</i> 1	meroscopy d	nd X-rav d	iffraction			12
				nd X-ray d	iffraction			1,2
				2				
CO4	Identify the form of corrosi	on	and suggest	2			4	1,2 2,3

Cou	rse Code	:	MTMI12							
Cou	rse Title	:	Physical N	Aetallurgy	and Hea	at 7	Freatment			
Num	ber of Credits		3							
LTP	C Breakup	:	L	Т	Р		Contact hour	rs	С	
			3	0	0		3		3	
	equisites (Course code)	:	NIL							
	rse Type	:	MINOR							
	rse Learning Objectives						1		<u> </u>	• •
	evelop an understanding of t				urgy and	cor	relate structu	ire o	f mater	rials
	their properties for engineer	ing	applications	•						
	rse Content									
	duction to engineering mate						•			-
-	alline materials – types of p		-	~ ~			-		-	-
	design using lattice position	s an	nd interstitial	voids. Pla	nes and d	lire	ctions and im	perf	ections	s in solid
•	morphism and allotropy.									
	ision, energetic of solidi									
	ogeneous nucleation and gro			endritic gro	wth in pu	ure	metals, const	tituti	onal su	iper
cooli	ng and dendritic growth in a	lloy	/S.							
	e diagrams – solid solution –			-		-	•		-	
Solid	lification of different trunce o	£							•	1
	lification of different types of				-	-			• •	iement o
	carbon diagram. Ternary pha				-	-			• •	lement o
Iron-	carbon diagram. Ternary pha	ase	diagrams- U	nderstandi	ng of isot	ther	rms and isople	eths.		
Iron- Heat	• •	ase /s;	diagrams- U Annealing,	nderstandii Normalisii	ng of isot	ther an	rms and isople	eths. gram	ıs, Har	rdening
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CO4	Analyse the microstructure of metallic materials using phase diagrams and modify the microstructure and properties using different heat treatments		2,3
CO5	Understand the various types of strengthening mechanisms to improve the material properties.		1

Course Code	:	MTMI13					
Course Title	:	Deformati	on Proces	sing			
Number of Credits		3					
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		3	0	0	3	3	
Prerequisites (Course code)	:	NIL					
Course Type	:	MINOR					
Course Learning Objectives							

To know the concepts of metal forming and associate technologies and apply them to the conventional and advanced materials manufacturing for various structural applications.

Course Content

Yielding criteria of von Mises and Tresca. Levy-Von Mises equations and Prantl Reuses equations for

ideal plastic and elastic plastic solids respectively. Yield Locus. Methods of load calculation including slab method, slip line field theory, FEM, upper and lower bound methods.

Texture effects. Metallurgical factors affecting recrystallization temperature and grain size. Effect of temperature, strain rate, hydrostatic pressure, Microstructure. Residual stresses, Friction and lubrication mechanisms. Lubricants in rolling, forging, extrusion, wire drawing, sheet metal forming. Tool design

Types of rolling mills, Geometrical factors and forces, Factors affecting rolling load and minimum

thickness, Roll pass design, wheel and tyre production. Rolling defects, Processes and equipment, Forgeability, effect of various factors, definitions. Selection of equipment, die design, parting line, flash, draft, tolerance. Defects, causes and remedies.

High velocity forming methods, superplastic forming, hydroforming, isothermal forging. Principles and processes. FLD and LDR, CAD, CAM in forming use of softwares like OPTRIS, DEFORM, etc. Workability.

Severe Plastic Deformation – Brief introduction

Reference Books

Itert	Lichce Dooks			
1	Dieter, G.E., "Mechanical Metallurgy", McGraw Hill, 2001.			
2	ASM "Metals Handbook, Vol. 14, Forming & Forging", ASM, Metals	s Park, Ol	hio, USA, 19	998.
3	Kurt Lange, "Handbook of Metal Forming", Society of Manufacturin	g Enginee	ers, Michiga	ın, 1985.
4	Belzalel Avitzur, "Metal Forming- Processes and Analysis", Tata McC	Graw Hill,	1977.	
5	Mahmood Aliofkhazraei (Editor) "Handbook of Mechanical Nanostru	ucturing"	Wiley-VCH	I Verlag
	GmbH & Co, Germany, 2015			
Cou	rse Outcomes			
At th	ne end of the course, students will be able to	P	O Correlati	on
		Low	Medium	High
COI	Apply the concept of plastic deformation for metals and alloys to convert them in to useful shapes for intended engineering			1
CO2	2 Differentiate the various metal forming technology and choose the appropriate one for required engineering applications		3	2
CO3	Analyze various operational and materials parameters influencing the metal forming quality.			2
CO4	Understand the non conventional metal forming methods			1
CO5	Use softwares related to metal forming	2	1	5

