ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

B. TECH. CERAMIC TECHNOLOGY

REGULATION - 2015

CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES(PEOs)

I. To prepare the students to excel in academic and research or to succeed In Ceramic Technology profession through global, rigorous undergraduate education
II. To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve ceramic technology problems.
III. To train the students with good scientific and engineering knowledge so as to comprehend, analyze, design and create novel products and solutions for the real life problems
IV. To inculcate students in professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach and an ability to relate issues to broader social context.
V. To provide students with an academic environment aware of excellence, leadership, written ethical codes and guidelines, and the life long leaning needed for a successful professional career.

PROGRAMME OUTCOMES(POs)

On successful completion of the programme

I. Graduate will demonstrate knowledge of mathematics, science and engineering
II. Graduate will demonstrate an ability to identify, formulate and solve engineering problems
III. Graduate will demonstrate an ability to design and conduct experiments, analyze and interpret data
IV. Graduate will demonstrate an ability to design a system, component or process as per needs and specifications
V. Graduate will demonstrate an ability to visualize and work on laboratory and multidisciplinary tasks
VI. Graduate will demonstrate skills to use modern engineering tools, software and equipment to analyze problems
VII. Graduate will demonstrate knowledge of professional and ethical responsibilities
VIII. Graduate will be able to communicate effectively in both verbal and written form
IX. Graduate will show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues
X. Graduate will develop confidence for self education and ability for long life learning

Attested

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Programme Educational Objectives	Programme Outcomes									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
I	√	√				√	√	√	√	√
II	√	√	√	√	√	√				
III		√	√	√	√	√			√	√
IV						√	√		√	√
V	√						√		√	√

YEAR	SEM	COURSE TITLE	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10
YEAR 1	SEM 1	Foundational English	√	√						√		
		Mathematics I	√	√	√							
		Engineering Physics	√	√	√		√					
		Engineering Chemistry	√	√	√		√					
		Engineering Graphics	√	√	√							
		Basic Sciences Laboratory										
		Computer Practices Laboratory	√	√	√		√					
		Engineering Practices Laboratory	√	√	√	√						
	SEM 2	Technical English	√	√						√		
		Mathematics II	√	√	√							
		Physics of Materials	√	√	√		√					
		Chemistry for Technologists	√	√	√		√					
		Engineering Mechanics	√	√	√	√						
		Basic Mechanical Engineering	√	√		√	√					
		Unix Programming Lab	√	√	√	√						
		Mechanical Engineering Lab	√	√		√	√	√				
YEAR 2	SEM 3	Engineering Ethics & Human Values							√		√	√
		Transform Techniques & Partial Differential Equations	√	√	√							

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		Materials Science for Ceramics	√			√	√					√
		Principles of Unit Operations	√			√	√	√				
		Elements of Ceramics	√					√				
		Thermodynamics for Ceramics	√			√	√	√				
		Ceramic Science Lab			√	√	√	√				
		Unit Operations Lab			√	√	√	√				
	SEM 4	Ceramic Raw Materials	√								√	√
		Processing of Ceramic Raw Materials	√								√	√
		Metallurgy	√		√	√		√			√	
		Traditional Ceramics	√					√	√			
		Phase Equilibria	√	√	√	√	√	√				
		Instrumental Methods of Analysis	√	√	√	√	√	√				
		Chemical Analysis of Ceramic Raw Materials	√	√	√		√					√
		Ceramic Testing Lab	√	√	√	√	√					
YEAR 3	**SEM 5**	Ceramic Processing I	√					√			√	√
		Glaze Technology	√					√			√	√
		Refractories I	√				√	√			√	√
		Glass Engineering I	√			√	√				√	√
		Professional Elective I	√						√		√	√
		Professional Elective II	√						√		√	√
		Ceramic Processing Lab	√	√	√	√	√	√				
		CAD Lab for Ceramics	√	√	√	√	√	√				
		Technical Seminar							√	√		√
	SEM 6	Environmental Science and Engineering	√					√			√	√
		Ceramic Processing II	√					√			√	√
		Refractories II	√					√			√	√
		Glass Engineering II	√					√			√	√
		Professional Elective III	√						√		√	√
		Open Elective I	√						√		√	√
		Refractory Ceramics Lab	√	√	√	√	√	√				
		Glass Lab	√	√	√	√	√	√				
YEAR 4	**SEM 7**	Process Economics and Industrial Management	√					√			√	√
		Structural Ceramic Materials	√						√		√	√
		Professional Elective IV	√						√		√	√

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		Professional Elective V	√						√		√	√
		Open Elective II	√						√		√	√
		Employability Skills							√	√	√	√
		Advanced Instrumental Methods Lab	√	√	√							
		Industrial Training During Summer (4 Weeks)	√	√	√	√	√	√	√		√	√
		Advanced Ceramic Processing Lab		√	√	√	√	√		√	√	√
	SEM 8	Professional Elective VI	√						√		√	√
		Professional Elective VII	√						√		√	√
		Project Work	√	√	√	√	√	√	√		√	√

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CURRICULA AND SYLLABI I - VIII SEMESTERS

SEMESTER - I

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	HS7151	Foundational English	HS	4	4	0	0	4
2.	MA7151	Mathematics I	BS	4	4	0	0	4
3.	PH7151	Engineering Physics	BS	3	3	0	0	3
4.	CY7151	Engineering Chemistry	BS	3	3	0	0	3
5.	GE7152	Engineering Graphics	ES	5	3	2	0	4
PRACTICALS								
6.	BS7161	Basic Sciences Laboratory	BS	4	0	0	4	2
7.	GE7162	Engineering Practices Laboratory	ES	4	0	0	4	2
8.	GE7161	Computer Practices Laboratory	ES	4	0	0	4	2
			TOTAL	**31**	**17**	**2**	**12**	**24**

SEMESTER - II

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	HS7251	Technical English	HS	4	4	0	0	4
2.	MA7251	Mathematics II	BS	4	4	0	0	4
3.	PH7257	Physics of Materials	BS	3	3	0	0	3
4.	CY7255	Chemistry for Technologists	BS	3	3	0	0	3
5.	GE7153	Engineering Mechanics	ES	4	4	0	0	4
6.	ME7251	Basic Mechanical Engineering	ES	3	3	0	0	3
PRACTICALS								
7.	CH7262	Unix Programming Lab	ES	4	0	0	4	2
8.	ME7262	Mechanical Engineering Lab	ES	4	0	0	4	2
			TOTAL	**29**	**21**	**0**	**8**	**25**

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SEMESTER – III

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	CT7301	Elements of Ceramics	PC	3	3	0	0	3
2	CT7302	Materials Science for Ceramics	ES	3	3	0	0	3
3	CT7303	Principles of Unit Operations	ES	3	3	0	0	3
4	CT7304	Thermodynamics for Ceramics	PC	3	3	0	0	3
5	GE7351	Engineering Ethics and Human Values	HS	3	3	0	0	3
6	MA7358	Transform Techniques and Partial Differential Equations	BS	4	4	0	0	4
PRACTICALS								
7	CT7311	Ceramics Science Lab	ES	4	0	0	4	2
8	CT7312	Unit Operations Lab	ES	4	0	0	4	2
			TOTAL	**27**	**19**	**0**	**8**	**23**

SEMESTER – IV

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	CT7401	Ceramic Raw Materials	PC	3	3	0	0	3
2	CT7402	Metallurgy	PC	3	3	0	0	3
3	CT7403	Phase Equilibria	PC	3	3	0	0	3
4	CT7404	Processing of Ceramic Raw Materials	PC	3	3	0	0	3
5	CT7405	Traditional Ceramics	PC	3	3	0	0	3
6	CY7351	Instrumental Methods of Analysis	ES	3	3	0	0	3
PRACTICALS								
7	CT7411	Ceramic Testing Lab	PC	4	0	0	4	2
8	CT7412	Chemical Analysis of Ceramic Raw Materials Lab	PC	4	0	0	4	2
			TOTAL	**26**	**18**	**0**	**8**	**22**

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SEMESTER – V

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	CT7501	Ceramic Processing I	PC	3	3	0	0	3
2	CT7502	Glass Engineering I	PC	3	3	0	0	3
3	CT7503	Glaze Technology	PC	3	3	0	0	3
4	CT7504	Refractories I	PC	3	3	0	0	3
5		Professional Elective I	PE	3	3	0	0	3
6		Professional Elective II	PE	3	3	0	0	3
PRACTICALS								
7	CT7511	CAD Lab for Ceramics	PC	4	0	0	4	2
8	CT7512	Ceramic Processing Lab	PC	4	0	0	4	2
9	CT7513	Technical Seminar	EEC	2	0	0	2	1
			'TOTAL	**28**	**18**	**0**	**10**	**23**

SEMESTER – VI

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	CT7601	Ceramic Processing II	PC	3	3	0	0	3
2	CT7602	Glass Engineering II	PC	3	3	0	0	3
3	CT7603	Refractories II	PC	3	3	0	0	3
4	GE7251	Environmental Science and Engineering	HS	3	3	0	0	3
5		Professional Elective III	PE	3	3	0	0	3
6		Open Elective I	OE	3	3	0	0	3
PRACTICALS								
7	CT7611	Glass Lab	PC	4	0	0	4	2
8	CT7612	Refractory Ceramics Lab	PC	4	0	0	4	2
			TOTAL	**26**	**18**	**0**	**8**	**22**

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SEMESTER – VII

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	CT7701	Process Economics and Industrial Management	HS	3	3	0	0	3
2	CT7702	Structural Ceramic Materials	PC	3	3	0	0	3
3	HS7551	Employability Skills	HS	3	3	0	0	3
4		Professional Elective IV	PE	3	3	0	0	3
5		Professional Elective V	PE	3	3	0	0	3
6		Open Elective II	OE	3	3	0	0	3
PRACTICALS								
7	CT7711	Advanced Instrumental Methods Lab	PC	4	0	0	4	2
8	CT7712	Industrial Training During Summer (4 Weeks)	EEC	0	0	0	0	2
9	CT7713	Advanced Ceramic Processing Lab	PC	4	0	0	4	2
			TOTAL	**26**	**18**	**0**	**8**	**24**

SEMESTER – VIII

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1		Professional Elective VI	PE	3	3	0	0	3
2		Professional Elective VII	PE	3	3	0	0	3
PRACTICALS								
2	CT7811	Project Work	EEC	20	0	0	20	10
			TOTAL	**26**	**6**	**0**	**20**	**16**

TOTAL NUMBER OF CREDITS:181

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PROFESSIONAL ELECTIVES (PE)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	CT7001	Abrasive Technology	PE	3	3	0	0	3
2.	CT7002	Advanced Refractory Materials	PE	3	3	0	0	3
3.	CT7003	Bioceramic Materials	PE	3	3	0	0	3
4.	CT7004	Cement Technology	PE	3	3	0	0	3
5.	CT7005	Electronic Ceramics	PE	3	3	0	0	3
6.	CT7006	Fibres and Composites	PE	3	3	0	0	3
7.	CT7007	Fuels and Energy Engineering	PE	3	3	0	0	3
8.	CT7008	Functional Glasses	PE	3	3	0	0	3
9.	CT7009	Kilns, Furnaces and Pyrometry	PE	3	3	0	0	3
10.	CT7010	Materials Management	PE	3	3	0	0	3
11.	CT7011	Mechanical Behaviour of Ceramic Materials	PE	3	3	0	0	3
12.	CT7012	Microwave Processing of Ceramics	PE	3	3	0	0	3
13.	CT7013	Monolithic Refractories	PE	3	3	0	0	3
14.	CT7014	Non Destructive Testing and Evaluation	PE	3	3	0	0	3
15.	CT7015	Plant Equipment and Furnace Design	PE	3	3	0	0	3
16.	CT7016	Process Automation	PE	3	3	0	0	3
17.	CT7017	Quality Control in Ceramic Industries	PE	3	3	0	0	3
18.	CT7018	Quantitative Techniques in Ceramics	PE	3	3	0	0	3
19.	CT7019	Refractory Engineering and Management	PE	3	3	0	0	3
20.	CT7020	Special Coating Technology	PE	3	3	0	0	3
21.	GE7071	Disaster Management	PE	3	3	0	0	3
22.	GE7073	Fundamentals of Nano Science	PE	3	3	0	0	3
23.	GE7074	Human Rights	PE	3	3	0	0	3
24.	GE7652	Total Quality Management	PE	3	3	0	0	3
25.	GE7072	Foundation Skills in Integrated Product Development	PE	3	3	0	0	3

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HUMANITIES AND SOCIAL SCIENCES (HS)

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	HS7151	Foundational English	HS	4	4	0	0	4
2.	HS7251	Technical English	HS	4	4	0	0	4
3.	GE7351	Engineering Ethics & Human Values	HS	3	3	0	0	3
4.	HS7551	Employability Skills	HS	3	3	0	0	3
5.	GE7251	Environmental Science and Engineering	HS	3	3	0	0	3
6.	CT7701	Process Economics and Industrial Management	HS	3	3	0	0	3

BASIC SCIENCES (BS)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MA7151	Mathematics I	BS	4	4	0	0	4
2.	PH7151	Engineering Physics	BS	4	4	0	0	4
3.	CY7151	Engineering Chemistry	BS	4	4	0	0	4
4.	BS7161	Basic Sciences Laboratory	BS	4	0	0	4	2
5.	MA7251	Mathematics II	BS	4	4	0	0	4
6.	PH7257	Physics of Materials	BS	3	3	0	0	3
7.	CY7255	Chemistry for Technologists	BS	3	3	0	0	3
8.	MA7358	Transform Techniques and Partial Differential Equation	BS	4	4	0	0	4

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ENGINEERING SCIENCES (ES)

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	GE7152	Engineering Graphics	ES	5	3	2	0	4
2.	GE7162	Engineering Practices Laboratory	ES	4	0	0	4	2
3.	GE7161	Computer Practices Laboratory	ES	4	0	0	4	2
4.	ME7251	Basic Mechanical Engineering	ES	3	3	0	0	3
5.	CH7262	Unix Programming Lab	ES	4	0	0	4	2
6.	ME7262	Mechanical Engineering Lab	ES	4	0	0	4	2
7.	CT7302	Materials Science for Ceramics	ES	3	3	0	0	3
8.	CT7303	Principles of Unit Operations	ES	3	3	0	0	3
9.	GE7153	Engineering Mechanics	ES	4	4	0	0	4
10.	CT7311	Ceramic Science Lab	ES	4	0	0	4	2
11.	CT7312	Unit Operations Lab	ES	4	0	0	4	2
12.	CY7351	Instrumental Methods of Analysis	ES	3	3	0	0	3

PROFESSIONAL CORE (PC)

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	CT7301	Elements of Ceramics	PC	3	3	0	0	3
2.	CT7401	Ceramic Raw Materials	PC	3	3	0	0	3
3.	CT7404	Processing of Ceramic Raw Materials	PC	3	3	0	0	3
4.	CT7304	Thermodynamics for Ceramics	PC	3	3	0	0	3
5.	CT7405	Traditional Ceramics	PC	3	3	0	0	3

6.	CT7403	Phase Equilibria	PC	3	3	0	0	3
7.	CT7402	Metallurgy	PC	3	3	0	0	3
8.	CT7412	Chemical Analysis of Ceramic Raw Materials Lab	PC	4	0	0	4	2
9.	CT7411	Ceramic Testing Lab	PC	4	0	0	4	2
10.	CT7501	Ceramic Processing I	PC	3	3	0	0	3
11.	CT7503	Glaze Technology	PC	3	3	0	0	3
12.	CT7504	Refractories I	PC	3	3	0	0	3
13.	CT7502	Glass Engineering I	PC	3	3	0	0	3
14.	CT7512	Ceramic Processing Lab	PC	4	0	0	4	2
15.	CT7511	CAD Lab for Ceramics	PC	4	0	0	4	2
16.	CT7601	Ceramic Processing II	PC	3	3	0	0	3
17.	CT7603	Refractories II	PC	3	3	0	0	3
18.	CT7602	Glass Engineering II	PC	3	3	0	0	3
19.	CT7612	Refractory Ceramics Lab	PC	4	0	0	4	2
20.	CT7611	Glass Lab	PC	4	0	0	4	2
21.	CT7702	Structural Ceramics Materials	PC	3	3	0	0	3
22.	CT7711	Advanced Instrumental Methods Lab	PC	4	0	0	4	2
23.	CT7713	Advanced Ceramic Processing Lab	PC	4	0	0	4	2

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	CT7513	Technical Seminar	EEC	2	0	0	2	1
2.	CT7712	Industrial Training During Summer (4 Weeks)	EEC	0	0	0	0	2
3.	CT7811	Project Work	EEC	20	0	0	20	10

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SUMMARY

S.No	Subject Area	Credits per Semester								Credits Total
		I	II	III	IV	V	VI	VII	VIII	
1	HS	4	4	3	-	-	3	6	-	**20**
2	BS	12	10	4	-	-	-	-	-	**26**
3	ES	8	11	10	3	-	-	-	-	**32**
4	PC	-	-	6	19	16	13	7	-	**61**
5	PE	-	-	-	-	6	3	6	6	**21**
6	OE	-	-	-	-	-	3	3	-	**6**
7	EEC	-	-	-	-	1	-	2	10	**13**
	Total	**25**	**24**	**24**	**22**	**23**	**22**	**26**	**16**	**181**
8	Non-Credit/Mandatory									

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HS7151 FOUNDATIONAL ENGLISH L T P C
4 0 0 4

COURSE DESCRIPTION:

This course aims at developing the language skills necessary for the first year students of Engineering and Technology.

OBJECTIVES:

- To develop the four language skills – Listening, Speaking, Reading and Writing.
- To improve the students' communicative competence in English.
- To teach students the various aspects of English language usage.

CONTENTS

UNIT I GREETING AND INTRODUCING ONESELF 12

Listening- Types of listening – Listening to short talks, conversations; **Speaking** – Speaking about one's place, important festivals etc. – Introducing oneself, one's family/ friend; **Reading** – Skimming a passage– Scanning for specific information; **Writing**- Guided writing - Free writing on any given topic (My favourite place/ Hobbies/ School life, writing about one's leisure time activities, hometown, etc.); **Grammar** – Tenses (present and present continuous) -Question types - Regular and irregular verbs; **Vocabulary** – Synonyms and Antonyms.

UNIT II GIVING INSTRUCTIONS AND DIRECTIONS 12

Listening – Listening and responding to instructions; **Speaking** – Telephone etiquettee - Giving oral instructions/ Describing a process – Asking and answering questions; **Reading** – Reading and finding key information in a given text - Critical reading - **Writing –**Process description(non-technical)- **Grammar** – Tense (simple past& past continuous) - Use of imperatives – Subject – verb agreement – Active and passive voice; - **Vocabulary** – Compound words – Word formation – Word expansion (root words).