Coul	rse Code	:	MTMI14						
Cour	rse Title	:	Manufactu	uring Meth	ods				
Num	ber of Credits		3						
LTP	C Breakup	:	L	Т	Р	Con	tact hour	rs C	
			3	0	0		3	3	
Prer	equisites (Course code)	:	NIL						
Cour	rse Type	:	MINOR						
Cour	rse Learning Objectives								
To u	nderstand the fundamentals	of r	nanufacturin	g methods	in the vie	ew of n	netallurgi	ical pers	pective
with	reference to engineering app	olica	ations						
Cour	rse Content								
Туре	s of production and pr	odu	iction proce	esses, pro	duct con	figurat	ion and	l manuf	acturing
requi	rements.								
Patte	rn making, allowances and		re making	Casting pr	OCESSES (of ferro	us and	non-ferr	ous meta
	ding die casting, investme								
	lification principles, design of								moulam
			,	~F	8	, .			
Mate	l joining processes: solderir	ησι	brazing fusi	ion and not	-fusion v			es vario	us mode
ivieta				ion and noi	i-iusion v	velding			
	ing processes like TIG, MIG								
weld	ing processes like TIG, MIG	, St	ibmerged Ai	c Welding,	Friction	Weldin	g. Weldi		
weld		, St	ibmerged Ai	c Welding,	Friction	Weldin	g. Weldi		
weldi Fund	ing processes like TIG, MIG	, Su rkir	ibmerged Ai	rc Welding, – forging, e	Friction ` extrusion	Weldin and rol	g. Weldi ling.	ing defec	ts.
weldi Fund Intro	ing processes like TIG, MIG amentals of hot and cold wo	rkir po	ibmerged Ai ng processes wders. Com	rc Welding, – forging, o paction and	Friction Textrusion sintering	Weldin and rol	ig. Weldi ling. sses. Seco	ing defec	ts.
weld Fund Intro finish	ing processes like TIG, MIG amentals of hot and cold wo duction. Production of metal ning operations. Economics,	rkir po	ibmerged Ai ng processes wders. Com	rc Welding, – forging, o paction and	Friction Textrusion sintering	Weldin and rol	ig. Weldi ling. sses. Seco	ing defec	ts.
weldi Fund Intro- finish Refe	ing processes like TIG, MIG amentals of hot and cold wo duction. Production of metal ning operations. Economics, rence Books	rkir rkir po adv	abmerged An ng processes wders. Comp rantages, and	rc Welding, – forging, o paction and l application	Friction Textrusion sintering as of pow	Weldin and rol proces der me	g. Weldi ling. sses. Seco tallurgy.	ing defec	ts.
weldi Fund Intro finish Refe 1	ing processes like TIG, MIG amentals of hot and cold wo duction. Production of metal ning operations. Economics, rence Books Manufacturing Technology:	rkir rkir l po ⁻ adv	abmerged An ng processes wders. Comp rantages, and undry, Form	rc Welding, – forging, o paction and l application ing and We	Friction Textrusion sintering ns of pow	Weldin and rol proces der mer P.N.Rad	g. Weldi ling. sses. Seco tallurgy. o, TMH.	ondary a	ts.
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Course Code	:	MTMI15						
Course Title	:	Testing an	d Evaluat	ion of M	laterial	S		
Number of Credits		3						
LTPC Breakup	:	L	Т	Р	Cor	ntact hours	C	
		3	0	0		3	3	
Prerequisites (Course code)	:	NIL						
Course Type	:	MINOR						
Course Learning Objectives								
To develop the fundamental know the quality in manufacturing and p						rials, in orc	ler to o	control
Course Content								
Visual examination, Basic princip Radiography - basic principle, ele techniques, applications, limitatio	ectro	omagnetic ra and safety.	diation sou	irces, rad	iograph	nic imaging,	, inspe	
Eddy current testing - principle, a beam, transducers, inspection met limitations; acoustic emission test Leak testing, Holography and The and selection of NDT methods; de	thoo ting erm	ls, flaw char ography - pr	acterisation	n techniq rocedures	ue, imn s and ap	nersion testi oplications,	ing, ad [,]	vantage,