UNIT III READING AND UNDERSTANDING VISUAL MATERIAL 12

Listening- Listening to lectures/ talks and completing a task; **Speaking** –Role play/ Simulation – Group interaction; **Reading** – Reading and interpreting visual material;**Writing**- Jumbled sentences – Discourse markers and Cohesive devices – Essay writing (cause & effect/ narrative);**Grammar** – Tenses (perfect), Conditional clauses –Modal verbs; **Vocabulary** –Cause and effect words; Phrasal verbs in context.

UNIT IV CRITICAL READING AND WRITING 12

Listening- Watching videos/ documentaries and responding to questions based on them; **Speaking** Informal and formal conversation; **Reading** –Critical reading (prediction & inference);**Writing**–Essay writing (compare & contrast/ analytical) – Interpretation of visual materials; **Grammar** – Tenses (future time reference);**Vocabulary** – One word substitutes (with meanings) – Use of abbreviations & acronyms – Idioms in sentences.

UNIT V LETTER WRITING AND SENDING E-MAILS 12

Listening- Listening to programmes/broadcast/ telecast/ podcast; **Speaking** – Giving impromptu talks, Making presentations on given topics- Discussion on the presentation; **Reading** –Extensive reading; **Writing**- Poster making – Letter writing (Formal and E-mail) ;**Grammar** – Direct and Indirect speech – Combining sentences using connectives; **Vocabulary** –Collocation;

TEACHING METHODS:

Interactive sessions for the speaking module.
Use of audio – visual aids for the various listening activities.

Contextual Grammar Teaching.

EVALUATION PATTERN:
Internals – 50%
End Semester – 50%

TOTAL : 60 PERIODS

LEARNING OUTCOMES:
- Students will improve their reading and writing skills
- Students will become fluent and proficient in communicative English
- Students will be able to improve their interpersonal communication

TEXTBOOK:
1. Richards, Jack.C with Jonathan Hull and Susan Proctor **New Interchange : English for International Communication. (level2, Student's Book)** Cambridge University Press,New Delhi: 2010.

REFERENCES:
1. Bailey, Stephen. **Academic Writing: A practical guide for students**. New York: Rutledge,2011.
2. Morgan, David and Nicholas Regan. **Take-Off: Technical English for Engineering**. London: Garnet Publishing Limited, 2008.
3. Redston, Chris & Gillies Cunningham **Face2Face** (Pre-intermediate Student's Book& Workbook) Cambridge University Press, New Delhi: 2005
4. Comfort, Jeremy, et al. **Speaking Effectively : Developing Speaking Skillsfor Business English.** Cambridge University Press, Cambridge: Reprint 2011.

MA7151	MATHEMATICS – I	L	T	P	C
		4	0	0	4

(Common to all branches of B.E. /B.Tech. Programmes in I Semester)

COURSE OBJECTIVES
- The goal of this course is for students to gain proficiency in calculus computations. In calculus, we use three main tools for analyzing and describing the behavior of functions: limits, derivatives, and integrals. Students will use these tools to solve application problems in a variety of settings ranging from physics and biology to business and economics.
- To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model engineering problems.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.

UNIT I DIFFERENTIAL CALCULUS **12**

Representation of functions - New functions from old functions - Limit of a function - Limits at infinity - Continuity - Derivatives - Differentiation rules - Polar coordinate system - Differentiation in polar coordinates - Maxima and Minima of functions of one variable.

12

UNIT II FUNCTIONS OF SEVERAL VARIABLES

Partial derivatives – Homogeneous functions and Euler's theorem – Total derivative – Differentiation of implicit functions – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Errors and approximations –

Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

UNIT III INTEGRAL CALCULUS 12

Definite and Indefinite integrals - Substitution rule - Techniques of Integration - Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals.

UNIT IV MULTIPLE INTEGRALS 12

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals.

UNIT V DIFFERENTIAL EQUATIONS 12

Method of variation of parameters – Method of undetermined coefficients – Homogenous equation of Euler's and Legendre's type – System of simultaneous linear differential equations with constant coefficients.

TOTAL : 60 PERIODS

COURSE OUTCOMES

- Understanding of the ideas of limits and continuity and an ability to calculate with them and apply them.
- Improved facility in algebraic manipulation.
- Fluency in differentiation.
- Fluency in integration using standard methods, including the ability to find an appropriate method for a given integral.
- Understanding the ideas of differential equations and facility in solving simple standard examples.

TEXT BOOKS

James Stewart, "Calculus with Early Transcendental Functions", Cengage Learning, New Delhi, 2008.

2. Narayanan S. and Manicavachagom Pillai T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2007.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 9th Edition, New Delhi, 2014.
4. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.

REFERENCE BOOKS

1. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., New Delhi, 11th Reprint, 2010.
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 3rd Edition, 2007.
3. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
4. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education, New Delhi, 2nd Edition, 5th Reprint, 2009.
5. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, New Delhi, 2007.

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PH7151 **ENGINEERING PHYSICS** **L T P C**

(Common to all branches of B.E / B.Tech programmes) **3 0 0 3**

OBJECTIVE:

- To introduce the concept and different ways to determine moduli of elasticity and applications.
- To instill the concept of sound, reverberation, noise cancellation, and ultrasonic generation, detection and applications
- To inculcate an idea of thermal properties of materials, heat flow through materials and quantum physics
- To promote the basic understanding of interferometers, principles and applications of lasers, optical fibers and sensors
- To establish a sound grasp of knowledge on the basics, significance and growth of single crystals

UNIT I PROPERTIES OF MATTER **9**

Elasticity – Poisson's ratio and relationship between moduli (qualitative) - stress-strain diagram for ductile and brittle materials, uses - factors affecting elastic modulus and tensile strength - bending of beams - cantilever - bending moment - Young's modulus determination - theory and experiment - uniform and non-uniform bending - I shaped girders - twisting couple - hollow cylinder - shaft - torsion pendulum - determination of rigidity modulus- moment of inertia of a body (regular and irregular).

UNIT II ACOUSTICS AND ULTRASONICS **9**

Classification of sound - loudness and intensity - Weber-Fechner Law - standard intensity and intensity level - decibel - reverberation - reverberation time - calculation of reverberation time for different types of buildings – sound absorbing materials - factors affecting acoustics of buildings : focussing, interference, echo, echelon effect, resonance - noise and their remedies. Ultrasonics: production - magnetostriction and piezoelectric methods - detection of ultrasound - acoustic grating – ultrasonic interferometer - industrial applications – Non-destructive testing - ultrasonic method: scan modes and practice.

UNIT III THERMAL AND MODERN PHYSICS **9**

Thermal expansion - thermal stress - expansion joints - bimetallic strips - thermal conductivity- heat conductions in solids – flow of heat through compound media - Forbe's and Lee's disc method: theory and experiment- Black body radiation – Planck's theory (derivation) – Compton effect – wave model of radiation and matter – Schrödinger's wave equation – time dependent and independent equations – Physical significance of wave function – particle in a one dimensional box.

UNIT IV APPLIED OPTICS **9**

Interference - Michelson interferometer: construction, working, determination of wave length and thickness - anti-reflection coating - air wedge and its applications - Lasers – principle and applications – Einstein's coefficients – CO_2 and Nd:YAG laser - semiconductor lasers: homo junction and hetro junction - construction and working – applications. Optical fibres - classification (index & mode based) - principle and propagation of light in optical fibres - acceptance angle and numerical aperture - fibre optic communication system - active and passive sensors.

UNIT V CRYSTAL PHYSICS **9**

Single crystalline, polycrystalline and amorphous materials – Single crystals: unit cell, crystal systems, Bravais lattices, ditections and planes in a crystal, Miller indices - interplanar distance for a cubic crystal - coordination number and packing factor for SC, BCC, FCC, HCP and diamond structures - structure and significance of NaCl, CsCl, ZnS and graphite - crystal imperfections: point defects, line defects – Burger vectors, dislocations and stacking faults – Growth of single crystals: Bridgman and Czochralski methods.

TOTAL: 45 PERIODS

OUTCOME:

- The students will understand different moduli of elasticity, their determination and applications.
- The students will gain knowledge on the properties of sound, noise cancellation, and production, detection and applications of ultrasonics
- The students will acquire sound knowledge on thermal expansion and thermal conductivity of materials. Further they will gain an idea of quantum physics.
- The students will gain knowledge on interferometers, lasers and fiber optics
- The students will secure knowledge on the basics of crystal structures and their significance. Further they gain basic ideas of growing single crystals.

TEXTBOOKS:

1. Gaur R.K. and Gupta S.L., "Engineering Physics", Dhanpat Rai Publications (2013)
2. Palanisamy P.K., "Engineering Physics", Scitech Publications (P) Ltd. (2006).
2. Arumugam M., "Engineering Physics", Anuradha Publications (2000)

REFERENCES:

1. Serway R.A. and Jewett, J.W. "Physics for Scientists and Engineers with Modern Physics". Brooks/cole Publishing Co. (2010).
2. Tipler P.A. and Mosca, G.P., "Physics for Scientists and Engineers with Modern Physics". W.H.Freeman, (2007).
3. Markert J.T.,Ohanian, H. and Ohanian, M. "Physics for Engineers and Scientists". W.W.Norton & Co. (2007).

CY7151	**ENGINEERING CHEMISTRY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To develop an understanding about fundamentals of polymer chemistry.
- Brief elucidation on surface chemistry and catalysis.
- To develop sound knowledge photochemistry and spectroscopy.
- To impart basic knowledge on chemical thermodynamics.
- To understand the basic concepts of nano chemistry.

UNIT I POLYMER CHEMISTRY 9

Introduction: Functionality-degree of polymerization. Classification of polymers- natural and synthetic, thermoplastic and thermosetting. Types and mechanism of polymerization: addition (free radical, cationic, anionic and living); condensation and copolymerization. Properties of polymers: Tg, tacticity, molecular weight-weight average, number average and polydispersity index. Techniques of polymerization: Bulk, emulsion, solution and suspension.

UNIT II SURFACE CHEMISTRYAND CATALYSIS 9

Adsorption-Types of adsorption-adsorption of gases on solids- adsorption from solutions- Types of isotherms–Frendlich adsorption isotherm,Langmuir adsorption isotherm.Industrial applications of adsorption. Catalysis: Characteristics and types of catalysts-homogeneous and heterogeneous, auto catalysis. Enzyme catalysis -factors affecting enzyme catalysis, Michaelis-Menton equation.Industrial applications of catalysts.

UNIT III PHOTOCHEMISTRY AND SPECTROSCOPY 9

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Photochemistry: Laws of photochemistry-Grotthuss-Draper law, Stark-Einstein law and Lambert-Beer Law. Photo processes-internal conversion, inter-system crossing, fluorescence, phosphorescence, chemiluminescence and photo-sensitization. Spectroscopy: Electromagnetic spectrum-absorption of radiation-electronic, vibrational and rotational transitions. Width and intensities of spectral lines.Spectrophotometric estimation of iron.UV-Vis and IR spectroscopy-principles, instrumentation (Block diagram) and applications.

UNIT IV CHEMICAL THERMODYNAMICS 9

Second law: Entropy-entropy change for an ideal gas, reversible and irreversible processes; entropy of phase transitions; Free energy and work function: Helmholtzand Gibbs free energy functions; Criteria of spontaneity; Gibbs-Helmholtz equation; Clausius Clapeyron equation; Maxwell relations-Van't Hoff isotherm and isochore. Chemical potential; Gibbs-Duhem equation-variation of chemical potential with temperature and pressure.

UNIT V NANOCHEMISTRY 9

Basics-distinction between molecules, nanoparticles and bulk materials; size-dependent properties.Preparation of nanoparticles – sol-gel and solvothermal.Preparation of carbon nanotube by chemical vapour deposition and laser ablation.Preparation of nanowires by VLS growth, electrochemical deposition and electro spinning.Properties and uses of nanoparticles, nanoclusters, nanorods, nanotubes and nanowires.

TOTAL : 45 PERIODS

COURSE OUTCOMES

- Will be familiar with polymer chemistry, surface chemistry and catalysis.
- Will know the photochemistry, spectroscopy and chemical thermodynamics.
- Will know the fundamentals of nano chemistry.

TEXT BOOKS

1. Jain P. C. & Monica Jain., "Engineering Chemistry", DhanpatRai Publishing Company (P) Ltd, New Delhi, 2014.
2. Kannan P., Ravikrishnan A., "Engineering Chemistry", Sri Krishna Hitech Publishing Company Pvt. Ltd. Chennai, 2014

REFERENCES

1. Pahari A., Chauhan B., "Engineering Chemistry", Firewall Media, New Delhi, 2012.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
3. AshimaSrivastava. Janhavi N N, Concepts of Engineering Chemistry", ACME Learning Private Limited., New Delhi., 2010.
4. Vairam S., Kalyani P., Suba Ramesh., "Engineering Chemistry", Wiley India Pvt Ltd., New Delhi., 2011.

ENGINEERING GRAPHICS

	L	T	P	C
GE7152	**3**	**2**	**0**	**4**

OBJECTIVES

• To develop in students, graphic skills for communication of concepts, ideas and design of engineering products and expose them to existing national standards related to technical drawings.

CONCEPTS AND CONVENTIONS (NOT FOR EXAMINATION) **1**

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT I PLANE CURVES ANDFREE HANDSKETCHING **14**

Basic Geometrical constructions, Curves used in engineering practices-Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves. Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Free hand sketching of multiple views from pictorial views of objects

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACES **14**

Orthographic projection- principles-Principal planes-First angle projection-Projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes-Determination of true lengths and true inclinations by rotating line method and trapezoidal method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS **14**

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to both the principal planes by rotating object method and auxiliary plane method.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES **14**

Sectioning of solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section.

Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Development of lateral surfaces of solids with cut-outs and holes.

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS **15**

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions and miscellaneous problems.

Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method and vanishing point method.

COMPUTER AIDED DRAFTING (DEMONSTRATION ONLY) **3**

Introduction to drafting packages and demonstration of their use.

L=45+T=30, TOTAL: 75 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

- Perform free hand sketching of basic geometrical shapes and multiple views of objects.
- Draw orthographic projections of lines, Planes and Solids
- Obtain development of surfaces.
- Prepare isometric and perspective views of simple solids.

TEXT BOOK:

1 N.D.Bhatt and V.M.Panchal, “Engineering Drawing”, Charotar Publishing House, 50th Edition, 2010.

REFERENCES:

1. K.R.Gopalakrishna., "Engineering Drawing" (Vol I&II combined) SubhasStores, Bangalore, 2007
2. Luzzader, Warren.J., and Duff,John M.,,'' Fundamentals of Engineering Drawingwith an introduction to Interactive Computer Graphics for Design and Production",Eastern Economy Edition, Prentice Hall of India Pvt Ltd, New Delhi, 2005
3. M.B.Shah and B.C.Rana, "Engineering Drawing", Pearson, 2nd Edition, 2009
4. K.Venugopal and V.Prabhu Raja, "Engineering Graphics", New Age International (P)Limited ,2008.
5. K. V.Natarajan, "A text book of Engineering Graphics", 28th Edition, Dhanalakshmi Publishers, Chennai, 2015.
6. BasantAgarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
7. N.S Parthasarathy and Vela Murali, " Engineering Drawing", Oxford University Press, 2015

Publication of Bureau of Indian Standards:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out ofdrawing sheets
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

Special points applicable to University Examinations on Engineering Graphics:

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day.

BS7161	**BASIC SCIENCES LABORATORY**	**L T P C**
	(Common to all branches of B.E. / B.Tech Programmes)	**0 0 4 2**

PHYSICS LABORATORY: (Any Seven Experiments)

OBJECTIVE:

- To inculcate experimental skills to test basic understanding of physics of materials including properties of matter, thermal and optical properties.
- To induce the students to familiarize with experimental determination of velocity of ultrasonic waves, band gap determination and viscosity of liquids.

1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of disc
2. Non-uniform bending - Determination of young's modulus
3. Uniform bending – Determination of young's modulus
4. Lee's disc Determination of thermal conductivity of a bad conductor
5. Potentiometer-Determination of thermo e.m.f of a thermocouple
6. Laser- Determination of the wave length of the laser using grating
7. Air wedge - Determination of thickness of a thin sheet/wire
8. a) Optical fibre -Determination of Numerical Aperture and acceptance angle
   b) Compact disc- Determination of width of the groove using laser.
9. Acoustic grating- Determination of velocity of ultrasonic waves in liquids.
10. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids

11. Post office box -Determination of Band gap of a semiconductor.
12. Spectrometer- Determination of wavelength using gating.
13. Viscosity of liquids - Determination of co-efficient of viscosity of a liquid by Poiseuille's flow

TOTAL: 30 PERIODS

OUTCOME:

Upon completion of the course, the students will be able

- To determine various moduli of elasticity and also various thermal and optical properties of materials.
- To determine the velocity of ultrasonic waves, band gap determination and viscosity of liquids.

CHEMISTRY LABORATORY:

(Minimum of 8 experiments to be conducted)

1. Estimation of HCl using Na_2CO_3 as primary standard and Determination of alkalinity in water sample.
2. Determination of total, temporary & permanent hardness of water by EDTA method.
3. Determination of DO content of water sample by Winkler's method.
4. Determination of chloride content of water sample by argentometric method.
5. Estimation of copper content of the given solution by Iodometry.
6. Determination of strength of given hydrochloric acid using pH meter.
7. Determination of strength of acids in a mixture of acids using conductivity meter.
8. Estimation of iron content of the given solution using potentiometer.
9. Estimation of iron content of the water sample using spectrophotometer (1, 10-Phenanthroline/thiocyanate method).
10. Estimation of sodium and potassium present in water using flame photometer.
11. Determination of molecular weight of poly vinyl alcohol using Ostwald viscometer.
12. Pseudo first order kinetics-ester hydrolysis.
13. Corrosion experiment-weight loss method.
14. Determination of CMC.
15. Phase change in a solid.

TOTAL: 30 PERIODS

TEXTBOOKS

1. Vogel's Textbook of Quantitative Chemical Analysis (8^{TH} edition, 2014)
2. Laboratory Manual- Department of Chemistry, CEGC, Anna University (2014).

GE7162 ENGINEERING PRACTICES LABORATORY
(Common to all Branches of B.E. / B.Tech. Programmes)

L T P C
0 0 4 2

COURSE OBJECTIVES

- To provide exposure to the students with hands-on experience on various Basic Engineering Practices in Civil, Mechanical, Electrical and Electronics Engineering.

GROUP – A (CIVIL & ELECTRICAL)

CIVIL ENGINEERING PRACTICES 15

PLUMBING

- Basic pipe connections involving the fittings like valves, taps, coupling, unions, reducers, elbows and other components used in household fittings. Preparation of plumbing line sketches.
- Laying pipe connection to the suction side of a pump.
- Laying pipe connection to the delivery side of a pump.
- Practice in connecting pipes of different materials: Metal, plastic and flexible pipes used in householdappliances.

WOOD WORK

- Sawing, planing and making joints like T-Joint, Mortise and Tenon joint and Dovetail joint.

STUDY

- Study of joints in door panels and wooden furniture
- Study of common industrial trusses using models.

ELECTRICAL ENGINEERING PRACTICES 15

- Basic household wiring using Switches, Fuse, Indicator and Lamp etc.,
- Stair case light wiring
- Tube – light wiring
- Preparation of wiring diagrams for a given situation.
- Study of Iron-Box, Fan Regulator andEmergency Lamp

GROUP – B (MECHANICAL AND ELECTRONICS)

MECHANICAL ENGINEERING PRACTICES 15

WELDING

- Arc welding of Butt Joints, Lap Joints, and Tee Joints
- Gas welding Practice.
- Basic Machining - Simple turning, drilling and tapping operations..
- Study and assembling of the following:

a. Centrifugal pump
b. Mixie
c. Air Conditioner.

DEMONSTRATION ON FOUNDRY OPERATIONS.

ELECTRONIC ENGINEERING PRACTICES 15

- Soldering simple electronic circuits and checking continuity.
- Assembling electronic components on a small PCB and Testing.
- Study of Telephone, FM radio andLow Voltage Power supplies.

TOTAL: 60PERIODS

COURSE OUTCOMES

- Ability to fabricate carpentry components and to lay pipe connections including plumbing works.
- Ability to use welding equipments to join the structures

- Ability to do wiring for electrical connections and to fabricate electronics circuits.

GE7161 COMPUTER PRACTICES LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES

- To understand the basic programming constructs and articulate how they are used to develop a program with a desired runtime execution flow.
- To articulate where computer programs fit in the provision of computer-based solutions to real world problems.
- To learn to use user defined data structures.

LIST OF EXPERIMENTS

1. Search, generate, manipulate data using MS office/ Open Office
2. Presentation and Visualization – graphs, charts, 2D, 3D
3. Problem formulation, Problem Solving and Flowcharts
4. C Programming using Simple statements and expressions
5. Scientific problem solving using decision making and looping.
6. Simple programming for one dimensional and two dimensional arrays.
7. Solving problems using String functions
8. Programs with user defined functions
9. Program using Recursive Function
10. Program using structures and unions.

TOTAL: 60 PERIODS

OUTCOMES

At the end of the course, the student should be able to:

- Write and compile programs using C programs.
- Write program with the concept of Structured Programming
- Identify suitable data structure for solving a problem
- Demonstrate the use of conditional statement.

LABORATORY REQUIREMENTS FOR BATCH OF 30 STUDENTS

30 Systems with C compiler

HS7251 TECHNICAL ENGLISH

L	T	P	C
4	0	0	4

OBJECTIVES

- To enable students acquire proficiency in technical communication.
- To enhance their reading and writing skills in a technical context.
- To teach various language learning strategies needed in aprofessional environment.

CONTENTS

UNIT I ANALYTICAL READING **12**

Listening- Listening to informal and formal conversations; **Speaking** – Conversation Skills(opening, turn taking, closing)-explaining how something works-describing technical functions and

applications;**Reading** –Analytical reading, Deductive and inductive reasoning; **Writing**- vision statement–structuring paragraphs.

UNIT II SUMMARISING 12

Listening- Listening to lectures/ talks on Science & Technology;**Speaking** –Summarizing/ Oral Reporting, **Reading** – Reading Scientific and Technical articles; **Writing**- Extended definition –Lab Reports – Summary writing.

UNIT III DESCRIBING VISUAL MATERIAL 12

Listening- Listening to a panel discussion; **Speaking** – Speaking at formal situations; **Reading** – Reading journal articles - Speed reading;**Writing**-data commentary-describing visual material-writing problem-process- solution-the structure of problem-solution texts- writing critiques

UNIT IV WRITING/ E-MAILING THE JOB APPLICATION 12

Listening- Listening to/ Viewing model interviews; **Speaking** –Speaking at different types of interviews – Role play practice (mock interview); **Reading** – Reading job advertisements and profile of the company concerned;**Writing**- job application – cover letter –Résumé preparation.

UNIT V REPORT WRITING 12

Listening- Viewing a model group discussion;**Speaking** –Participating in a discussion - Presentation;**Reading** – Case study - analyse -evaluate – arrive at a solution;**Writing**– Recommendations- Types of reports (feasibility report)- designing and reporting surveys- – Report format.- writing discursive essays.

TEACHING METHODS:

Practice writing
Conduct model and mock interview and group discussion.
Use of audio – visual aids to facilitate understanding of various forms of technical communication.
Interactive sessions.

EVALUATION PATTERN:

Internals – 50%
End Semester – 50%

TOTAL:60 PERIODS

LEARNING OUTCOMES

- Students will learn the structure and organization of various forms of technical communication.
- Students will be able to listen and respond to technical content.
- Students will be able to use different forms of communication in their respective fields.

TEXTBOOK:

1. Craig,Thaine**. Cambridge Academic English: An integrated skills course for EAP(Student's Book)Level: Intermediate** Cambridge University Press, New Delhi: 2012

REFERENCES:

1. Laws, Anne. **Presentations.** Hyderabad: Orient Blackswan, 2011.
2. Ibbotson, Mark. **Cambridge English for Engieering**. Cambridge University Press, Cambridge,New Delhi: 2008
3. Naterop, Jean B. and Rod Revell. **Telephoning in English**. Cambridge: Cambridge University Press, 2004.
4. Rutherford, Andrea J. **Basic Communication Skills for Technology**. New Delhi: Pearson Education, 2001.
5. Bailey, Stephen. **Academic Writing A practical Guide for Students**. Routledge, London: 2004.
6. Hewings, Martin**. Cambridge Academic English: An integrated skills course for EAP(Student's Book)Level: Intermediate** Cambridge University Press, New Delhi: 2012.

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MA7251	MATHEMATICS – II	L	T	P	C
		4	0	0	4

(Common to all branches of B.E. /B.Tech. Programmes in II Semester)

COURSE OBJECTIVES

- To develop the use of matrix algebra techniques this is needed by engineers for practical applications.
- To acquaint the student with the concepts of vector calculus, needed for problems in all engineering disciplines.
- To develop an understanding of the standard techniques of complex variable theory so as to enable the student to apply them with confidence, in application areas such as heat conduction, elasticity, fluid dynamics and flow the of electric current.
- To make the student appreciate the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated.

UNIT I MATRICES 12

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of eigenvalues and eigenvectors – Cayley-Hamilton theorem – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II VECTOR CALCULUS 12

Gradient and directional derivative – Divergence and Curl – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green's, Gauss divergence and Stoke's theorems – Verification and application in evaluating line, surface and volume integrals.

UNIT III ANALYTIC FUNCTION 12

Analytic functions – Necessary and sufficient conditions for analyticity - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions $w = z + c,\ az,\ \frac{1}{z},\ z^2$ - Bilinear transformation.

UNIT IV COMPLEX INTEGRATION 12

Line integral - Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour with no pole on real axis.

UNIT V LAPLACE TRANSFORMS 12

Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems -Transforms of derivatives and integrals – Initial and final value theorems – Inverse transforms – Convolution theorem — Transform of periodic functions – Application to solution of linear ordinary differential equations with constant coefficients.

TOTAL : 60 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

- Evaluate real and complex integrals using the Cauchy integral formula and the residue theorem
- Appreciate how complex methods can be used to prove some important theoretical results.
- Evaluate line, surface and volume integrals in simple coordinate systems
- Calculate grad, div and curl in Cartesian and other simple coordinate systems, and establish identities connecting these quantities
- Use Gauss, Stokes and Greens theorems to simplify calculations of integrals and prove simple results.

TEXT BOOKS

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 9th Edition, New Delhi, 2014.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.

REFERENCES

1. Ramana, B.V. "Higher Engineering Mathematics", Tata McGraw Hill, New Delhi, 2010.
2. Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, New Delhi, 2007.
3. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 3rd Edition, 2007.
4. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
5. Peter V. O'Neil , "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, New Delhi, 2007.

PH7257 PHYSICS OF MATERIALS L T P C

(Common to Chemical, Ceramic, Food, Leather, Textile, Apparel, Industrial Biotechnology, Pharmaceutical and PET) **3 0 0 3**

OBJECTIVE:

- To make the students to understand the basics of phase diagrams and various materials preparation techniques
- To equip the students to have a knowledge on different types of electron theory, basics of quantum mechanics and about superconductors
- To introduce the physics of semiconducting materials and applications of semiconductors in device fabrication
- To familiarize the students with the theory and applications of magnetic and dielectric materials
- To provide the students a sound platform towards learning about advanced materials and their applications.

UNIT I PREPARATION OF MATERIALS 9

Phases - phase rule – binary systems – tie line rule – lever rule – phase diagram – invariant reactions - nucleation – homogeneous and heterogeneous nucleation – free energy of formation of a critical nucleus – Thin films – preparation: PVD, CVD method – Nanomaterials Preparation: wet chemical, solvothermal, sol-gel method.

UNIT II ELECTRICAL AND SUPERCONDUCTING MATERIALS 9

Classical free electron theory - expression for electrical conductivity – thermal conductivity, - Wiedemann-Franz law - Quantum free electron theory – applications of Schrodinger wave equation: particle in a finite potential well – particle in a three-dimensional box- degenerate states – Fermi-Dirac statistics – density of energy states – electron in periodic potential – electron effective mass – concept of hole. Superconducting phenomena, properties of superconductors – Meissner effect and isotope effect. Type I and Type II superconductors, High T_c superconductors – Magnetic levitation and SQUIDS.

UNIT III SEMICONDUCTING MATERIALS 9

Elemental Semiconductors - Compound semiconductors - Origin of band gap in solids (qualitative) - carrier concentration in metals - carrier concentration in an intrinsic semiconductor (derivation) – Fermi level – variation of Fermi level with temperature – electrical conductivity – band gap determination – carrier concentration in n-type and p-type semiconductors (derivation) – variation of Fermi level with temperature and impurity concentration – Hall effect – determination of Hall coefficient – LED - Solar cells.

UNIT IV DIELECTRIC AND MAGNETIC MATERIALS 9

Dielectric, Paraelectric and ferroelectric materials - Electronic, Ionic, Orientational and space charge polarization – Internal field and deduction of Clausius Mosotti equation – dielectric loss – different types of dielectric breakdown – classification of insulating materials and their applications - Ferroelectric materials - Introduction to magnetic materials - Domain theory of ferromagnetism, Hysteresis, Soft and Hard magnetic materials – Anti-ferromagnetic materials – Ferrites, Giant Magneto Resistance materials.

UNIT V NEW MATERIALS AND APPLICATIONS 9

Ceramics – types and applications – Composites: classification, role of matrix and reinforcement – processing of fibre reinforced plastics and fibre reinforced metals – Metallic glasses – Shape memory alloys – Copper, Nickel and Titanium based alloys – grapheme and its properties – Relaxor ferroelectrics - Bio materials – hydroxyapatite – PMMA – Silicone - Sensors: Chemical Sensors - Bio-sensors – Polymer semiconductors – Photoconducting polymers.

TOTAL: 45 PERIODS

OUTCOME:

On completion of the course, the students will be able to

- acquire knowledge of phase diagram, and thin film and nanomaterial preparation techniques
- familiarize with conducting materials, basic quantum mechanics, and properties and applications of superconductors.
- gain knowledge on semiconducting materials based on energy level diagrams, its types, temperature effect. Also, fabrication methods for semiconductor devices will be understood.
- realize with theories and applications of dielectric and ferromagnetic materials
- familiarize with ceramics, composites, metallic glasses, shape memory alloys, biomaterials and their important applications.

.

REFERENCES:

1. Callister W. D. and Rethwisch, D. G., “Materials Science and Engineering”, 9th Edition, Wiley (2014).
2. Raghavan V., “Materials Science and Engineering”, Prentice Hall of India (2004).
3. Askeland D.R. and Wright, W.J., “Essentials of Materials Science and Engineering”, 3rd Edition, Cengage Learning (2014).
4. Pillai, S.O., “Solid State Physics”, New Age International, 7th Edition (2015).
5. Viswanathan, B., “Nanomaterials”, Narosa Book Distributors Pvt Ltd. (2011).

CY7255	CHEMISTRY FOR TECHNOLOGISTS	L	T	P	C
		3	0	0	3

OBJECTIVE

- The students should be conversant with
- boiler feed water requirements, water treatment techniques,
- Applications of oil and its properties, principles of different chemical analysis.
- Different kinds of preparations of important chemicals.

OUTCOME

- Will be familiar with boiler feed water requirements, water treatment techniques.
- Will know the oil and its properties, principles of different chemical analysis.
- Will know the preparations of important chemicals.

UNIT I WATER TECHNOLOGY 9

Water quality parameters- hardness -definition - units of hardness - determination of hardness (EDTA method).Alkalinity - definition - determination of alkalinity.TDS, BOD, COD and iron and their significance. Softening – zeolite and demineralization processes. Boiler troubles (scale, sludge, boiler corrosion, caustic embrittlement and carry over) and remedies – removal of oils and silica, internal conditioning.Desalination by electro-dialysis and reverse osmosis.

UNIT II OILS, FATS, SOAPS & LUBRICANTS 9

Chemical constitution, chemical analysis of oils and fats – free acid, saponification and iodine values, definitions, determinations and significance.Soaps and detergents - cleaning action of soap. Lubricants - definition, characteristics, types and properties – viscosity, viscosity index, carbon residue, oxidation stability, flash and fire points, cloud and pour points, aniline point. Solid lubricants – graphite and molybdenum disulphide.

UNIT III CHEMICAL ANALYSIS – AN ANALYTICAL INSIGHT 9

Gravimetric analysis – principles – method – applications.redox titrations – principle – method – applications. Thin layer chromatography – principles – techniques – applications. Principles underlying the estimations of nitrogen in nitrogeneous fertilizers, phenol and aniline.

UNIT IV DYE CHEMISTRY 9

Witt's theory and modern theory of colors – synthesis of methyl red, methyl orange, congo red, malachite green, p-rosaniline, phenolphthalein, fluorescence, eosin dyes.

UNIT V CHEMICALS AND AUXILIARIES 9

Preparations of bleaching powder, sodium hypochlorite, hydrogen peroxide, chlorine dioxide – estimation of available chlorine in hypochlorite – determination of strength of hydrogen peroxide.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Jain & Jain, "Engineering Chemistry", 16th Edition, 2014,DhanpatRai Publishing Company, New Delhi.
2. Sharma B.K, "Industrial Chemistry", 16th Edition, 2014, GOEL Publishing House, Meerut.

REFERENCES

1. Dara SS, Umare SS, "A Textbook of Engineering Chemistry", S. Chand & Company Ltd., New Delhi, 2010.
2. Puri BR, Sharma LR, Pathania S, "Principles of Physical Chemistry", 42nd Edition, 2008, Vishal Publishing Co., Jalandhar.

3. Morrison RT, Boyd RN, Bhattacharjee SK, "Organic Chemistry", 7th Edition, Pearson India, 2011.

GE7153 ENGINEERING MECHANICS

L	T	P	C
4	0	0	4

OBJECTIVE :

The objective of this course is to inculcate in the student the ability to analyze any problem in a simple and logical manner and to predict the physical phenomena and thus lay the foundation for engineering applications.

UNIT I STATICS OF PARTICLES 12

Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles -Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors.

Equilibrium of a Particle- Newton's First Law of Motion, Space and Free-Body Diagrams, Forces in Space, Equilibrium of a Particle in Space.

UNIT II EQUILIBRIUM OF RIGID BODIES 12

Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point ,Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple - Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force -Couple system, Further Reduction of a System of Forces, Equilibrium in Two and Three Dimensions - Reactions at Supports and Connections.

UNIT III DISTRIBUTED FORCES 16

Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration , Theorems of Pappus-Guldinus, Distributed Loads on Beams, Center of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies , Determination of Centroids of Volumes by Integration.

Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration , Polar Moment of Inertia , Radius of Gyration of an Area , Parallel-Axis Theorem , Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates , Determination of the Moment of Inertia of a Three-Dimensional Body by Integration.

UNIT IV FRICTION 8

The Laws of Dry Friction. Coefficients of Friction, Angles of Friction, Wedges, Wheel Friction. Rolling Resistance , Ladder friction.

UNIT V DYNAMICS OF PARTICLES 12

Kinematics - Rectilinear Motion and Curvilinear Motion of Particles.

Kinetics- Newton's Second Law of Motion -Equations of Motions , Dynamic Equilibrium, Energy and Momentum Methods - Work of a Force , Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact, Method of Virtual Work - Work of a Force, Potential Energy, Potential Energy and Equilibrium.

L – 45 + T – 15 TOTAL: 60 PERIODS

OUTCOMES:

- Upon completion of this course, students will be able to construct meaningful mathematical models of physical problems and solve them.

TEXT BOOK

1. Beer,F.P and Johnson Jr. E.R, "Vector Mechanics for Engineers", McGraw-Hill Education

(India) Pvt. Ltd. 10th Edition, 2013.

REFERENCES

1. Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
2. J.L. Meriam & L.G. Karige, Engineering Mechanics: Statics (Volume I) and Engineering Mechanics: Dynamics, 7th edition, Wiley student edition, 2013.
3. P. Boresi & J. Schmidt, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
4. Irving H. Shames, G. Krishna Mohana Rao, Engineering Mechanics - Statics and Dynamics, Fourth Edition – PHI / Pearson Education Asia Pvt. Ltd., 2006.
5. Vela Murali, "Engineering Mechanics", Oxford University Press (2010)

ME7251 BASIC MECHANICAL ENGINEERING L T P C
3 0 0 3

OBJECTIVE

To impart knowledge on thermodynamics and thermal engineering power generating units such as engines and theory of machines

OUTCOME

- Students should learn thermodynamics and thermal engineering to understand the principles behind the operation of thermal equipments like IC engines and turbines etc., Students should be able to appreciate the theory behind operation of machinery and be able to design simple mechanisms

UNIT I LAWS OF THERMODYNAMICS 10

Basic concepts and hints; Zeroth law; First Law of Thermodynamics - Statement and application; Steady flow energy equation-problems- Second law of Thermodynamics – Kelvin - Plank statement and Clausius statement- problems; Limitations; Heat Engine, Refrigerator and Heat Pump, Available energy, Third law of Thermodynamics - Statement.

UNIT II HEATING AND EXPANSION OF GASES 6

Expressions for work done, Internal energy and heat transfer for Constant Pressure, Constant Volume, Isothermal, Adiabatic and Polytropic processes-Derivations and problems; Free expansion and Throttling process.

UNIT III AIR STANDARD CYCLES 6

Carnot cycle; Stirlings cycle; Joule cycle; Otto cycle; Diesel cycle; Dual combustion Cycle-Derivations and problems.

UNIT IV I.C. ENGINES, STEAM AND ITS PROPERTIES AND STEAM TURBINES 12

Engine nomenclature and classification; SI Engine; CI Engine; Four Stroke cycle, Two stroke cycle; Performance of I.C.Engine; Brake thermal efficiency; Indicated Thermal Efficiency, Specific fuel consumption.