Mechanical Testing: Indentation h test-sample types and dimensions interpretation and estimation of te	, stı ensi	ess-strain di le properties	principle, p agrams for ; compress	practice, p ductile a ion, shea	precauti and brit	ions and use tle materials	s,	
Mechanical Testing: Indentation h test-sample types and dimensions, interpretation and estimation of te principle, practice and uses; introd Charpy and Izod impact tests - teo S-N diagram, applications; creep a	, stu ensi duc chni	ess-strain di le properties tion to releva iques and ap	principle, p agrams for ; compress ant standar plications;	oractice, p ductile a ion, shea ds. low and	precauti and britt r, bend high cy	ions and use tle materials and torsion	s, tests - testing	methods
Mechanical Testing: Indentation h test-sample types and dimensions, interpretation and estimation of te principle, practice and uses; introd Charpy and Izod impact tests - tec S-N diagram, applications; creep a standards	, stu ensi duc chni	ess-strain di le properties tion to releva iques and ap	principle, p agrams for ; compress ant standar plications;	oractice, p ductile a ion, shea ds. low and	precauti and britt r, bend high cy	ions and use tle materials and torsion	s, tests - testing	methods
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Course Co	ode	:	MTMI16						
Course Ti	tle	:	Non-Meta	llic Materi	ials				
Number o	f Credits		3						
LTPC Bre		:	L	Т	Р	(Contact hours	C	
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Proroquisi	ites (Course code)	:		0	0		5	5	
Course Ty		•							
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	an understanding of th	ne v	arious non-r	netallic ma	terials, th	neir p	properties and	applicat	ions
Course Co	ontent								
Definition, Non-Cryst	tion of Engineering m classification; Ionic an alline ceramics	nd (Covalent cer	amics; Oxi	de and N	lon-	oxide ceramic	es; Crysta	alline and
refractories Non-oxide	amics – Examples, S s, glasses, abrasives and ceramics - Examples production, indicative a	d B	iomaterials tructures, Pr	roperties a					
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Course Code	:	MTHO1	0					
Course Title	:	Advance	ed Thermod	ynamics	of Mate	erials		
Number of Credits		3						
LTPC Breakup	:	L	Т	Р	Conta	ct hours	С	
		3	0	0		3	3	
Prerequisites (Course code)	:	MTPC1	1					
Course Type	:	HONOUI	RS					
Course Learning Objectives	5	1						
To become familiar with rece	ent deve	lopments i	in thermody	namics and	applica	tions; and	l get ex	posed
to thermodynamic modelling		-	·		••		0	•
Course Content								
Review of thermodynamics –	metallu	urgical, me	chanical and	statistical	perspec	tives		
Application of themadura	ning to	C						
Application of thermodynam and novel materials Modeling techniques used in t calculations, electrochemical exposure to techniques in co systems	thermoo cells, o	dynamics of corrosion,	of materials - solution the	In the cor rmodynan	ntext of p nics, slag	bhase diag gs and all	rams, f loy dev	ree energ velopmer
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Cou	rse Code	:	MTHO11						
Cou	rse Title	:	Crystallog	graphy					
Num	ber of Credits		3						
LTP	C Breakup	:	L	Т	Р	Contact hou	ırs	С	
			3	0	0	3		3	
Prer	equisites (Course code)	:	MTPC12						
	rse Type	:	HONOURS	5					