Steam - Properties of steam; Dryness fraction; latent heat; Total heat of wet steam; Dry steam; Superheated steam. Use of steam tables; volume of wet steam, volume of superheated steam; External work of evaporation; Internal energy; Entropy of vapour, Expansion of vapour, Rankine cycle.

Steam turbines – Impulse and Reaction types - Principles of operation.

UNIT V SIMPLE MECHANISM, FLY WHEEL, DRIVES AND BALANCING 11

Definition of Kinematic Links, Pairs and Kinematic Chains;Flywheel-Turning moment Diagram; Fluctuation of Energy.Belt and rope drives; Velocity ratio; slip; Creep; Ratio of tensions; Length of belt; Power Transmitted; gear trains-types.Balancing of rotating masses in same plane; Balancing of masses rotating in different planes.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Nag, P.K., " Engineering Thermodynamics ", II Edition, Tata McGraw Hill Publishing Co., Ltd., 1995
2. Rajput, R .K, "Thermal Engineering", Laxmi publications (P) Ltd, 2001.
3. Khurmi R.S., and Gupta J.K, "Theory of Machines", Eurasia Publishing House (P) Ltd., 2004.

REFERENCES

1. Smith, " Chemical Thermodynamics ", Reinhold Publishing Co., 1977.
2. Bhaskaran, K.A., and Venkatesh, A., " Engineering Thermodynamics ",Tata McGraw Hill, 1973.
3. Pandya A. and Shah, " Theory of Machines ", Charatakar Publishers, 1975.
4. Khurmi R.S., and Gupta J.K, "Thermal Engineering", S.Chand & Company (P) Ltd.,2001.
5. Kothandaraman and Dhomkundwar,": A course in Thermal Engineering (SI Units)", Dhanpat Rai and Sons, Delhi (2001)

CH7262 UNIX PROGRAMMING LAB L T P C

0 0 4 2

OBJECTIVE

To introduce working in UNIX environment.

OUTCOME

- To introduce the basic commands in UNIX.
- To teach UNIX shell programming.
- To introduce programming in C with UNIX system calls.

1. Basic Unix commands

i) Directory Related Commands
ii) File Related Commands.
iii) File Compression Related Commands
iv) Network Communication Commands
v) Commands for sending messages between the users
vi) Miscellaneous Commands

2. Editors for file operations.

i) Vi Editor
ii) Gedit
iii) Kwrite

3. Filters and Pipes

i) Concatenating Files
ii) Display beginning and End of Files
iii) Cut and Paste
iv) Sorting

v) Translating Characters
vi) Count Characters, words, Lines
vii) Comparing Files

4. **Grep Operations – Grep, Fast Grep, Extended Grep**
5. **Sed Operations – Sed Scripts, Addresses, Commands**
6. **Awk**
7. **Input Redirection and Out Redirection Commands**
8. **Simple shell programming.**
9. **Shell programming using complex control structures**
   1. if - fi
   2. if-else-fi
   3. if-elif
   4. case-esac
   5. while- do- done
   6. For-do-done
10. **Shell Programming using Arrays & Functions .**
11. **C Programs using file system related system calls.**
12. **C Programs using process related system calls.**
13. **Programs for inter process communication using pipes, FIFOs.**
14. **Programs using signals.**
15. **Programs using shared memory**

TOTAL : 60 PERIODS

TEXT BOOK

1. Brain W. Kernighan and Rob Pike, “The programming Environment”, PHI, 2002.

REFERENCE

1. Neil Matthew, Richard Stones, “”Linux Programming”,3rd Edition,2004.

ME7262 MECHANICAL ENGINEERING LABORATORY L T P C
0 0 4 2

OBJECTIVE

To impart practical knowledge in operating IC engines and conduct experiments. To understand test procedures in testing material for engineering applications

OUTCOME

- Students will be able to understand Power-generating units such as engines and operate IC engines and conduct tests. They will be able to appreciate the theory behind the functioning of engines. Material properties, their behavior under different kinds of loading and testing can be

visualized.

LIST OF EXPERIMENTS

1. Port timing diagram
2. Valve timing diagram
3. Study of 2,4 stroke I C Engines
4. Load test on 4-stroke petrol engine
5. Performance test on 4-stroke single cylinder diesel engine
6. Performance test on 4-stroke twin cylinder diesel engine
7. Heat balance test on diesel engines
8. Tension test
9. Compression test
10. Deflection test
11. Hardness test (Rockwell and Brinell)
12. Spring test
13. Torsion test
14. Impact test

TOTAL : 60 PERIODS

* Minimum 10 experiments shall be offered.

GE7351 ENGINEERING ETHICS AND HUMAN VALUES L T P C
3 0 0 3

OBJECTIVES

- To emphasise into awareness on Engineering Ethics and Human Values.
- To understand social responsibility of an engineer.
- To appreciate ethical dilemma while discharging duties in professional life.

UNIT I HUMAN VALUES 3

Morals, Values and Ethics – Integrity – Work Ethic – Honesty – Courage –Empathy – Self-Confidence – Discrimination- Character.

UNIT II ENGINEERING ETHICS 9

Senses of 'Engineering Ethics' - variety of moral issued - types of inquiry - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy – Models of Professional Roles - theories about right action - Self-interest –Professional Ideals and Virtues - uses of ethical theories. Valuing Time – Co-operation – Commitment –

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as experimentation - engineers as responsible experimenters - codes of ethics – Importance of Industrial Standards - a balanced outlook on law – anticorruption- occupational crime - the challenger case study.

UNIT IV ENGINEER'S RIGHTS AND RESPONSIBILITIES ON SAFETY

Attested

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12

Collegiality and loyalty – Respect for authority – Collective Bargaining – Confidentiality- Conflict of interest – Occupational Crime – Professional Rights – IPR- Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk - the Three Mile Island, Bhopal Gas plant and chernobyl as case studies.

UNIT V GLOBAL ISSUES **12**

Multinational corporations - Environmental ethics - computer ethics - weapons development - engineers as managers-consulting engineers-engineers as expert witnesses and advisors -moral leadership-Sample code of conduct.

TOTAL : 45 PERIODS

OUTCOMES

- Students will have the ability to perform with professionalism , understand their rights , legal ,ethical issues and their responsibilities as it pertains to engineering profession with engaging in life-long learning with knowledge of contemporary issues.

TEXT BOOKS

1. Mike Martin and Roland Schinzinger, “Ethics in Engineering”, McGraw-Hill, New York 2005.
2. Charles E Harris, Michael S. Protchard and Michael J Rabins, “Engineering Ethics – Concepts and Cases”, Wadsworth Thompson Leatning, United States, 2000 (Indian
3. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.

REFERENCES

1. Charles D. Fleddermann, “Engineering Ethics”, Pearson Education / Prentice Hall, New Jersey, 2004
2. Charles E Harris, Michael S. Protchard and Michael J Rabins, “Engineering Ethics – Concepts and Cases”, Wadsworth Thompson Leatning, United States, 2000
3. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003.
4. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford Press , 2000
5. R.Subramanian , “Professional Ethics “,Oxford University Press ,Reprint ,2015.

MA7358 TRANSFORM TECHNIQUES AND PARTIAL DIFFERENTIAL EQUATIONS L T P C
(Branch specific course) 4 0 0 4

OBJECTIVES:

- To introduce the effective mathematical tools for the solutions of partial differential equations that model physical processes;
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems;
- To acquaint the student with Fourier transform techniques used in wide variety of situations in which the functions used are not periodic;
- To develop Z- transform techniques which will perform the same task for discrete time systems as Laplace Transform, a valuable aid in analysis of continuous time systems.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS **12**

Formation – Solutions of first order equations – Standard types and Equations reducible to standard types – Singular solutions – Lagrange’s Linear equation – Integral surface passing through a given

curve – Classification of partial differential equations - Solution of linear equations of higher order with constant coefficients – Linear non-homogeneous partial differential equations.

UNIT II FOURIER SERIES 12

Dirichlet's conditions – General Fourier series – Odd and even functions – Half-range Sine and cosine series – Complex form of Fourier series – Parseval's identity – Harmonic Analysis.

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATION 12

Method of separation of variables – Solutions of one dimensional wave equation and one-dimensional heat equation – Steady state solution of two-dimensional heat equation – Fourier series solutions in cartesian coordinates.

UNIT IV FOURIER TRANSFORM 12

Fourier integral theorem – Fourier transform pair - Sine and cosine transforms – Properties – Transform of elementary functions – Convolution theorem – Parseval's identity.

UNIT V Z – TRANSFORM AND DIFFERENCE EQUATIONS 12

Z-transform – Elementary properties – Inverse Z-transform – Convolution theorem – Initial and final value theorems – Formation of difference equation – Solution of difference equation using Z - transform.

TOTAL : 60 PERIODS

OUTCOMES :

The students can able to solve the partial differential equations , find the Fourier series analysis and solve the problems by using Fourier transform and Z transform techniques.

TEXTBOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Erwin kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 9th Edition, , New Delhi, 2014

REFERENCES:

1. Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, New Delhi, 2007.
2. Ramana, B.V. "Higher Engineering Mathematics", Tata McGraw Hill, New Delhi, 11th Reprint , 2010.
3. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
4. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, New Delhi, 2007.

CT7302 MATERIALS SCIENCE FOR CERAMIC L T P C

3 0 0 3

AIM

The course is aimed to enable the students to have a basic knowledge about crystal systems, microstructure and dependence on various properties.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt about the atomic structure and bonding.
- Have studied about the structure of solids and various imperfections.
- Have learnt the basics about phase diagrams and phase transformations.

- Have learnt the basic concepts of diffusion in solids.
- Have studied the general properties of the solids.

UNIT I BONDING AND STRUCTURE 10

Materials and Engineering - Classification of engineering materials – structure-property relationships – Competition among materials – Design and selection - atomic structure – periodic variation in atomic size, ionization energy, electron affinity, bonding – bond energy, bond length, bond type - ionic, metallic, covalent, mixed bonding , secondary bonding – van der waals, hydrogen bonding, variation in bonding character and properties – polymorphic transformations – structure of ceramics – metallic and ceramic structures – binary, ternary, silicate structures.

UNIT II IMPERFECTIONS 9

Crystalline and non crystalline state, Imperfections – point – vacancy, Schottky, Frenkel- Line – dislocations – edge, screw, properties of dislocations – surface - grain boundary, interface boundary, twin and twist boundary, stacking faults – volume imperfections.

UNIT III PHASE DIAGRAMS AND PHASE TRANSFORMATIONS 8

Phase rule – single component system – binary phase diagrams – micro structural changes during cooling – lever rule – applications of phase diagrams – phase transformations – time scale for phase changes – nucleation & growth – applications.

UNIT IV DIFFUSION 9

Diffusion – Rate process in solids – Atomic Diffusion in Solids – Fick's laws of Diffusion – Solution to Fick's second law – applications based on the second law solution. Atomistic mechanisms of Diffusion – vacancy, interstitial, substitutional, interstitialcy, ring mechanism. Different types of diffusion – tracer self diffusion, tracer solute diffusion, inter diffusion, chemical diffusion - Temperature dependence on diffusion - Kirkendall effect and Matano interface. Diffusion studies in Ceramics.

UNIT V PROPERTIES OF CERAMICS 9

Physical properties – density, specific gravity. Thermal Properties – heat capacity, thermal conductivity, thermal expansion. Dielectric properties – polarization, dielectric constant, dielectric strength, dielectric loss, capacitance. Electrical Properties – Electronic conductivity, Ionic conductivity, semiconductor, Super Conductivity – Magnetic Properties – Source of Magnetism, origin, exchange interaction, Hystersis, applications, Optical Properties – Absorption and Transparency, Color, Phosphorescence, Index of refraction.

TOTAL: 45 PERIODS

TEXT BOOKS

1. V.Ragavan, Materials Science & Engineering, Prentice Hall of India, New Delhi, 2004.
2. W.D.Kingery, H.K.Bowen and D.R.Uhlmann, Introduction to Ceramics, John Wiley & Sons,2nd Edn, 2004.
3. William F. Smith, Javad Hashemi, Foundations of Materials Science and Engineering, Fifth Edition, Mc Graw Hill, 2010

REFERENCES

1. David W Richerdson, Modern Ceramic Engineering, Marcel Dekker Inc, New York,3rd Edn, 2006.
2. Michael W Barsoum, Fundamentals of Ceramics, McGraw Hill Co, New York.2000.
3. Dr.M.Arumugam, Materials Science, Anuradha Agencies, 2002.
4. Upadyaya G.S and Anish Upadhyaya, Materials Science and Engineering, Viva Books Pvt. Ltd., 2006.

Attested

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CT7303 **PRINCIPLES OF UNIT OPERATIONS** **L T P C**
3 0 0 3

AIM

The course is aimed to enable the students to have a better understanding on the principles of unit operations like fluid mechanics, heat transfer and mass transfer.

OBJECTIVES

On completion of the course the students are expected to

- Have a thorough knowledge on the fluid statics and the fluid flow phenomena.
- Have studied the different equations involved in fluid flow and the changes that occur in a fluid flowing past immersed solids.
- Have understood the concepts involved in transfer of heat by conduction and convection.
- Have a clear idea on principle of heat transfer by radiation and radiative heat transfer between different surfaces.
- Have studied the basic mass transfer operations commonly come across in ceramic technology, like diffusion, humidification, drying of solids and crystallization.

UNIT I FLUID STATICS AND FLUID FLOW PHENOMENA 8

Fluid statics – hydrostatic equilibrium, applications of fluid statics – manometer, gravity & centrifugal decanter. Fluid flow phenomena – laminar flow, rheological properties of fluids, turbulence, boundary layers.

UNIT II FLUID FLOW EQUATIONS AND FLOW PAST IMMERSED SOLIDS 9

Fluid flow equation – Mass balance in a flowing fluid, mechanical energy equation for flowing fluid. Flow past immersed solids – drag and drag coefficient, flow through a bed of solids, motion of particles through fluids.

UNIT III CONDUCTIVE AND CONVECTIVE HEAT TRANSFER 10

Conductive heat transfer – basic laws of conduction, steady state conduction, unsteady state conduction. Convective heat transfer – typical heat transfer equipments, energy balance, heat flux and heat transfer coefficient, heat transfer by forced convection in laminar flow, turbulent flow and transition region between laminar and turbulent flow, natural convection.

UNIT IV RADIATIVE HEAT TRANSFER 8

Emission of radiation, absorption of radiation by opaque bodies, radiation between surface, radiations to semi transparent materials, combined heat transfer by conduction, convection and radiation.

UNIT V BASICS OF MASS TRANSFER OPERATIONS 10

Diffusion – definition, prediction of diffusivities. Humidification operation – definition, humidity chart, wet bulb temperature. Drying of solids – classification of dryers, solids handling in dryer, principles of drying, cross circulation drying, through circulation drying, freeze drying, drying equipments for solids, pastes, solutions and slurries. Crystallization – crystal geometry, super saturation, mechanism of crystallization.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Warren L.McCabe, Julian C.Smith and Peter Harriott, Unit Operations of Chemical Engineering, 7th Edn., McGraw Hill International Edition, 2005.
2. SalilK.Ghosal, ShyamalK.Sanyal and Siddhartha Datta, Introduction to Chemical Engineering, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2003.
3. J F Richardson J. M. Coulson J R Backhurst J H Harker, Chemical Engineering, Volume 1, Sixth edition(Fluid Flow, Heat Transfer and Mass Transfer), Elsevier, 1999.

REFERENCES
1. Perry R.H and Green D (eds), Perry's Chemical Engineers' Handbook, 6th Edn.,McGraw-Hill, New York, 1984.
2. Walas S.M, Chemical Process Equipment, Butterworths, Stoneham, MA, 1988.
3. Treybal R.E, Mass Transfer Operations, 3rd Edn., McGraw-Hill, New York, 1980.

CT7301 ELEMENTS OF CERAMICS L T P C
3 0 0 3

(Fundamentals Only –Qualitative Study)

AIM

The course is aimed to impart a basic knowledge about ceramics and about various fields in ceramics.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the process of preparing a white ware article.
- Have understood the importance and types of ceramic coatings, and the process of preparing and applying the same.
- Have an idea on preparation of glass and different glass articles.
- Have knowledge on importance and types of refractories.
- Have an introduction on different advanced ceramics materials and products.

UNIT I WHITEWARE 8

Introduction – classification – traditional and advanced ceramics , triaxial bodies – raw materials, body composition, preparation, forming-slip casting, plastic forming, pressing, finishing, drying, firing, glazing and decoration.

UNIT II CERAMIC COATINGS 9

Introduction, classification, Glaze formulation – Segar formula, preparation - raw materials, milling, application, firing, glaze defects. Enamels – introduction, types, substrate preparation, enamel preparation and application, enamel defects

UNIT III GLASS 8

Introduction, classification glass preparation– raw materials, mixing, charging, melting, processing, manufacture of glass products-flat ware and hollow ware, glass defects.

UNIT IV REFRACTORIES 10

Introduction, classification, Raw materials, preparation, properties and uses of – silica, alumino silicate, alumina, magnesite, forsterite, dolomite, chromite, chrome magnesite, zirconia and carbon.

UNIT V ADVANCED CERAMICS 10

Introduction, properties and applications of – oxides, carbides, nitrides; Advanced ceramic products – ceramic fibers, glass ceramics.

TOTAL : 45 PERIODS

TEXT BOOKS

1. F. Singer and S. Singer, Industrial Ceramics, Oxford and IBH Publishing Co., 1991.
2. Ryan W, Properties of Ceramic Raw Materials, Pergamon Press, 2nd Edn., 1978.

REFERENCE BOOKS

1. Sudhir Sen, Ceramic White ware, Oxford & IBH Publishing Co., New Delhi, 1992.
2. Tailor J.R and Bull A.C, Ceramic Glaze Technology, Pergamon Press, NY, 1986.
3. Heinz G. Pfaender, Schott Guide to Glass, Chapman and Hall, 1996.
4. Nandi D.N, Handbook of Refractories, Tata McGraw – Hill Publishing Co., New Delhi, 1991.
5. Norton F.H, Fine Ceramics: Technology and Applications, McGraw – Hill Co., NY, 1978.

CT7304 THERMODYNAMICS FOR CERAMICS L T P C
3 0 0 3

AIM

To enable the students to have a basic knowledge about thermodynamics and the applications of thermodynamic laws of various systems.

OBJECTIVE

On completion of the course the students are expected to

- Have an understanding about the basic concepts of thermodynamics and the thermodynamic laws.
- Have an idea about the behavior of gases under conditions of temperature, pressure and volume.
- Have a basic knowledge about concepts of heat capacity.
- Have learnt the various applications of thermodynamics and solve some thermodynamic problems.
- Have a knowledge about solution thermodynamics.

UNIT I BASIC CONCEPTS 9

Fundamental concepts – system, process, state, properties, force, work, pressure, energy, equilibrium state, phase rule. Thermodynamic laws – zeroth law, internal energy, first law for flow process, non flow process, enthalpy, limitations, second law, entropy, Clausius inequality, third law.