Cou	rse Learning Objectives		1						
To st	udy structure property corre	elatio	ons						
Cou	rse Content								
Radi AX,/	nce, linear density packing us ration for coordination AX2,AB03 A 2B04 crystal s kel- Schkotty ionic defects, 1	nu nu	mber 2,4,6, tures	8. Interstit	ial solid	solution, Inte	-		pound
Elect Band Symi Crys absei Refe 1	ronic defect Electronic defe l Gap, density of states, defe metry and crystallography. tallographic point groups, nces, space groups special po rence Books Donald E. Sands, Introducti	ect co ects. Sym ositiv	Defects and metry in cry icro translat on	chemical re estals. Rotations, sym	eaction. ional sym metry of rier Corpo	metry, stereog f reciprocal pration, 2012	lattice,	syste	matic
Elect Band Symi Crys abser Refe 1 2	ronic defect Electronic defe l Gap, density of states, defe metry and crystallography. tallographic point groups, nces, space groups special pe rence Books Donald E. Sands, Introducti Donald R. Askeland and Pra	ect co ects. Sym osition ion t adee	Defects and metry in cry icro translat on to crystallogs p phule, The	chemical re ystals. Rotat tions, sym	eaction. ional sym metry of rier Corpo d Enginee	metry, stereog f reciprocal pration, 2012 ering Materials	lattice,	system on,200	matic
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Course Code	-	MTHO12					
Course Code	:	MTHO12					
Course Title	:	Aerospace	Materials				
Number of Credits		3			1		
LTPC Breakup	:	L	Т	Р	Contact hour		
		3	0	0	3	3	
Prerequisites (Course code)	:	NIL					
Course Type Course Learning Objectives	:	HONOURS					
To learn about Aerospace compor To develop an understanding of th Assess the surface testing method Course Content	ne d s ai	lifferent type nd comprehe	of materia nd the degr	ls used in a adation pro	aerospace and a operties		
Classification and different compo Airworthiness-Aerospace material requirements for aerospace structur	des res,	ign drivers-(Engines and	Quality Star Rockets	ndards for	aerospace indu	stry-Mate	erials
Mechanical and durability testing of health monitoring and non-destruct aerospace materials – Materials sel stealth technology, Yield strength a	tive ecti	testing of ai	ircraft comp pace, space	onents-Co environm	prrosion and co	prrosion te	sting of
Materials for Gas turbine-Ni-based coating(plasma spraying)-Materials base alloy- Stellite-Columbium allo Al-Li alloys-Magnesium alloys-Tit	s fé oy	or Rocket co	mbustion c	hambers a	nd Nozzles-Co	pper alloy	
Composites-Polymer matrix composites Reference Books	osit	es-Carbon-C	arbon com	posites-Ab	lative composi	tes	
1Adrian P Mouritz, Introducti2Cantor, B., Assender. H., and						2012	
			-		•		
3 Reed.R.C., The Superalloys -					-		
4 Campell.F.C., Manufacturin 5 Krishnadas Nair,C.G. Handl							10
6 Balram Guptha, Aerospace N		0			8)	
7 Horst Buhl, Advanced Aeros				-	<i>incuno</i> 113,1775		
8 Harvey M Flower, High Perj					ringer, 2006.		
Course Outcomes							
At the end of the course, students	wil	ll be able to				O Correlat	
			0. 5. 1		Low	Medium	High
CO1 Know about the component Helicopter	ts u	sed in Aircra	aft, Rocket	and	2		1,4
CO2 Understand different type of components	of te	esting method	ds for aeros	pace	4		1,2
CO3 Choose a suitable base matter turbine applications	eria	and coating	g material f	or gas	1	,2	3
CO4 Describe the properties and magnesium, titanium and st	-	• •		l,	3		1,2
CO5 Demonstrate the utilization composites in aerospace ap			l ceramic m	atrix	3		1,2

Course Code	:	MTHO13	MTHO13						
Course Title	:	Ladle Meta	allurgy an	d Continu	ous Casting of s	teels			
Number of Credits		3							
LTPC Breakup	:	L	Т	Р	Contact hours	С			
		3	0	0	3	3			
Prerequisites (Course code)	:	MTPC18			· · · · · ·				
Course Type	:	HONOURS							

Course Learning Objectives

To develop an understanding of the basic principles of ladle metallurgy and continuous casting, impart modeling skills and to apply them for industrial problems to enable them to solve the problems encountered in the steel industries.

Course Content

Terminology – scrap based operation Vs refining ; trends in quality of liquid steel; different approaches to refining; overview of various treatments including vacuum, inert gas, injection, electroslag.

Terminology related to injection metallurgy; Ladle furnace; advantages and approaches; injectibles – type of materials; discussion of some specific treatments; impact on overall quality; foaming of slags Ingot casting Vs continuous casting (CC); difficulties in CC of steels; increasing CC output in the steel industry; mould and machine details including different components and configurations; SEN, Ladle and Tundish

Role of mould powders (fluxes) in CC; physical and chemical interactions during CC; overview of defects in CC; production stoppages such as breakouts; indicative heat sizes and machine output; concept and implementation of sequence casting;

Overview of process modeling; applications in ladle metallurgy and CC; mathematical modeling of solidification; physical modeling of fluid flow in CC; case studies from current literature

Refe	erence Books			
1	Tupkary R.H., 'Introduction to Modern Steel Making', Khanna Publis	shers, 200)4	
2	B.Deo, R. Boom, 'Fundamentals of steel making metallurgy', Pren	ntice Hal	l Internatio	nal, New
	York, 1993			
3	Continuous casting – Vol.1, 'Chemical and Physical Interactions du	ring tran	sfer operati	ons', Iron
	and Steel Society, Warrendale, PA, USA, 1983.			
4	Ahindra Ghosh, 'Textbook of Materials and Metallurgical Thermodyn	namics', I	PHI Learnir	ıg, 2002.
Cou	rse Outcomes			
At th	he end of the course, students will be able to	J	PO Correlat	ion
		Low	Medium	High
COI	Understand the terminologies used in the field of ladle		2	1
	metallurgy and continuous casting of steels			
CO2	2 Classify different kinds of treatments for the steel during manufacturing		5	1,2
CO3	Compare the capabilities of ingot casting and continuous casting		2	4
CO4	Apply the basic modeling skills in the area of ladle metallurgy and continuous casting		3	4,5

Course Code	:	MTHO14					
Course Title	:	Recent Tre	ends in Na	no mater	ials		
Number of Credits		3					
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		3	0	0	3	3	-
Prerequisites (Course code)	:	NIL	•				
Course Type	:	HONOURS	5				
Course Learning Objectives							

To provide an understanding of the various concepts involved in fabrication of nanomaterial and the focus is on technological applications in various fields of science and engineering.

Course Content

Synthesis of Nanomaterials Recent advances in Physical Vapor Deposition (PVD), pulsed laser deposition, Magnetron sputtering, Multi Beam Epitaxy, Arc-Discharge, Chemical Vapor Deposition (CVD), Atomic Layer Deposition (ALD) - Micro lithography, Vapor (or solution) – liquid – solid (VLS or SLS) growth - pulsed electrochemical deposition – Super Plastic Deformation, High energy ball milling, Chemical-Mechanical milling, Electro explosion, Laser ablation.

Nanotechnology in Electronics and Energy Nano electronic devices and circuits – Semiconductor Memories - Dynamic Radom Access Memory- Nonvolatile Semiconductor Memories- Quantum Dot based Memory Cell- Sensors; physical and chemical- Electronic noses- Actuators- Micro and Nano-Electromechanical systems– Lighting and Displays –Quantum optical devices- Lasers – Batteries – Super capacitors- Fuel cells–Role of nanomaterials in fuel cell applications- Photovoltaic cells – Application of nanotechnology in solar cells- Application of power in transportation including space

Nanotechnology in Biomedical Industry Nanoparticles and Micro–organism- Biosensors- Bioreceptors and their properties - Biochips- Integrated nanosensor networks for detection and response- Natural nanocomposite systems; spider silk, bones, shells - Nanomaterials in bone substitutes and dentistry – Tissue Engineering – Neuroscience - Neuro-electronic Interfaces -Nanorobotics— Protein Engineering – Nanosensors in Diagnosis–Drug delivery – Cancer therapy and other therapeutic applications.

Nanotechnology in Agriculture and Food Sector Nanotechnology in Agriculture -Precision farming, Smart delivery systems – Insecticides using nanotechnology – Potential of nano-fertilizers – Potential benefits in Nanotechnology in Food industry – Global Challenges- Productinnovation and Process improvement- Consumer benefits- Food processing - Packaging- - Packing materials; physical properties- Improvements of mechanical and barrier properties- Antimicrobial functionality- Active packaging materials- -Information and communication technology- Sensors- RF identification- Food safety- Nanomaterial based Food diagnostics – Contaminant detection – Intelligent packaging-Nanoengineered Food ingredients- Potential risks to Nanofood to consumers

Nanotechnology in Defence and Aerospace Pathways to Physical protection- Detection and diagnostics of chemical and biological agents, methods- Chemical and Biological counter measures-Decontamination- Post exposure and pre exposure protection and decontamination- Nanotechnology enabled bio chemical weapons- Influence operations- Evasion of medical countermeasures-Nanotechnology based satellite communication system- Guidance, Navigation and control-Spacecraft thermal control- mini, micro, nanosatellite concepts- Fiber optic and Chemical microsensors for space craft and launch support- Micro/Nano pressure and temperature sensors for space missions.