UNIT II PVT BEHAVIOUR 9

PVT behavior – equation of state – concept of ideal gas – constant volume constant pressure, constant temperature, adiabatic process, isotropic process – equation of state for real gases – compressibility chart – heat effects accompanying a chemical reaction.

UNIT III CONCEPTS OF HEAT CAPACITY 9

Free energy and entropy – Gibb's equation – Helmholtz equation – equilibrium constant and heat of reaction – Clausius – Claypeyron equation – partial free energy – Gibb's phase rule and its interpretation – condensed system – one component system – polymorphic transformations– P-T diagram of silica.

UNIT IV APPLICATIONS OF THERMODYNAMICS 9

Flow process – continuity equation – energy equation – Bernoulli's equation – flow through nozzles, pipes – ejectors - throttling process – compressors – Carnot cycle – refrigeration cycle – vaporization of liquid – Rankine cycle – diesel cycle

UNIT V SOLUTION THERMODYNAMICS 9

Classification of thermodynamics properties – relationship among thermodynamics properties – fugacity – activity – thermodynamic diagrams – partial molar properties – chemical potential – activity in solutions – property changes of mixing – heat effects of mixing process.

Attested

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Anna University, Chennai-600 025.

TOTAL : 45 PERIODS

TEXT BOOKS

1. K.V.Narayanan, A Text Book of Chemical Engineering Thermodynamics, Prentice Hall India Pvt Ltd, New Delhi, 2001.
2. J.M.Smith and H.C.Van Hess, Introduction to Chemical Engineering Thermodynamics, Kogakushai, 1976.

REFERENCES

1. Robert E Treybac, Mass Transfer Operations, McGraw Hill, 1981.
2. S.I.Sandler, Chemical Engineering Thermodynamics, John Wiley & Sons, NY, 1989.

CT7312 UNIT OPERATIONS LAB L T P C
0 0 4 2

1. Determination of pressure drop in a fluid using manometer
2. Determination of liquid viscosity
3. Estimation of settling velocity of particles through fluid
4. Separation of solid from suspension by sedimentation
5. Estimation of thermal conductivity of insulating material
6. Effect of N_{Re} on Heat Transfer
7. Estimation of LMTD in Co-current Heat Transfer
8. Estimation of LMTD in Counter-current Heat Transfer
9. Calculation of RH, Enthalpy and Specific Volume of Air using Humidity Chart
10. Crystallization of solid from a super saturated solution
11. Drying rate estimation during drying of a solid

TOTAL : 60 PERIODS

EQUIPMENTS REQUIRED:

1. Manometer
2. Orifice
3. Ostwald viscometer
4. Dryer
5. Electronic balance
6. Hot plate
7. Concentric tube heat exchanger
8. Lee's Disc Apparatus

CT7311 CERAMIC SCIENCE LAB L T P C
0 0 4 2

1. Physical Identification of Ceramic Raw Materials
2. Determination of Moisture Content of Ceramic Powders
3. Determination of Loss on Ignition of Ceramic Powders
4. Preparation of Ceramic Body by Extrusion
5. Preparation of Ceramic Body by Pressing
6. Determination of Shrinkage of Ceramic Body – Dry & Fired, Volume & Linear
7. Determination of Density - True & Bulk
8. Determination of Porosity
9. Determination of Water Absorption
10. Determination of Water of Plasticity of extruded body

TOTAL : 60 PERIODS

EQUIPMENTS REQUIRED:

1. Hot Air Oven
2. Hot Plate

3. Electronic Balance
4. Furnace

CT7401 CERAMIC RAW MATERIALS L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a complete knowledge on the basics of geology, mineralogy and different raw materials used commonly in ceramic industries.

OBJECTIVES

On completion of the course the students are expected to

- Have studied the basics of rock formation, its types, and mineral formation and its physical and optical properties.
- Have learnt about clay formation, clay minerals and types of clays.
- Have studied the different types of fluxes and their characteristics.
- Have learnt the types of silicate minerals, their properties and uses.
- Have an understanding on other ceramic raw materials, their properties and uses.

UNIT I GENERAL GEOLOGY AND MINEROLOGY 9

Rocks – formation, characteristics, classification into igneous, sedimentary and metamorphic. Some important rocks – granite, sandstone, marble. Minerals – formation, relation of mineral deposit to igneous activity; chemical and physical properties like composition, color, streak, luster, fracture, cleavage, hardness, density and tenacity; radioactive properties and optical properties.

UNIT II PLASTIC MATERIALS 10

Clay minerals. Clay structures – kaolinite and montmorillonite groups. Occurrence of clay deposits. Classification of clays – china clay, ball clay, fire clay, building clay etc. Beneficiation of clays. Clay properties – charged nature, cation exchange capacity, flow behavior, plasticity, effect of heating. Mica, talc, pyrophyllite and wollastonite group – physical and chemical properties.

UNIT III FLUXES 7

Occurrence, properties and uses of natural fluxes – feldspar group, nepheline syenite, Cornish stone, lithium containing minerals. Bone ash – preparation, properties and uses.

UNIT IV SILICA AND OTHER RAW MATERIALS 9

Silica – occurrence, structure, polymorphic transformation, physical and chemical properties. Silicate minerals – quartz, sillimanite, kyanite, andalusite – properties and uses. Bauxite, magnesite, dolomite, chromite, limestone, rutile, zircon, beryllia minerals, alumina, slag and ashes, cullet – occurrence, properties and uses.

UNIT V TESTING 10

Coning and quartering of sample – sampling on delivery – measurement of moisture content by IR moisture balance – speedy moisture test – particle size analysis – sieve test, sedimentation method – Stokes, Andreasen Pipette, sedigraph, Determination of surface area by permeametry, adsorption.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Parbin Singh, Engineering and General Geology, S.K.Kataria and Sons, New Delhi, 2001.
2. Worrall W.E, Ceramic Raw Materials, Pergamon Press, NY, 1992.
3. Venkat Reddy D, Engineering Geology, Vikas Publishing House Pvt. Ltd., New Delhi, 2010.

REFERENCES

1. Norton F.H, Fine Ceramics: Technology and Applications, McGraw-Hill Co., NY, 1978.
2. Wilson M.J, Clay Mineralogy, Chapman and Hall, 1955.
3. Deer W.A, Howie R.A and Zussman J, Rock Forming Minerals, Longmans, London, 1967.
4. Ryan .W, Properties of Ceramic Raw Materials, Pergamon Press, 2nd Edn., 1978.

CT7404 PROCESSING OF CERAMIC RAW MATERIALS L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a complete knowledge on the steps involved in the processing of ceramic raw materials and the equipments used for those processes.

OBJECTIVES

On completion of the course the students are expected to

- Have a thorough knowledge on the quarrying of different plastic and non-plastic raw materials.
- Have a better understanding on the different equipments used for size reduction of raw materials and the laws involved in size reduction.
- Have a clear understanding on the mechanical separation operations like screening, filtration, sedimentary separation and magnetic separation.
- Have studied the principle and working of various equipments used for mixing, conveying and storage of ceramic raw materials.
- Have a clear knowledge on methods for characterizing the ceramic powder for its shape and size.

UNIT I QUARRYING 7

Winning of clays, quarrying of non plastic materials, transportation. Clay purification methods – wet and dry methods. Weathering of clay. Beneficiation of non plastic materials.

UNIT II SIZE REDUCTION 9

Laws of size reduction, mechanism of size reduction. Different crushers and grinders – jaw crusher, gyratory crusher, hammer mill, different types of tumbling mill, jet mill, attrition mill, vibro energy mill – principle of working. Closed circuit and open circuit grinding.

UNIT III MECHANICAL SEPARATION 10

Introduction, types. Screening – dry and wet screening, equipments, effectiveness of screen, test sieves-ASTM, BSS, BIS, IS. Filtration – theory of filtration, batch and continuous filters, principles of cake filtration. Separation based on movement through a fluid – sedimentation, cyclone separation, air classification. Magnetic separation.

UNIT IV MIXING 9

Mixing – mechanism of mixing, types of mixers – batch and continuous mixers – pan mixer, shaft mixer, U mixer, muller mixer and other mixers, liquid mixers – mechanism, blungers, agitators.

UNIT V CONVEYING AND STORAGE OF MATERIALS 10

Conveying – solid conveying-types of conveyors, criteria for selecting a conveyor; liquid conveying-condition for liquid conveying, different types of pumps. Storage methods for different ceramic powders. Problems in bin storage

TOTAL: 45 PERIODS

TEXT BOOKS

1. Warren L.McCabe, Julian C.Smith and Peter Harriott, Unit Operations of Chemical Engineering, 7th Edn., McGraw Hill International Edition, 2005.
2. Charles Burroughs Gill, Materials Beneficiation, Springer Verlag, 1991.

REFERENCES

1. Ryan W and Redford C, Whitewares: Production, Testing and Quality Control, Pergamon Press, NY, 1987.
2. Vincenzini P, Fundamentals of Ceramic Engineering, Elsevier Applied Science, London,1991.
3. Paul De Garmo E, Black J.J and Ronald A.Kohser, Materials and Processes in Keishi Gotoh, Powder Technology Handbook, Marcel Dekker Inc., 1997.
4. F. Singer and S. Singer, Industrial Ceramics, Oxford and IBH Publishing Co., 1991.
5. Mohamed N.Rahaman, Ceramic Processing, Taylor & Francis, 2007.Manufacturing, 8th Edn., Prentice-Hall India Pvt. Ltd., New Delhi, 1997.
6. Tooley F.V, Handbook of Glass Manufacture, Vol I&II, Ogden Publishing Co., NY, 1960.

CT7402 METALLURGY L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a basic knowledge about the basics of metallurgy, the various operations in the metallurgical process and in specific about steel making.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the basics about metals, ores and its extraction.
- Have learnt the various metallurgical processes that take place during the high temperature operation.
- Have learnt to measure and estimate the physical properties of metals.
- Have an immense knowledge about steelmaking.
- Have a basic knowledge about powder metallurgy.

UNIT I BASICS OF METALLURGY 10

Introduction – classification – metals, metallic ores, sampling, identification, extraction – copper, aluminum, lead, iron & steel – iron carbon diagram – heat treatment process – annealing, normalizing, hardening, tempering, surface hardening process – carburizing, nitriding, cyaniding, carbonitriding, flame hardening, metallography – sampling, grinding, polishing, microscope – metallurgical, electron, testing – hardness, impact, creep, non destructive testing.

UNIT II HIGH TEMPERATURE METALLURGICAL PROCESS 9

Introduction – reactions involving solids & gases – reduction of metal oxides, oxidation, coking, chemical vapour synthesis- reactions involving liquid phases smelting, slag refining, vaccum degassing, zone refining, casting process – thermo-mechanical process.

UNIT III MEASUREMENT & ESTIMATION OF PHYSICAL PROPERTIES 9

Introduction – factors affecting physical properties and their measurements –microstructure, thermal expansion coefficient, electrical resistivity, diffusion coefficient, yield strength, fracture toughness and hardness.

UNIT IV STEEL MAKING 9

Introduction – process design – thermodynamics & mass balance – kinetics of mass transfer & heat transfer – optimization of interfacial reactions – micro modelling –improving steel making – process and properties with reference to market, energy and environment, process for controlling inclusions, integrated optimization, future trends.

UNIT V POWDER METALLURGY 8

Introduction – production process of powders – mechanical routes, atomization routes, physical routes, chemical routes, plasma forming process- powder consolidation, compaction and sintering – advantages – disadvantages – limitations- applications.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Seshadri Seetharaman, Fundamentals of Metallurgy, 1st Edn, Wood head Publishing Limited, 2005.

REFERENCES

1. K.H.Prabhdev, Handbook of Heat Treatment of Steels, Tata McGraw Hill Publishing Company Ltd, 1998.
2. R.A.Higgins, Engineering Metallurgy, Part 2, Metallurgical Process Technology, 2nd Edn, ELBS,1974.
3. S.H.Avner, Introduction to Physical Metallurgy, 15th Edn, McGraw Hill Book Company, 1997.

CT7405 TRADITIONAL CERAMICS L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a sound knowledge about the whiteware and heavy clayware products and their manufacturing processes, their properties and quality control.

OBJECTIVES

On completion of the course the students are expected to

- Have a basic knowledge about whiteware and heavy clayware, their classification and formulation.
- Be capable of classifying the various whiteware products and know the body formulation and properties.
- Have learnt in detail about the manufacturing process of various whiteware products.
- Have a better understanding about the heavy clayware products and their applications.
- Have learnt about the properties and the various properties methods.

UNIT I DESIGNING OF BODY COMPOSITION 9

History – definition – classification. Raw materials – Plastic and non plastic. Additives- Binders, electrolytes, plasticizers. Body designing –batch calculation vs chemical analysis. Recipe preparation-mixing, screening, magnetic separation, storage system of slip process.

UNIT II BODY FORMULATIONS 9

Body composition – porcelain, earthenware, bone china, sanitary ware, hotel china, terracotta, majolica, steatite bodies, cordierite bodies, rutile bodies, titanate bodies, zircon bodies, lava bodies.

UNIT III WHITEWARE PRODUCTS 9

Manufacturing process & properties – whitewares at home – tableware, kitchenware, flame resistant ware, art ware, containers, whitewares in construction – floor tile, wall tiles, sanitary ware, whitewares

in electrical applications – low tension insulators, high tension insulators, high frequency low loss insulators, whitewares in industrial use – abrasion resistance, chemical resistance, heat resistance.

UNIT IV HEAVY CLAYWARE PRODUCTS 9

Introduction – classification- body composition – properties and applications of heavy clayware products – face bricks, paving bricks, hollow bricks, roofing tiles, sewer pipes, stoneware pipes, floor tiles, vitrified tiles, fireclay sanitaryware.

UNIT V PROPERTIES & TESTING 9

Rheological properties of slip- Fludity, thixotropy, density. Moisture content.Glaze properties- pick up ,testing of viscosity of glazes at room temperatures and high temperatures Tests on unfired strength-bulk density, green MOR, Contraction. Fired properties- strength, density, porosity, moisture expansion, abrasion resistance, chemical durability and electrical properties.

TOTAL: 45 PERIODS

TEXT BOOKS

1. F.Singer & S.Singer, Industrial Ceramics, Oxford & IBH Publishing Co, 1991.
2. Alen Dinsdale, Pottery Science : Materials, Processes and Products, Ellis Horwood Ltd, 1986.
3. Sudhir Sen, Ceramic Whitewares : Production, Testing and Quality Control, Pergamon Press, 1987.

REFERENCES

1. Mohamed N.Rahaman, Ceramic Processing, Taylor & Francis, 2007.
2. Rexford Newcomb Jr, Ceramic Whitewares : History, Technology and Applications, Pitman Publishing Corporation, 1947.

CT7403 PHASE EQUILIBRIA L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a thorough knowledge about the importance of phase equilibrium and analyzing different systems.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the basics of phase equilibrium and phase diagrams.
- Have studied the thermodynamics behind phase equilibria.
- Have a better understanding on the different two component and three component phase diagrams.
- Have studied the types and theory behind phase transformations and also about nucleation and growth.
- Have gained knowledge on the different experimental methods to determine phase diagrams.

UNIT I INTRODUCTION 9

Introduction, phase, component, variable, Gibb's phase rule, single component system – H_2O, SiO_2, iron, Hume Rothery's rule; binary phase diagrams – solid solutions, eutectic, peritectic, liquid immiscibility, exsolution, invariant reactions, lever rule, ternary diagrams.

UNIT II THERMODYNAMICS OF PHASE EQUILIBRIA 9

Introduction, criteria of phase equilibrium, criterion of stability, phase equilibria in single and multi component system; binary solutions – constant pressure system, constant temperature system, partially miscible and immiscible system, liquid-liquid and ternary equilibrium diagrams.

UNIT III PHASE DIAGRAMS 9

$Al_2O_3 – SiO_2$, $MgO – Al_2O_3$, $MgO – SiO_2$, $Al_2O_3 – ZrO_2$, $K_2O – Al_2O_3 – SiO_2$, $MgO – Al_2O_3 – SiO_2$, $Na_2O – Al_2O_3 – SiO_2$. Prediction of alkali corrosion of alumino silicate refractories using phase diagrams.

UNIT IV PHASE TRANSFORMATIONS 9

Introduction, Time Scale for phase transformations, types of transformations – spinoidal, nucleation & growth, theory of transformation kinetics; nucleation and growth – nucleation kinetics- homogeneous nucleation, heterogeneous nucleation, growth and overall transformation kinetics.

UNIT V EXPERIMENTAL METHODS 9

Techniques for determining phase diagrams – dynamic, static, microscopic methods – optical, electron microscopy, X-ray methods, thermal analysis Electrochemical methods, Volumetric technique.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Kingery W.D, Yet Ming Chiang and Dunbar P.Birnie III, Physical Ceramics – Principles for Ceramic Science and Engineering, John Wiley & Sons, 1995.
2. Floyd A.Hammel, Phase Equilibria in Ceramic Systems, Marcel Dekker, 1984.
3. Svein Stolen and Tor Grande Chemical thermodynamics of materials, , 2004 John Wiley & Sons.

REFERENCES

1. Kingery W.D, Bowen H.K and Uhlmann D.R, Introduction to Ceramics, 2nd Edn., John Wiley & Sons, 2004.
2. Allen M.Alper, Phase diagrams in Advanced Ceramics, Academic Press Inc., 1995.
3. Barsoum M.W, Fundamentals of Ceramics, McGraw Hill, 1997.

CY7351	INSTRUMENTAL METHODS OF ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVE

- To know the principle and importance of various analytical instruments used for the characterization of various materials

UNIT I INTRODUCTION TO SPECTROSCOPICAL METHODS OF ANALYSIS 9

Electromagnetic radiation: various ranges, dual properties, various energy levels, interaction of photons with matter, absorbance & transmittance and their relationship, permitted energy levels for the electrons of an atom and simple molecules, various electronic transitions in organic and inorganic compounds effected by UV, and visible radiations, various energy level diagrams of saturated, unsaturated and carbonyl compounds, excitation by UV and visible radiations, choice of solvents, cut off wavelengths for solvents

UNIT II QUALITATIVE ANALYSIS BY UV AND VISIBLE SPECTROCOPY 9

Lamda max and epsilon max rules, Woodward -Fieser rules for the calculation of absorption maxima (Lamda max) for dienes and carbonyl compounds, Effects of auxochromes and effects of conjugation on the absorption maxima, Different shifts of absorption peaks(Bathochromic, hypsochromic, hypochromic), Instrumentation for UV and Visible spectrophotometers (source, optical parts and detectors), Applications of UV and Visible spectroscopy.

UNIT III QUANTITATIVEANALYSIS BY UV AND VISIBLE SPECTROCOPY 9

Beer-Lambert's law, limitations, deviations (real, chemical, instrumental), estimation of inorganic ions such as Fe, Ni and estimation of nitrite using Beer -Lambert's law, multicomponent analysis (no overlap, single way overlap and two way overlap), photometric titration(experimental set -up and various types of titrations and their corresponding curves).

UNIT IV IR SPECTROSCOPY 9

Theory of IR spectroscopy, various stretching and vibration modes for diatomic and triatomic molecules (both linear and nonlinear), various ranges of IR (near, mid, finger print and far) and their usefulness, Instrumentation (only the sources and detectors used in different regions), sample preparation techniques, qualitative analysis of alkanes, alkenes and carbonyl compounds.

UNIT V CHROMATOGRAPHIC METHODS 9

Classification of chromatographic methods, column, thin layer, paper, gas, High Performance Liquid Chromatographical methods (principle, mode of separation and technique).

TOTAL: 45 PERIODS

OUTCOME

- To have thorough understanding of theory, instrumentation and applications of analytical equipments used in industries for testing quality of raw materials,intermediates and finished products**.** To know the importance of analytical instrumentation during the purification, compounding and formulating the finished product.

TEXT BOOKS:

1. Sivasankar B., "Instrumental Methods of Analysis", Oxford University Press., 2012.
2. William Kemp, Organic Spectroscopy, 3rd Edition, Palgrave publishers, 2007.

REFERENCES

1. Douglas A. Skoog, F. James Holler, Stanley R. Crouch, Instrumental Analysis, Cengage Learning, India, 7th Edition, 2007.
2. Willard H.H, Merritt L.L, Dean J.A and Settle F.A, Instrumental method of analysis, 7th edition, Wadsworth Publishing Company, 1988.
3. Gurdeep R. Chatwal, Sharma K. Anand, Instrumental methods of Chemical Analysis, Himalaya Publishers, New Delhi, 2014
4. John R Dyer, Applications of Absorption Spectroscopy of Organic Compounds, Prentice-hall of India Pvt. Ltd., 2012
5. Robert M. Silverstein, Francis X. Webstrer, David Kiemle, David L. Bryce, Spectrometric Identification of Organic Compounds, Wiley, 8th Edition, 2010.

CT7412 CHEMICAL ANALYSIS OF CERAMIC RAW MATERIALS LAB L T P C
0 0 4 2

1. Determination of moisture content
2. Determination of loss on ignition
3. Determination of SiO_2 content by gravimetric method
4. Determination of SiO_2 content by hydrofluoric acid
5. Determination of Al_2O_3 by EDTA method
6. Determination of Na_2O by flame photometry
7. Determination of K_2O by flame photometry
8. Determination of Li_2O by flame photometry
9. Determination of CaO by complexometry
10. Determination of MgO by complexometry

TOTAL: 60 PERIODS

Attested

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EQUIPMENTS

1. Flame Photometer
2. Hot Plate
3. Hot Air Oven
4. Electronic Balance
5. Furnace

CT7411 CERAMIC TESTING LAB L T P C
0 0 4 2

1. Determination of particle size by Screen Analysis
2. Determination of particle size by Hydrometer Method
3. Determination of particle size by Andreasen Pipette method
4. Determination of moisture content by IR Analyzer
5. Determination of moisture content by Speedy Moisture Balance
6. Determination of moisture content by Oven method.
7. Determination of shrinkage of ceramic products
8. Determination of density, porosity and water absorption for ceramic products by Archimedes principle
9. Determination of plasticity of ceramic materials by Pfefferkorn test
10. Determination of plasticity of ceramic materials by Atterberg test
11. Determination of rheological properties like density, fluidity and thixotropy by torsion viscometer
12. Determination of Modulus of Rupture for ceramic products
13. Determination of Cold Crushing Strength for ceramic products

TOTAL: 60 PERIODS

Equipments Required

1. Sieve Shaker
2. IR Mositure Analyser
3. Universal Testing Machine
4. Atterberg Apparatus
5. Pfefferkorn Apparatus
6. Torsion Viscometer

CT7501 CERAMIC PROCESSING I L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a thorough knowledge about the different ceramic fabrication process and the other final operations involved after the fabrication of the product.

OBJECTIVES

On completion of the course the students are expected to

- Have complete knowledge about the slip casting process.
- Have a complete knowledge about the various plastic forming process.
- Have a complete knowledge about the various dry forming process.
- Have a sound understanding on the mechanism of drying and the construction and working of the various drying equipments.
- Understand effectively the importance of firing and the mechanism and types of firing equipments.

UNIT I SLIP FORMING PROCESS 9

Introduction. Slip- selection of materials, slip properties – density, fluidity, particle size measurement, viscosity, surfactant concentration, binders, pH, zeta potential, settling, solid recovery, slip recovery, slip conditioning and storage. Plaster mould – process, preparation. Slip casting – methods, mechanisms.

UNIT II PLASTIC FORMING PROCESS 9

Plastic mass preparation – filter press, pug mill, pugging defects. Shaping methods – extrusion, jiggering, injection molding, roller machine, compression molding.

UNIT III DRY FORMING PROCESS 9

Theory of packing. Powder properties, additives, factors influencing powder flow, Pressing- Uniaxial pressing – stress distribution on green body – defects and remedies, vibration compaction, isostatic pressing, reactive hot pressing – advantages – defects and remedies.

UNIT IV DRYING AND FIRING 9

Mechanism of drying – transfer of heat – factors that control drying – types of dryers – intermittent and continuous dryers – process of drying – drying defects – finishing – cutting and trimming – sponging, fettling and towing – scumming. Action of heat on ceramic bodies – physical changes, chemical changes. Firing equipments, firing schedules – fast firing, firing range. Problems, defects. Liquid phase sintering, vitrification, microstructure control.

UNIT V FIRING AND TESTING 9

Density porosity, water absorption, shrinkage, contraction – wet to dry, dry to fired, wet to fired modulus of rupture – dried and fired, Plasticity – Perferkon test, Atterberg test, Casting – Control of casting slips- fluidity, thixotropy, specific gravity.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Alan G. King, Ceramic Technology and Processing, Noyes Publication, USA, 2002.
2. James S. Reed, Principles of Ceramic Processing, John Wiley and Sons, NY, 1988.

REFERENCES

1. Norton F. H, Fine Ceramics Technology and Applications, McGraw-Hill Co., 1978.
2. Terpstra, Ceramic Processing, Chapman and Hall, 1995.
3. I.J. McColm, N.J.Clark, Forming, Shaping and Working of High Performance Ceramics, Chapman and Hall, 1998.
4. Sudhir Sen, Ceramic Whiteware, Oxford & IBH Publishing Co., New Delhi, 1992

CT7503 GLAZE TECHNOLOGY L T P C
3 0 0 3

AIM

To enable the students to have a complete knowledge on the importance of glazing, its processing and application techniques.

OBJECTIVE

On completion of the course the students are expected to

- Have learnt the definition of glazes and classification of glazes.
- Have a thorough knowledge about the raw materials and properties of the glaze raw materials.
- Have a thorough knowledge about the various glazing techniques.
- Have learnt the properties and defects produced by glazing.
- Have complete understanding about the various methods of decorating the glazed article.

UNIT I INTRODUCTION TO GLAZE 9

Definitions - glaze raw materials- frit preparation - frit rules - engobe - classification of glazes - compounding of lead and leadless glazes, alkaline glazes, calcarious glazes and feldspathic glazes.- batch calculation

UNIT II RAW MATERIALS AND PROCESSING 9

Role of individual raw materials - colouring agents - stains - mixed colours - metallic lustures - unit operations and processes - glaze Additives - special glazes - matt glazes, snake skin glazes, crackled glazes, salt glazes and other glazes.

UNIT III GLAZING TECHNIQUES AND DEFECTS 9

Glazing techniques - dipping, pouring, spraying, brushing, painting and other techniques - Glaze body reactions- interface layers- glaze defects and remedies- crazing, peeling, crawling, rolling, blisters, pin holes, dunting.

UNIT IV PROPERTIES AND TESTING 9

Thermal, mechanical, optical and chemical properties of glazes – Testing of glazes - Particle size distribution, Slip density, Viscosity, Fluidity , coherence parameter, glaze pick up, solubility of lead frits, glaze fit, thermal expansion, chemical durability , colour measurement, thermal shock measurement,

UNIT V DECORATION 9

Classification of decoration methods- advantages- different decorating techniques- painting, spraying, stencilling, stamping, lithographic transferring, printing-silk screen printing, digital printing - dusting, decalcomania- liquid gold decoration and decoration techniques.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Kenneth Shaw, Ceramic Glazes, Elsevier Publishing Co., NY, 1971.
2. Tailor J.R and Bull A.C, Ceramics Glaze Technology, Pergamon Press, NY, 1986.

REFERENCES

1. Emmanuel Cooper, The Potter Book of Glaze Recipes, B.T.Batsford Ltd., London, 1986.
2. Hiraoki Yanagida, The Chemistry of Ceramics, John Wiley and Sons, 1996.

CT7504 REFRACTORIES- I L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a basic knowledge about the various types of refractories used in the industries.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the basics about refractories and its demand.
- Have a sound knowledge about silica refractories.
- Have learnt about properties and applications of alumino silicate refractories.
- Have learnt about the various basic refractories.
- Have a knowledge about special refractories.

UNIT I INTRODUCTION 9

Definition – production - demand & growth of refractories in India - Layout of a refractory plant - classification of refractory - fundamental properties of refractories and their testing - factors for selection and use of refractories.

UNIT II SILICA REFRACTORIES 9

Raw materials & composition – manufacturing process steps – phase transformation of quartzite - properties &applications – types.

UNIT III ALUMINOSILICATE REFRACTORIES 9

Al_2O_3 – SiO_2 phase diagram, - types of raw materials - different alumino silicate refractories – manufacturing steps – properties & applications.

UNIT IV BASIC REFRACTORIES 9

Raw materials, manufacturing process, properties and applications of magnesite, forsterite, dolomite and chrome based refractories.

UNIT V SPECIAL REFRACTORIES 9

Manufacture and applications of different Carbide & nitride refractories - carbon and carbon based refractory – zirconia – beryllia - thoria refractory - fused cast refractories – cermets – ceramic fibers.

TOTAL : 45 PERIODS

TEXT BOOKS

1. D.N.Nandi, Handbook of Refractories, Tata McGraw Hill Publishing Co, New Delhi, 1991.
2. Chesters J.H, Refractories: Production & Properties, Iron & Steel Institute, London, 1973.

REFERENCES

1. B.M.Coope & E.M.Dickson, Raw Materials for the Refractories Industries, An Industrial Minerals Consumer Survey, 1981.
2. Shaw K, Refractories & Their Uses, App,Science Publishers, UK,1972.
3. A. O. Surendranathan, An Introduction to Ceramics and Refractories, CRC Press, 2014.

CT7502 GLASS ENGINEERING – I L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a complete knowledge on the principle behind glass formation, raw materials and melting of glass batch, glass properties and quality control in glass.

OBJECTIVE

On completion of the course the students are expected to

- Have understood the principle behind glass formation and structures of different glasses.
- Have studied about the raw materials for glass making and calculation of a glass batch for a given composition.
- Have learnt about the reactions involved in the conversion of solid glass batch into a liquid glass melt.
- Have studied about the thermo-dynamical, thermal, mechanical, electrical and other properties of glass.
- Have learnt the defects found in a flat ware and a hollow ware, and the quality control procedure for a coated glass.

UNIT I PRINCIPLES OF GLASS FORMATION 10

Definition. Difference between a glass and crystalline material. Glass Formation – atomistic hypothesis of glass formation, kinetic approach to glass formation. Structures of glasses – fundamental laws, elements of structural models for glasses, structural models for silicate glasses. Phase diagrams of glass forming oxide systems – $CaO\text{-}Al_2O_3\text{-}SiO_2$, $Na_2O\text{-}CaO\text{-}SiO_2$ etc.

UNIT II RAW MATERIALS AND PREPARATION OF GLASS BATCH 10

Raw materials – Glass formers, intermediates and modifiers, cullet, minor ingredients like oxidizing/reducing agents, refining agents, decolourisers, colouring oxides – description and importance. Selection of glass composition, change in properties in relation to change in composition, Glass batch calculation.

UNIT III GLASS MELTING PROCESS 10

Physiochemical reactions during glass melting – effect of particle size and pre-sintering on melting. Refining – sources of gas bubbles, identification of gases, solubility of gases in glass, growth & rise of bubbles, refining agents. Homogenization – sources of inhomogenity, rate of homogenization in relation to diffusion kinetics, conventional currents & rise of bubbles.

UNIT IV PROPERTIES AND TESTING OF GLASS 8

Thermodynamic & thermal properties – density, surface tension, thermal expansion, specific heat, thermal conductivity. Mechanical properties – viscosity, elastic properties, hardness, strength. Electrical & Transport properties – electrical conductivity, dielectric property, ionic diffusion. Other properties – refractive index, dispersion, chemical durability.

UNIT V QUALITY CONTROL OF GLASS 7

Flat glass defects – origin, remedies. Container glass defects – origin, remedies. Quality control in special glasses like coated glass, laminated glass, tempered glass.

TOTAL: 45 PERIODS

TEXT BOOKS

1. James E.Shelby, Introduction to Glass Science & Technology, The Royal Society of Chemistry, 1997.
2. Paul, Chemistry of Glasses, 2nd Edn, Chapman & Hall, 1990.

REFERENCE BOOKS

1. D.Ganguli, S.Kumar, Elements of Ceramics –Vol II, Indian Institute of Ceramics, 1984.
2. Fundamentals of Glass Manufacturing Process 1991, Proceedings of the First Conference of the European Society of Glass Science and Technology, Society of Glass Technology, 1991.
3. Tooley F.V, Handbook of Glass Manufacture, Vol I&II, Ogden Publishing Co., NY, 1960.
4. A. Charles A Harper, Handbook of Ceramic Glasses & Diamonds, McGraw Hill, 2001.
5. Glass Furnaces-Design, Construction & Operation, Wolfgang Trier, Society of Glass Technology, 2000.
6. Narottam P Banral, R.H.Doremus, Handbook of Glass Properties, Academic Press, Inc, 1986.

CT7512 CERAMICS PROCESSING LAB L T P C
0 0 4 2

LIST OF EXPERIMENTS

1. Preparation of Ceramic Slip in a Pot Mill
2. Determination of Slip Specific Gravity.
3. Determination of Slip Viscosity.

4. Effect of Water on Viscosity of Slip.
5. Effect of Deflocculant on Viscosity of Slip.
6. Determination of Residue in a Slip.
7. Plaster Mould Making.
8. Determination of Setting Time and Setting Temperature of Plaster of Paris
9. Forming of Solid Slip Cast Article.
10. Forming of Drain Slip Cast Article.
11. Biscuit Firing.
12. Glaze Preparation
13. Glaze Application
14. Glost Firing
15. Property Evaluation – Thermal Expansion, Chemical Durability, Abrasion Resistance

Equipments Required:

1. Pot Mill
2. Gibbs Viscometer
3. Hot Air Oven
4. Sieves
5. Moulds
6. Furnace

TOTAL : 60 PERIODS

CT7511 CAD LAB FOR CERAMICS L T P C
0 0 4 2

AIM

To impart CAD modeling and design of ceramic components using FEA software.

OBJECTIVE

The students are trained to create modeling of basic ceramic components and analyze the same using finite element analysis software.

1. Design of Mold for Ceramic Products.
2. Thermal Stress Behavior for mould
3. Stress Analysis of beams with point Load.
4. Stress Analysis of beams with varying Load.
5. 1-D Conduction Problem with Single Wall.
6. 1-D Conduction Problem with Multi wall.
7. Non Linear Problem.
8. Stress Analysis Of An Axis -Symmetric Component
9. Coupled Structural/Thermal Analysis
10. Fatigue Problems.

TOTAL : 60 PERIODS

(All the above Experiments solve Using Design and Analysis soft wares)

Equipment's: 15 No's of higher end Pentium PC with minimum 64 bit, 4GB RAM and Suitable Finite element analysis software like ANSYS/ABAQUS.

GE7251 ENVIRONMENTAL SCIENCE AND ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

To the study of nature and the facts about environment.

- To find and implement scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth's interior and surface.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 14

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

Field study of common plants, insects, birds

Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION 8

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c)Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards– soil waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides.

Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES 10

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over- utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.

Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain,

ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment production act– Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health – Case studies.

TOTAL: 45 PERIODS

OUTCOMES:

Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course.

- Public awareness of environment at infant stage.
- Ignorance and incomplete knowledge has lead to misconceptions.
- Development and improvement in standard of living has lead to serious environmental disasters.

TEXT BOOKS:

1. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education 2004.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2006.

REFERENCES:

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia',Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT LTD,New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press 2005.

CT7601 CERAMIC PROCESSING II L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a thorough knowledge on the advanced processing techniques in ceramics.

OBJECTIVES

On completion of the course the students are expected to

- Have a thorough knowledge on the preparation of ceramic powder by mechanical and chemical methods.
- Have studied the additives used in ceramic forming and different ceramic forming processes in dry powder, slurry and plastic consistency.
- Have a better understanding on the mechanisms of solid state and liquid phase sintering, and crystal growth during sintering.
- Have learnt the advanced sintering processes and their mechanisms.

- Have understood the processes involved in machining and surface finishing of ceramic products.

UNIT I POWDER PROCESSING 9

Powder preparation by mechanical methods – comminution, mechano-chemical synthesis. Powder synthesis by chemical methods – solid state reaction, liquid solutions, vapour phase reactions. Synthesis of nano scale ceramic powder–liquid solution technique, vapour phase technique.

UNIT II FORMING 10

Additives in ceramic forming – solvents, dispersant, binder, plasticizer, other additives. Forming of ceramics – dry and semidry pressing - die compaction and isostatic compaction; casting methods - slip casting, pressure casting, gel casting, electrophoretic deposition; plastic forming methods - extrusion, co-extrusion, injection molding, solid freeform fabrication - particle filled polymer methods, powder methods, suspension methods- Porous ceramic forming- foaming, intrusion, organic additives.

UNIT III SINTERING MECHANISMS 10

Solid state sintering – driving force, effect of surface curvature and boundary defects, mechanism, stages of sintering. Liquid phase sintering – stages, kinetic and thermodynamic factors, phase diagram in liquid phase sintering. Grain growth – different grain growth process, control of grain growth, grain growth and pore evolution in a porous compact, interaction between pore and grain boundary.

UNIT IV ADVANCED SINTERING 7

Pressure assisted sintering – hot pressing and hot iso-static pressing. Reaction bonded sintering, microwave sintering.

UNIT V MACHINING AND SURFACE FINISHING OF CERAMICS 9

Mechanism of material removal and its effect on strength, surface grinding and mechanical polishing, non abrasive finishing, ceramic surface coating, joining of ceramics – metal ceramic joints.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Mohamed N.Rahaman, Ceramic Processing, Taylor & Francis, 2007.
2. David W. Richerson, Modern Ceramic Engineering, 3rd Edn., Taylor & Francis, 2005.