Ref	ference Books
1	B.S. Murty, P. Shankar, Baldev Raj, B B Rath, James Murday, Textbook of Nanoscience
	and Nanotechnology, University Press (I) Pvt. Ltd., 2013
2	Charles P. Poole, Jr., Frank J. Owens, "Introduction to nano technology", Wiley, 2003

r				
3	Gunter Schmid, "Nanoparticles: From Theory to Applications", Wiley	-VCH V	erlag GmbI	H & Co.,
	2004.			
4	Bharat Bhushan, "Springer Handbook of Nanotechnology", Barnes &	Noble, 20	004.	
5	Neelina H. Malsch (Ed.), "Biomedical Nanotechnology", CRC Press 2	2005.		
6	W.N. Chang, "Nanofibres fabrication, performance and applications",	Nova Sc	ience Publi	shers
	Inc, 2009.			
7	Margaret E, Kosal, "Nanotechnology for Chemical and Biological def	ence", Sp	oringer 200	9.
Cou	rse Outcomes			
At th	he end of the course, students will be able to	F	PO Correlat	ion
		Low	Medium	High
C01			1,2	3
	of the end product.			
CO2	provide instances of contemporary industrial applications of		4,12	1,2
	Nanotechnology.			
CO3	To provide an overview of future technological advancements		2,4,6	5,12
	and increasing role of nanotechnology in industries.			,
	······································			

Course Code	:	MTHO15					
Course Title	:	Advanced	Solidifica	tion Proce	essing		
Number of Credits		3					
LTPC Breakup	:	L	Т	Р	Contact hours	C	
F	-	3	0	0	3	3	
Prerequisites (Course code)	:	-	0	0	5	5	
Course Type	•		1				
Course Learning Objectives	•	HONOUK)				
A study of important thermodyna the characteristics of liquid-so functions. To analyze solidification process transport, and interface phen transformations. To apply these principles to indus capabilities and limitations. Assess properties Course Content Introduction and important thermod	olid sin nom stria ss tl	phase tra g of engine nena gover al solidificati ne surface tes	nsformation ering mate ning mich on processo sting metho	ns, laws rials in te costructure es, with en ods and con	of thermodyna erms of the pha development nphasis on micro mprehend the de	amics an ase equil in liq ostructura gradation	nd other ibrium, juid-solic
free energy and their interrelations Thermodynamics of solidification Solidification, Constitutional unde Cellular and Dendritic growth; Mu Modelling of solidification Heterogeneous systems –equilibri diagrams, principles of free energy chemical potential, Raoult/Henry' theory Evolution of Phase diagrams -pha retrograde solidus; determination diagrams; thermodynamic analysi Principles of applications- princip electrochemical methods and appl external and internal interfaces; so Point imperfections in crystalline	; N ercculti um y m 's la se n of a s o iles lica	ucleation an poling, Mulli phase solidif constants, E ninimization; aw, Gibbs-Da rule, free-ene activity and of f ternary and of application tions, aqueon electrolytes	ins-Sekerka ication: eu Cllingham-F energy bal uhem equat ergy-compo other therm multi com ons to molte us systems;	a instability fectic, peri Richardson ance of in- ions, regu osition diag odynamic ponent sys en slags an Interfaces	y; Single phase s tectic and mono diagrams, prede dustrial systems lar solutions, qu grams, solidus-li parameters from stems, interaction d silicate melts; s-energy, shape,	olidificat tectic; ominant a s solution asi chemi quidus li: n phase n parame segregati	area is- ical nes, ters on at
Reference Books							
1 Solidification Processing; Fle	emi	ng, M.C., M	cGraw-Hil	l, N.Y., 19	74		
2 Fundamentals of Solidification	on l	by Kurz, W.	and Fisher	D.J., Trar	ns-Tech Pub, Sw	itzerland	, 1989
Course Outcomes							
At the end of the course, students	wi	ll be able to			PO	Correlati	on
						/ledium	High
CO1 Understand thermodynamic	cs o	of solidificati	on processe	es and allo			1,2
CO2 Do thermodynamic modelli solutions			_		2,	3	4,5
CO3 Describe kinetics of solidific constitutional super cooling				•	nd 4		1,2
CO4 Perform thermodynamic an system	aly	sis of ternary	y and multi	componen	t 1,:	5	2,4

Course Code	:	MTHO16					
Course Title	:	Recent D	evelopme	nts in Wel	ding Processes		
Number of Credits		3					
LTPC Breakup	:	L	Т	Р	Contact hours	С	
		3	0	0	3	3	
Prerequisites (Course code)	:	MTPC20					•
Course Type	:	HONOURS					
Course Learning Objectives							

• Understand the various advancements in welding processes.

• Gain knowledge of the concepts, operating procedures, applications, advantages and limitations of various recent welding processes.

Course Content

GMAW, types of metal transfer, CO2 welding, pulsed and synergic MIG welding and surface tension transfer, CMT-Concepts, processes and applications.

Key hole TIG, Narrow gap TIG, cold and hot wire TIG, dual shielding TIG, multi cathode TIG, buried arc TIG, A-TIG, AA-TIG, micro- plasma arc welding and AC/DC submerged arc welding process, twin wire SAW, tandem SAW, metal power addition SAW. cold and hot wire -SAW.

MIAB, Micro wave welding Concepts, processes and applications, types of metal transfer and applications, advances in diffusion welding, advances in electron beam welding, laser welding, resistance welding, flash butt welding and under water welding-concepts, types and applications. Metal flow phenomena in friction stir welding, tool design, retreating tool, friction stir spot welding, friction stir processing, linear friction welding, orbital friction welding processes and applications. Advances in adhesive bonding, Brazing and soldering

Cladding, CVD, PVD, Laser and electron beam surface modification, ion implantation, and Cutting

rence Books				
Parmer R. S., 'Welding Engineering and Technology', Khanna Publi	shers, 19	97		
Cary, Howard, "Modern Welding Technology', prentice Hall, 1998				
Schwartz M., ' Materials and Applications - Metal Joining Manual', I	McGraw-	Hill, 1979		
Nadkarni S.V., 'Modern Arc Welding Technology', Oxford IBH Publ	ishers, 19	996		
Christopher Davis, 'Laser Welding - A Practical Guide', Jaico Publis	shing Hoi	ıse, 1994		
Mishra. R.S and Mahoney. M.W, Friction Stir Welding and Processin	ng, ASM,2	2007		
rse Outcomes				
e end of the course, students will be able to	PO Correlation			
	Low	Medium	High	
Explain the various advancements in GMW and their applications		2	1	
Explain the various advancements in TIG welding and their applications			1,2	
Explain the various advancements in MIAB, microwave welding, EBW, Laser and resistance welding and their applications		5	1,2	
Describe the various advancements in under water welding and their applications		5	1,4	
Explain the various advancements in FSW and their applications			1	
Explain the various advancements in surfacing methods and their applications		3,5	1	
	Cary, Howard, "Modern Welding Technology', prentice Hall, 1998 Schwartz M., 'Materials and Applications - Metal Joining Manual', I Nadkarni S.V., 'Modern Arc Welding Technology', Oxford IBH Publ Christopher Davis, 'Laser Welding - A Practical Guide', Jaico Publis Mishra. R.S and Mahoney. M.W, Friction Stir Welding and Processin rse Outcomes e end of the course, students will be able to Explain the various advancements in GMW and their applications Explain the various advancements in TIG welding and their applications Explain the various advancements in MIAB, microwave welding, EBW, Laser and resistance welding and their applications Describe the various advancements in under water welding and their applications Explain the various advancements in SFW and their applications Explain the various advancements in FSW and their applications Explain the various advancements in surfacing methods and their	Parmer R. S., 'Welding Engineering and Technology', Khanna Publishers, 19 Cary, Howard, ''Modern Welding Technology', prentice Hall, 1998 Schwartz M., ' Materials and Applications - Metal Joining Manual', McGraw-Nadkarni S.V., 'Modern Arc Welding Technology', Oxford IBH Publishers, 19 Christopher Davis, 'Laser Welding - A Practical Guide', Jaico Publishing Hot Mishra. R.S and Mahoney. M.W, Friction Stir Welding and Processing, ASM,2 rese Outcomes e end of the course, students will be able to Explain the various advancements in GMW and their applications Explain the various advancements in TIG welding and their applications Explain the various advancements in MIAB, microwave welding, EBW, Laser and resistance welding and their applications Describe the various advancements in under water welding and their applications Explain the various advancements in FSW and their applications Explain the various advancements in surfacing methods and their	Parmer R. S., 'Welding Engineering and Technology', Khanna Publishers, 1997 Cary, Howard, ''Modern Welding Technology', prentice Hall, 1998 Schwartz M., 'Materials and Applications - Metal Joining Manual', McGraw-Hill, 1979 Nadkarni S.V., 'Modern Arc Welding Technology', Oxford IBH Publishers, 1996 Christopher Davis, 'Laser Welding - A Practical Guide', Jaico Publishing House, 1994 Mishra. R.S and Mahoney. M.W, Friction Stir Welding and Processing, ASM,2007 se Outcomes e end of the course, students will be able to Explain the various advancements in GMW and their applications Explain the various advancements in TIG welding and their applications Explain the various advancements in MIAB, microwave welding, EBW, Laser and resistance welding and their applications Describe the various advancements in under water welding and their applications Explain the various advancements in FSW and their applications Explain the various advancements in surfacing methods and their	