REFERENCES

1. Paul De Garmo E, Black J.J and Ronald A.Kohser, Materials and Processes in Manufacturing, 8th Edn., Prentice – Hall India Pvt. Ltd., New Delhi, 1997.
2. Reed J.S, Introduction to the Principles of Ceramic Processing, Wiley, New York, 1988.
3. John G.P.Binner (Ed), Advanced Ceramics Processing and Technology, Noyes Publications, New Jersey, 1990.
4. Burtrand Lee and Sridhar Komarnei (Eds.), Chemical Processing of Ceramics, 2nd Edn., Taylor & Francis, 2005.

CT7603 REFRACTORIES II L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a sound knowledge about the various types of refractories used in the various applications.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the basics about refractories used in iron & steel industry.
- Have a sound knowledge about refractories used in non ferrous and non metallic industries.
- Have learnt about refractories used in glass and ceramic industry.
- Have learnt about the refractories used for insulation.
- Have a knowledge about special refractories used in space and atomic/nuclear energy.

UNIT I REFRACTORIES FOR IRON & STEEL INDUSTRY 9

Refractories for - coke oven, blast furnace, open hearth furnace, LD converter, THF, EAF, IF, Ladle furnace, slide plate system, nozzle, shroud, continous casting. Refractory - slag and refractory - metal interactions. Repair practices.

UNIT II REFRACTORIES FOR NON-FERROUS&NON-METALLIC INDUSTRIES 9

Refractories for non ferrous industries – copper, aluminum, lead. Refractories for non-metal industries – hydrocarbon industry, fertilizer industry, cement industry.

UNIT III REFRACTORIES FOR GLASS AND CERAMIC INDUSTRY 9

Refractories for glass industry – refractory practices in sidewall, basin, throat, forehearth and roof of glass tank, regenerator systems. Refractories for ceramic industry – kiln design – LTM concept, fast firing technology, kiln furnitures – types, properties, requirements – applications in different ceramic industry.

UNIT IV REFRACTORIES FOR INSULATION 9

Purpose of insulation – types of insulating materials and preparation of insulating refractories, ceramic fibre products – design and installation – ceramic coatings.

UNIT V REFRACTORIES FOR SPACE & NUCLEAR APPLICATIONS 9

Ceramics for space – materials used in space satellite, missiles, rockets nozzles. Ceramics for nuclear reactors – types of reactors, structural ceramic materials, ceramic fuel elements, control rod elements.

TOTAL: 45 PERIODS

TEXT BOOKS

1. D.N.Nandi, Handbook of Refractories, Tata McGraw Hill Publishing Co, New Delhi, 1991
2. Shaw K, Refractories & Their Uses, App,Science Publishers, UK,1972

REFERENCE BOOKS

1. Chesters J.H, Steel Plant Refractories, 2nd Edn, United Steel Company Limited, UK, 1973
2. Stephen Caniglia , Gordon L. Barna, Handbook of Industrial Refractories Technology: Principles, Types, Properties and Applications, Noyes Publications, 1992

CT7602 GLASS ENGINEERING – II L T P C

3 0 0 3

AIM

The course is aimed to enable the students to have a thorough knowledge on furnaces used for glass melting, fabrication of glass and the treatments to the final glass article.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the different furnaces used for glass melting, their design and operation.
- Have a better understanding on the heating process in tank furnace and the measurement and control of parameters in tank furnace.

- Have studied the fabrication methods of glass flat ware and hollow ware.
- Have a clear understanding on the purpose and process of annealing of glass products.
- Have learnt the different value adding processes done to glass.

UNIT I GLASS MELTING FURNACES 8

Construction and operation of pot furnace and day tank furnace.Tank furnace – types, design & construction. Electric tank furnace – design & operation, electrodes used, electric boosting in tank furnace. Forehearth & Feeder section in tank furnace.

UNIT II OPERATION OF TANK FURNACE 10

Heating process – temperature distribution, efficiencies, heat balance, thermal insulation & cooling. Measurement and control – temperature, pressure, volume and fuel/air mixture, glass level. Reversal, heating and cooling of glass furnace, hot repairs.

UNIT III FABRICATION PROCESS 9

Hand operations. Flatware – sheet glass, float glass, plate glass, patterned glass. Hollow ware – press & blow, blow & blow, IS machine, bulbs & tubes.

UNIT IV ANNEALING 9

Introduction, nature of generation & release of strain, temporary & permanent strain, dependence of strain on cooling rate, detection & measurement of strain, annealing equation, problems in annealing, annealing glass plate, optical glass, ideal annealing cycle.

UNIT V VALUE ADDING PROCESSES IN GLASS 9

Mirror, chemical vapour deposition, physical vapour deposition process, laminated glass, tempered glass, decorated glasses, vycor& micro porous glass, sealing glass, neutral glass, photosensitive glass, glass ceramic, glass fibers.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Glass Furnaces-Design, Construction & Operation, Wolfgang Trier, Society of Glass Technology, 2000.
2. Volf V.B, Technical Approach to Glass, Elsevier, 1990.

REFERENCE BOOKS

1. Tooley F.V, Handbook of Glass Manufacture, Vol I&II, Ogden Publishing Co., NY, 1960.
2. Alexis G.Pincus, Melting Furnace Operation in the Glass Industry, Magazines for Industry Inc., NY, 1980.
3. Cummings K, The Technique for Glass Forming, B.T.Batsford Ltd., London, 1980.
4. James E.Shelby, Introduction to Glass Science & Technology, The Royal Society of Chemistry, 1997.

CT7612 REFRACTORY CERAMICS LAB L T P C
0 0 4 2

[Minimum of 10 experiments]

1. Preparation of silica refractory with different additives
2. Preparation of fire clay refractory with different additives
3. Preparation of high alumina refractory with different additives.
4. Estimation of PLC of and silica, fire clay high alumina refractories.
5. Estimation of TEC of silica, fire clay high alumina refractories

6. Estimation of PCE of silica, fire clay high alumina refractories
7. Estimation of RUL of silica, fire clay high alumina refractories
8. Estimation of chemical attack resistance of silica, fire clay high alumina refractories
9. Comparison of density, porosity and strength of refractory prepared by powder pressing and extrusion.
10. Comparison of density, porosity and strength of silica, fire clay and high alumina refractories.
11. Preparation of porous refractory for insulation with different pore formers and comparison of their characteristics.
12. Comparing the characteristics of a dense and porous refractory.

TOTAL: 60 PERIODS

Equipments Required:

1. Universal Testing Machine
2. Hot Plate
3. Extruder
4. Electronic balance
5. Uniaxial pressing machine
6. Hot air oven
7. Furnace
8. Dilatometer
9. Optical microscope

CT7611	GLASS LAB	L T P C 0 0 4 2

[Minimum of 10 experiments]

1. Preparation of Soda Lime Glass
2. Influence of cullet size on melting behavior of soda lime glass.
3. Influence of cullet percentage on melting behavior of soda lime glass
4. Influence of refining agent on the melting behavior of soda lime glass.
5. Preparation of Amber Glass
6. Determination of Density.
7. Determination of Specific Gravity.
8. Determination of Refractive Index.
9. Determination of Thermal Expansion.
10. Determination of Chemical Durability.
11. Identification of defects in glass.

TOTAL: 60 PERIODS

Equipments Required

1. Sieve Shaker
2. Hot Plate
3. Hot Air Oven
4. Furnace
5. Electronic balance
6. Dilatometer
7. Spectrometer
8. Optical microscope

CT7701 PROCESS ECONOMICS AND INDUSTRIAL MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:
To introduce process economics and industrial management principles to chemical engineers.

UNIT I PRINCIPLES OF PRODUCTION MANAGEMENT AND ORGANISATION 15
Planning, organization, staffing, coordination, directing, controlling, communicating, organization as a process and a structure; types of organizations Method study; work measurement techniques; basic procedure; motion study; motion economy; principles of time study; elements of production control; forecasting; planning; routing; scheduling; dispatching; costs and costs control, inventory and inventory control.

UNIT II ENGINEERING ECONOMICS FOR PROCESS ENGINEERS - INTEREST, INVESTMENT COSTS AND COST ESTIMATION 10
Time Value of money; capital costs and depreciation, estimation of capital cost, manufacturing costs and working capital, invested capital and profitability.

UNIT III PROFITABILITY, INVESTMENT ALTERNATIVE AND REPLACEMENT 8
Estimation of project profitability, sensitivity analysis; investment alternatives; replacement policy; forecasting sales; inflation and its impact.

UNIT IV ANNUAL REPORTS AND ANALYSIS OF PERFORMANCE 4
Principles of accounting; balance sheet; income statement; financial ratios; analysis of performance and growth.

UNIT V ECONOMIC BALANCE AND QUALITY AND QUALITY CONTROL 8
Essentials of economic balance – Economic balance approach, economic balance for insulation, evaporation, heat transfer. Elements of quality control, role of control charts in production and quality control.

TOTAL: 45 PERIODS

OUTCOMES:
The objective of this course is to teach principles of cost estimation, feasibility analysis, management, organization and quality control that will enable the students to perform as efficient managers.

TEXT BOOKS:

1. Peters, M. S. and Timmerhaus, C. D., " Plant Design and Economics for Chemical Engineers ", V Edn., McGraw Hill, 2002.
2. Holand, F.A., Watson, F.A. and Wilkinson, J.K., " Introduction to process Economics ", IIEdn., John Wiley, 1983.
3. Narang, G.B.S. and Kumar, V., " Production and Costing ", Khanna Publishers, New Delhi, 1988.

REFERENCES:

1. Allen, L.A., " Management and Organization", McGraw Hill.
2. Perry, R. H. and Green, D., " Chemical Engineer's Handbook ", VIIEdn., McGraw Hill.

CT7702 STRUCTURAL CERAMIC MATERIALS L T P C
3 0 0 3

AIM
The course is aimed to enable the students to have a thorough knowledge about the various ceramic materials used for structural applications.

OBJECTIVES

On completion of the course the students are expected to have a studied the structural characteristics and properties of oxide, carbide, nitride, carbon and other ceramic materials used for structural applications**.**

UNIT I OXIDE CERAMICS 9

Structural characteristics, properties and applications of silica, alumina, zirconia, magnesia, titania, thoria, mullite, uranium oxide and plutonium oxide. high temperature superconducting oxides.

UNIT II NON OXIDE CERAMICS 9

Structural characteristics, properties and applications of silicon carbide, boron carbide, tungsten carbide, titanium carbide. Structural characteristics properties and applications of silicon nitride, boron nitride, titanium nitride, aluminum nitride

UNIT III CERMETS 9

Structural characteristics, properties and applications of cermets. Types of cermets, Uses, high temperature cermets, making of cermets.

UNIT IV ADVANCED STRUCTURAL CERAMICS 9

Structural characteristics, properties and applications of Carbon compounds, borides, silicides, Sialon,

UNIT V SINGLE CRYSTALS 9

Introduction, techniques for forming- Kyropolar technique. Czochralski method, edge defined- film fed growth method, Bridgman technique, floating zone method, flux technique, hydro-thermal growth technique, micro pulling down technique.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Mc Colm, Ceramic Science for Materials Technologists, Blackie & Sons Ltd.,Glasgow, 1983. 2. Handbook of Advanced Ceramics, Vol.I, Somiya.S et al (ed), Academic Press, 2003. REFERENCES
2. Brook R.J (ed), Concise Encyclopedia of Advanced Ceramic Materials, Pergamon Press, 1991.
3. Noboru Ichinose, Introduction to Fine Ceramics, John Wiley and Sons, 1987. 3. Gernot Kostorz, High Tech Ceramics, Academic Press, NY, 1989

HS7551 EMPLOYABILITY SKILLS L T P C

3 0 0 3

COURSE DESCRIPTION

This course aims to help the students acquire the employability skills necessary for the workplace situations. It also attempts to meet the expectations of the employers by giving special attention to language skills, presentation skills, group discussion skills and soft skills. This will be achieved through expert guidance and teaching activities focusing on employability skills.

COURSE OBJECTIVES

- To enhance the employability skills of students with a special focus on presentation skills, group discussion skills and interview skills
- To help them improve their reading skills, writing skills, and soft skills necessary for the workplace situations
- To make them employable graduates

CONTENTS

UNIT I READING AND WRITING SKILLS 9

Reading: skimming & scanning strategies – note making skills – interpreting visual material (charts & tables) – critical reading – fast reading necessary for reading letters & files - preparing job applications

- writing covering letter and résumé - applying for jobs online - email etiquette – writing official letters (placing an order, letters to consumers, etc.) writing reports – collecting, analyzing and interpreting data

UNIT II SOFT SKILLS 9

Hard skills & soft skills – soft skills: self-management skills & people skills - training in soft skills - persuasive skills – sociability skills –interpersonal skills – team building skills – leadership skills – problem solving skills – adaptability - stress management – motivation techniques – life skills -

UNIT III PRESENTATION SKILLS 9

Preparing slides with animation related to the topic – organizing the material - Introducing oneself to the audience – introducing the topic – answering questions – individual presentation practice— presenting the visuals effectively – 5 minute presentation

UNIT IV GROUP DISCUSSION SKILLS 9

Participating in group discussions – understanding group dynamics - brainstorming the topic — questioning and clarifying –GD strategies (expressing opinions, accepting or refusing others opinions, turn taking) – activities to improve GD skills – viewing recorded GD - mock GD

UNIT V INTERVIEW SKILLS 9

Interview etiquette – dress code – body language – mock interview -–attending job interviews – answering questions confidently – technical interview – telephone/Skype interview - practice in different types of questions – one to one interview &panel interview – FAQs related to job interview- Emotional and cultural intelligence.

LEARNING OUTCOMES

- Students will be able to make presentations and participate in group discussions with high level of self-confidence.
- Students will be able to perform well in the interviews
- They will have adequate reading and writing skills needed for workplace situations

TOTAL : 45 PERIODS

REFERENCES:

1. Corneilssen, Joep. How to Prepare for Group Discussion and Interview. New Delhi: Tata-McGraw-Hill, 2009.
2. Dabreo, Desmond A. Group Discussion and Team Building. Mumbai: Better Yourself Books, 2004.
3. Ramesh, Gopalswamy, and Mahadevan Ramesh. The ACE of Soft Skills. New Delhi: Pearson, 2010.
4. Gulati, Sarvesh. Corporate Soft Skills. New Delhi: Rupa and Co. 2006.
5. Van Emden, Joan, and Lucinda Becker. Presentation Skills for Students. New York: Palgrave Macmillan, 2004.

EXTENSIVE READING

1. Covey, Stephen R. The 7 Habits of Highly Effective People. New York: Free Press, 2013.
2. Bagchi, Subroto. The Professional. New Delhi: Penguin Books India, 2009.

WEB RESOURCES

1. www.humanresources.about.com
2. www.careerride.com
3. https://bemycareercoach.com/softskills

CT7711 ADVANCED INSTRUMENTAL METHODS LAB L T P C
[Minimum of 10 experiments] 0 0 4 2

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

1. Analysis of Trace Elements using Spectrophotometer, Flame Photometer
2. Thermal Analysis – TGA, DTA, DSC.
3. Determination of Viscosity by Brookfield Viscometer.
4. Particle Size Analysis – Laser Diffraction.
5. Microscopy – Optical
6. Vicker's Hardness.
7. Modulus of Rupture.
8. Cold Crushing Strength
9. Creep, Wear and Abrasion Resistance.
10. Thermal expansion – dilatometer
11. Impedance analyzer-LCR

TOTAL : 60 PERIODS

CT7712 INDUSTRIAL TRAINING
During Summer(4 weeks)

L	T	P	C
0	0	0	2

All the students have to undergo practical industrial training of four week duration in recognized establishments during summer either in the IV Semester or VI Semester. At the end of which they have to submit a report. The internal assessment will be based on the report and presentation and the examination marks be based on viva voce examination.

CT7713 ADVANCED CERAMIC PROCESSING LAB

L	T	P	C
0	0	4	2

[Minimum of 10 Experiments]

1. Powder synthesis by Communition / High Energy Ball milling
2. Powder preparation by Sol - Gel process
3. Powder preparation by Precipitation process
4. Powder preparation by Spray Drying
5. Forming by Gel Casting
6. Forming by Tape Casting
7. Role of additives in compaction by Pressing
8. Porous body making by Foaming
9. Porous body making by Intrusion / Replication
10. Microwave Sintering
11. Hot Pressing
12. Spray Pyrolysis - Coating
13. Surface Grinding and Roughness estimation

TOTAL : 60 PERIODS

Equipments Required:

1. High Energy Ball Mill	2. Hot Press
3. Spray Pyrolyser	4. Hot Air Oven

5. Uniaxial pressing Machine	6. Hot plate
7. Microwave Furnace	8. Spray Dryer
9. Surface Grinding Machine	10. Magnetic stirrer
11. Surface Roughness Tester Machine	12. Tape casting Equipment

CT7811 PROJECT WORK L T P C
0 0 20 10

AIM

The project work aims to train the students on systematic analysis of a problem and to enable them to bring out a solution it.

OBJECTIVE

The objective of the project is to make use of the knowledge gained by the student at various stages of the degree course.

Each student is required to submit a report on the project assigned to him/her by the department. The report should be based on the literature collected from the many sources and the actual analysis done by the student on the given project.

CT7001 ABRASIVE TECHNOLOGY L T P C
3 0 0 3

AIM

The course aimed to enable the students to have a basic knowledge about the types, manufacturing process, properties and applications of abrasives.

OBJECTIVES

On completion of the course the students are expected to

- Have a basic understanding on the abrasives, and different raw materials and their characteristics.
- Have studied the stages involved in the manufacture of a coated abrasive.
- Have learnt about the different types of backups used in a coated abrasive and how they affect the grinding characteristic.
- Have a good knowledge on the manufacturing of bonded abrasive, its types and characteristics.
- Have learnt the fundamentals of grinding operation, grinding aids and about polishing.

UNIT I INTRODUCTION 6

Abrasives – definition, classification, applications. Abrasive grains – classification, characteristics like hardness, toughness etc. Backings – cloth, paper, fibre, combination backing, their characteristics. Adhesives – classification, characteristics.

UNIT II MANUFACTURE OF COATED ABRASIVES 8

Raw material selection and preliminary treatments, maker coating, abrasive coating – methods and types of coating, sizer coating, drying and humidification, flexing, conversions – slitting, belt making, sheet cutting, disc cutting. Individual disc coating process. Quality control and testing.

UNIT III BACK UPS 7

Contact wheels – cloth contact wheels, rubber contact wheels, hardness, face serrations, shape, wheel diameter, speed, belt tension, dressing and protection of contact wheels – their characteristics. Drum, rolls, pads and platens – types, characteristics, choice and uses. Working principle of coated abrasive.

UNIT IV MANUFACTURE OF BONDED ABRASIVES 12

Abrasive grain type and characteristics required for bonded abrasives. Types of bonds – vitrified, silicate, resinoid, shellac, rubber and oxychloride. Bonded wheel manufacture with different bonds and their characteristics. Shapes and sizes of wheels. Factors determining grinding action – characteristics of abrasive grain, bond type, structure. Other types of wheels – Diamond wheels, reinforced wheels, mounted wheels. Selection of appropriate abrasive wheels for grinding metals.