	urse Code	:	MTHO17				
Co	urse Title	:		evelopmen	nts in Form	ning Processes	
	mber of Credits		3	·····			
	PC Breakup	:	L L	Т	Р	Contact hours	С
	i o Dicunup	•	3	0	0	3	3
Dre	erequisites (Course code)	:	MTPC21	0	0	5	5
	urse Type	:					
	urse Learning Objectives	•	nonoona	,			
	understand the concepts of ad	van	ced forming	processes a	and their ap	oplications.	
Co	urse Content			-			
Ring	rolling: types and classifications. Ring rolling mills.	on.	Ring rolling	of steels ar	nd non ferr	ous alloys- defec	ts, remedial
	emental bulk forming: Orbital ations. Presses and modificati						antages and
mate	erplastic forming: Superplastic crials – metals/alloys, composi itations.						
	sing and sintering: Production hanisms- near net shape produ		•	·		sequence of opera	ation –sintering
			· •				
	atic pressing: Definition – stream antages and limitations	ess t	ensor in Isos	static condi	tions – typ	es – near net shaj	pe production-
Adv			ensor in Isos	static condi	tions – typ	es – near net shaj	pe production-
Adv: Re f	antages and limitations						
Adv Ref	antages and limitations ference Books	and	Application	– Edited by	y john Aw	reicewicz, In Tec	h publisher,20
Adv Ref 1 2	antages and limitations ference Books Numerical Analysis- Theory J.M. Allwood, A.E. Tekkaya,	and T.I T.I	Application F. Stanistreet F. Stanistreet	– Edited b , The devel	y john Aw lopment of	reicewicz, In Tec ring rolling tech ring rolling tech	h publisher,20 nology, Steel R nology-part 2:
Adv Ref 1 2 3	antages and limitations ference Books Numerical Analysis- Theory J.M. Allwood, A.E. Tekkaya, Int, 76 (2005), pp. 111–120 J.M. Allwood, A.E. Tekkaya, investigation of process behav	and T.I T.I vior	Application F. Stanistreet F. Stanistreet and product	– Edited by , The devel , The devel	y john Aw lopment of lopment of nent, Steel	reicewicz, In Tec ring rolling tech ring rolling tech Res Int, 76 (2005	ch publisher,20 nology, Steel R nology-part 2: 5), pp. 491–
Adv: Ref 1 2 3 4	antages and limitations ference Books Numerical Analysis- Theory J.M. Allwood, A.E. Tekkaya, Int, 76 (2005), pp. 111–120 J.M. Allwood, A.E. Tekkaya, investigation of process behav 507.	and T.I T.I vior Ma	Application F. Stanistreet and product nufacturing E.A., Allwoo	– Edited by , The devel , The devel ion equipm with materiod J.M., Hi	y john Awa lopment of lopment of hent, Steel ials,1990, I	reicewicz, In Tec ring rolling tech ring rolling tech Res Int, 76 (2005 Butterworth Hein	ch publisher,20 nology, Steel R nology-part 2: 5), pp. 491–
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