UNIT V BASICS OF GRINDING AND POLISHING 12

Grinding wheel – definition, grinding chips, chemical reactions, grade selection, wheel wear, chemical grinding aids. Safe grinding practices. Grinding fluids – properties, types and purpose. Types of grinding – cylindrical grinding, centre less grinding, surface grinding, internal grinding. Polishing – definition, types.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Coes L Jr., Abrasive, Springer Verlag, New York, 1971.
2. Coated Abrasives – Modern Tool of Industry, Coated Abrasive Manufacturer's Institute, Cleaveland, Ohio, 1982.

REFERENCES

1. Metzger J.L, Super Abrasive Grinding, Butterworths, UK, 1986.
2. Francis T.Farago, Abrasive Methods Engineering, Vol.2, Industrial Press Inc., NY, 1980.
3. Edwards R, Cutting tools, The Institute of Materials, Cambridge, 1993.
4. Kenneth B.Lewis, William F.Schleicher, The Grinding Wheel, The Grinding Wheel Institute, Cleaveland, Ohio, 1976.
5. Fred B.Jacobs, The Abrasives, The Penton Publishing Co., Cleveland, USA, 1928.

CT7002 ADVANCED REFRACTORY MATERIALS L T P C
3 0 0 3

AIM

The course is aimed to impart basic knowledge about refractory for various industries and conservation.

OBJECTIVE

On completion of the course the students are expected to

- Have a basic understanding about applications of refractories in steel, cement, glass industries.
- Have learnt about various choice of refractory for kiln furniture.
- Have basic knowledge about energy conservation using ceramic fibres.

UNIT I SELECTION CRITERIA & INSTALLATION 9

Criteria for refractory selection – thermal criteria and calculations, structural criteria, chemical criteria. Installation – refractory bricks & shapes, castables, plastics, ceramic fibers.

UNIT II REFRACTORIES FOR FERROUS INDUSTRIES 9

Design, construction and refractories used in coke ovens, blast furnace, steel making furnaces, secondary steel making furnaces, continuous casting, heat treating & forging industries.

UNIT III REFRACTORIES FOR NON-FERROUS METALLIC INDUSTRIES 9

Design, construction and refractories used in copper, aluminum, lead, zinc extraction and processing industries.

UNIT IV REFRACTORIES FOR NON-METALLIC INDUSTRIES 9

Refractories used in refining & petrochemical, fertilizer, cement, glass, ceramic industries. Refractories used in combustors, boilers, incinerators etc.

UNIT V INDUSTRIAL MAINTENANCE & SAFETY 9

Refractory maintenance & repair; Refractory Economics; Safety, health hazards, pollution control & ecology.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Chester, J.H., Steel Plant Refractories, Second Ed., 1973, The United Steel Companies LTD., Sheffield, UK.
2. Chester, J.H., Refractories, Production and Properties, 1973, Iron and Steel Institute, London.

REFERENCES

1. Robert E.Fisher, Advances in Refractory Technology, Ceramic Transaction Vol.4.,1990, American Ceramic Society, Westerville, Ohio, USA.
2. Handbook of Monolithics, 1980, Plibrico, Japan.
3. Modern Refractories Practice, 1961, Habbison Walker Comp., Pittsburgh.
4. Amavis, R., Refractories for the Steel Industry, 1990, Elsevier Publications
5. G.V.Samsonov&J.M.Vinitskii, Handbook of Refractory, 1980, IFI Publications.
6. D.N.Nandi, Handbook of Refractories, 1987, Tata McGraw-Hill Publications.
7. Charless.A.Schacht, Refractories Handbook, 2007, Marcel Dekkar Publications.

CT7003 BIOCERAMIC MATERIALS L T P C

3 0 0 3

AIM

The course is aimed to enable the students to have a sound knowledge about the applications of ceramic materials in biological field.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt Introduction.
- Have a complete knowledge about inert ceramics.
- Have studied about Calcium Phosphate Bioceramic.
- Have studied about Silica based Ceramics.
- Have studied about Material Shaping.

UNIT I INTRODUCTION 9

Hard tissue- Structure, Properties, healing, repairing methods. Biomimetics, Implant materials – Autocraft, allocraft, metals, polymers, ceramics. Biological behavior of implant materials.

UNIT II INERT BIOCERAMICS 9

Types, Fabrication, application and biological response of alumina and Zirconia. Non-oxide ceramics in bio application – Si_3N_4, SiC, B_4C, WC. Carbon based materials in bio applications- Pyrolytic carbon, fullerenes, Carbon nanotubes, Carbon fibers, Diamond, amorphous carbon.

UNIT III CALCIUM PHOSPHATE BIOCERAMICS 9

Preparation, properties and biological performance of hydroxyapatite, Tricalcium Phosphate, Biphasic Calcium phosphate,Calcium phosphate nano particles. Invivo response of calcium phosphate ceramics and clinical applications of Calcium phosphate ceramics.

UNIT IV SILICA BASED CERAMICS 9

Glass as Bio materials, increasing bio activity of glasses, Strengthening and adding new capabilities to bioactive glasses. Non silicate glasses, Clinical application of glass. Mesoporous silica - Synthesis and Functionalization.

UNIT V MATERIAL SHAPING 9

Bioceramic coatings for implants- Method, bioactive ceramic coatings, bioinert ceramic coatings. Scaffold designing- Requirements, Processing techniques. Cements- Calcium phosphate cements- types, Chemistry, preparation, properties and application.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Joon Park :Bioceramics Properties, Characterization and Application, Springer, 1995.
2. Maria valet regi: Bioceramic with Clinical Applications, Wiley, 2010.
3. W.Bonfield, G.W.Harting, K.E.Tanner: Bioceramics Vol-IV, Butterworth Heinmann, 2010.

REFERENCE BOOKS

1. Takao Yamamuro, Larry L.Hench, June Wilson: Handbook of Bioactive Ceramics Vol –I, CRC press, 1990.
2. Takao Yamamuro, Larry L.Hench, June Wilson: Handbook of Bioactive Ceramics Vol –II, CRC press, 1991.
3. Heimo O.Ylanen: Bioactive Glasses Materials, Properties and Applications, Woodhead Publishing in materials 2011.

CT7018 QUANTITATIVE TECHNIQUES IN CERAMICS L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a basic knowledge about the methods of calculating the various ceramic properties.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the basic methods of calculating the properties of ceramic raw materials.
- Have learnt to calculate the properties of ceramic bodies.
- Have learnt to calculate the properties of suspensions.
- Have learnt to formulate glaze batches by varying the parameters.
- Have learnt to formulate glass batches.

UNIT I ULTIMATE & RATIONAL ANALYSIS 9

Ultimate analysis, proximate analysis, rational analysis of clay, stone and feldspar -mica convention – substitution of clays in body recipes – triangular plot.

UNIT II DETERMINATION OF PHYSICAL PROPERTIES 9

Shrinkage – Drying, Firing, Total, Volume, Moisture content – relationship between percentage moisture content and volume shrinkage - loss on ignition –density - specific gravity – effect of porosity on the function of ceramic materials – pore structure density – apparent volume – true volume – apparent solid volume, porosity – apparent, true, sealed pores.

UNIT III CALCULATIONS OF BODY & SUSPENSIONS 9

Density of a slip – calculations relating to mixtures of solid particles and water –dilution problems – Brongniarts Formula – dry measurement, wet measurement –effect of specific gravity – density of the body slip – dimensions of the mixing ark –adjustments to the wet recipe – addition of body stain.

UNIT IV GLAZE CALCULATIONS 9

Molecular weights – formula and use of chemical equations – oxides – percentage composition and formula – calculation of a recipe from a simple glaze formula – given the recipe of a glaze calculate the formula – synthesis of a fritted glaze – given the recipe calculate the formula for a fritted glaze – calculation of the percentage composition of the mill batch.

UNIT V GLASS CALCULATIONS 9

Determination of molecular formula of glass from chemical composition of the glass and from glass batch – determination of batch from molecular formula of glass – determination of batch from the given chemical composition.

TOTAL: 45 PERIODS

TEXT BOOKS

1. R.Griffiths & C.Radford, Calculations in Ceramics, Johns Hill, 1965.
2. A.I.Andrews, Ceramic Tests and Calculations, John Wiley & Sons, 1928.

REFERNCES

1. Hiraoki Yanagida, The Chemistry of Ceramics, John Wiley and Sons, 1996.
2. Terpstra, Ceramic Processing, Chapmann and Hall, 1995.
3. Tooley F.V, Handbook of Glass Manufacture, Vol I&II, Ogden Publishing Co., NY, 1960.
4. Alexis G.Pincus, Melting Furnace Operation in the Glass Industry, Magazines for Industry Inc., NY, 1980.
5. R.Charan, Handbook of Glass Technology.

CT7004 CEMENT TECHNOLOGY L T P C

3 0 0 3

AIM

The course is aimed to enable the students to have a complete knowledge on the manufacture, quality control and types of cement, and preparation, properties and different types of concrete.

OBJECTIVES

On completion of the course the students are expected to

- Have studied the raw materials, manufacturing process and mechanism of clinker production.
- Have learnt in detail about clinker
- Have studied the different types of Portland cements and their characteristics.
- Have learnt the types of blended cements and special cements
- Have understood the environmental impact of cement production.

UNIT I PRODUCTION OF CEMENT CLINKER 9

Introduction, Composition of Portland cement, Raw materials, Particle size distribution in raw materials, Preparation of kiln feed. Manufacturing process- Wet, Dry, Semidry, Preheating and precalcining process, Study of rotary kiln and shaft kiln.

UNIT II CLINKER STUDY 9

Study of Solid state rins, Sintering and Clinkering, Constitution of PC clinker, Study of important system in phase formation, Effect of impurities and role of minor components, QC of clinker- Litre weight test, Characterization of clinker- Chemical analysis, Optical microscopy, electron Microscopy, XRD.

UNIT III PORTLAND CEMENT 9

Cement milling, Fineness of Cement-Hydration of individual phases of Portland cement, hydration of Portland cement, Hydration at elevated T. QC of Cement- Chemical Composition, Setting time, Compressive strength, Workability, Soundness and Heat of hydration.

UNIT IV BLENDED CEMENTS AND SPECIAL CEMENTS 9

Introduction, Type I and related Portland cements, cement with mineral constituents, pozzolanic materials, Blast furnace slag and blast furnace slag cements, problem in specification of blended cements.

UNIT V ENVIRONMENTAL IMPACT 9

Introduction, emission to air, water, environmental aspects of alternative fuels, Environmental monitoring- Greenhouse gas emissions, Carbon footprinting.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Gerry Bye, "Portland Cement", Third Edition, Institution of Civil Engineers Publication, 2011.
2. P. Kumar Mehta and Paulo J.M.Monteiro, Concrete – Microstructure, Properties and Materials, 3rd Edn., Tata McGraw Hill, 2006.
3. A.M.Neville, Properties of Concrete, 4th Edn., Pearson Education, 1995.

REFERENCES

1. A.M.Neville and J.J.Brooks, Concrete Technology, Pearson Education, 1987.
2. Peter C.Hewlett (Editor), Lea's Chemistry of Cement and Concrete, 4th Edn., Elsevier, 1998.
3. Deborah DL. Chung, Multifunctional Cement Based Materials, Marcel Dekker Inc., 2003.
4. J. Bensted and P.Barnes (Editors), Structure and Performance of Cements, 2nd Edn., Spon Press, 2002.

CT7006 FIBRES AND COMPOSITES L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a sound knowledge about the different types of ceramic fibres, composites, their properties and applications.

OBJECTIVES

On completion of the course the students are expected to

- Have studied the different fibre reinforcements, their manufacturing routes, properties and applications.
- Have studied the different types of matrices, its manufacturing techniques and properties.
- Have a basic knowledge about the types, manufacturing process and properties of composites.
- Have a basic knowledge about the properties of composite materials.

- Have a sound knowledge about the different types of whiskers.

UNIT I REINFORCEMENTS **9**

Fibre definition, fibre flexibility; Glass fibres – types, manufacturing process, properties, glass wool forming process; Alumina fibres, mullite fibres, zirconia fibres, boron fibres, carbon fibres and graphite fibres – manufacturing techniques, properties and applications; Strength of reinforcements.

UNIT II WHISKERS **9**

Background of whisker growth – whisker nucleation and growth – composite processing – whisker purification, whisker / matrix powder mixing, densification, SiC and Si_3N_4 whiskers, VLC synthesis, properties.

UNIT III TYPES OF MATRICES **9**

Introduction, types – polymer, ceramic, metal, glass, thermosetting and thermoplastic matrices.

UNIT IV COMPOSITES **9**

Definition, classification – metal / polymer / ceramic matrix composites, particulate and fibre reinforcements – processing methods, microstructure. Carbon-carbon composites, nano composites.

UNIT V PROPERTIES OF COMPOSITES **9**

Elastic and strength properties – fracture behavior – fibre matrix load transfer – failure of a composite – criteria, damage of composites from physical and mechanisms to modeling, long term behavior of composite materials, high temperature stability – wear and friction.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Anthony R.Bunsell and Marie-Helene Berger, Fine Ceramic Fibres, Marcel Dekker Inc., 1999.
2. Chawla K.K, Ceramic Matrix Composites, Chapman and Hall, 1993.

REFERENCES

1. Hull D and Clyne T.W, An Introduction to Composite Materials, 2nd Edn., Cambridge University Press, 1996.
2. Bunsell A.R and Renard J, Fundamentals of Fine Fibre Reinforced Composite Materials, IOP Publishing Ltd., 2005.
3. Warren R, Ceramic Matrix Composites, Blackie, 1992.

CT7005 ELECTRONIC CERAMICS **L T P C**
3 0 0 3

AIM

The Course is aimed to enable the students to know the basic concepts of ceramic materials used for electronic applications and their applications in various fields.

OBJECTIVES

On completion of the course the students are expected to

- Have studied the use of ceramic materials as insulators and capacitors and their properties.
- Have learnt the processing, properties and various applications of ceramic materials in ferroelectric applications.
- Have learnt the manufacture, characteristics and properties of magnetic ceramics.
- Have a basic knowledge about superconductivity.
- Have a basic knowledge about the manufacture, characteristics and properties of varistors and fuel cells.

UNIT I CERAMIC INSULATORS 9

Insulators, insulator materials, triaxial and non-triaxial insulators – composition, properties and uses – dielectric properties - dielectric strength, dielectric breakdown mechanisms, factors affecting dielectric strength, dielectric constant and loss-polarization- different types of polarization – effect of frequency and temperature, thermal properties – thermal conductivity, thermal resistance, thermal coefficient of expansion, mechanical properties, conduction – electronic and ionic

UNIT II CERAMIC CAPACITORS 9

Introduction – classification - Capacitance-ferroelectric behavior – barium titanate – effect of solid solutions – additives – film capacitors, single layer discrete capacitors – multilayer capacitors – basic principles and fabrication processes, properties -

UNIT III FERROELECTRIC CERAMICS 9

Piezo-electricity – barium titanate, relaxor ferroelectrics, multiferroics, ferroelectricity, manufacture of barium titanate based ceramics – properties of ferroelectric ceramics – hysteresis loop – PZT – PLZT materials, compositional systems, processing and fabrication – mixed oxide and chemical precipitation processes.

UNIT IV MAGNETIC CERAMICS 9

Classification of magnetic materials – domain theory – Ferromagnetism – Spinel ferrites – structure, types of ferrites – manganese, zinc ferrites – hexagonal ferrites – garnets – standard ceramic processing and fabrication techniques-GMR.

UNIT V VARISTORS AND FUEL CELLS 9

Introduction- ZnO varistors – PN junction diode– electrical characteristics, fabrication of ZnO varistor behavior- microstructure – gas sensors fuel cells – types, principle, working, solid oxide fuel cells – applications- structure and operation principle of oxygen sensors, NOx sensors.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Hench L.L and J.K.West, Principles of Electronic Ceramics, John Wiley, New York, 1990.
2. Moulson AJ and HM Herbert, Electroceramics, Chapman and Hall, London, 1990.

REFERENCES

1. Setter N and Colla SL, Ferroelectric Ceramics, Birkhauser Ver Lag, 1993.
2. S.Somiya, F.Aldinger, N.Clausen, RM Sprigs, K.Uchino, K.Koumoto, M.Kaneno, Handbook of Advanced Ceramics : Vol.II, Processing and their applications, Academic Press, 2003.
3. Buchanan RC, Ceramic Materials for Electronics, Marcel Dekker Inc., NY, 1991.

CT7007 FUELS AND ENERGY ENGINEERING L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a thorough knowledge about different types of fuels used in industries and the mechanism involved in converting the fuel into a useful source of energy.

OBJECTIVES

On completion of the course the students are expected to

- Have a complete knowledge idea about the occurrence and characteristics of the different types of solid fuels.
- Have a better knowledge about the different types of liquid fuels and their properties.

- Have a complete understanding about the different liquid fuels and their properties.
- Have a basic knowledge about the combustion process involved in the fuels.
- Have an idea about the ways of heat transfer and the different heat recovery systems.

UNIT I SOLID FUEL 9

Wood, charcoal, coal characteristics – formation of coal, grading of coal, handling and storage of coal, coal washing, hardness and grind ability of coal, calorific value, coal analysis. Manufacture of coke. Agro based solid fuels – wheat, rice, bagasse, solid oxide fuel cells. Advantages disadvantages and storage of solid fuel

UNIT II LIQUID FUEL 9

Origin and composition of natural oil, refining process of liquid petroleum products, synthetic liquid fuels – calorific value, storage and handling of liquid fuels. Bio fuels – importance. Advantages disadvantages and storage of liquid fuel

UNIT III GASEOUS FUELS 9

Composition and calorific value – natural gas, liquefied petroleum gas, oil gas, coal gas, producer gas, water gas, other gaseous fuels. Non conventional fuels – importance, hydrogen fuel. Advantages disadvantages and storage of gaseous fuel

UNIT IV COMBUSTION PROCESS 9

Air requirement, combustion processes of solid, liquid, gaseous fuels, control of combustion process, combustion stoichiometry.

UNIT V HEAT TRANSFER 9

Heat transfer to charge by conduction, convection and radiation in a kiln, heat loss through kiln wall, opening, cooling etc., heat balance and thermal efficiency, heat recovery – recuperator and regenerator, co-generator – importance.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Samir Sarkar, Fuels and Combustion, 2nd Edn., Orient Longman, Bombay, 1990.
2. Om Prakash Gupta, Elements of Fuels, Furnaces and Refractories, Khanna Publishers, 1995.

REFERENCES

1. Wilfrid Francis and Martin C.Peter, Fuels and Fuel Technology, Pergamon Press, 1980.
2. J.P.Holman, Heat Transfer, McGraw – Hill, 1997. 3. J.D.Gilchrist, Fuels, Furnaces and Refractories, Pergamon Press, NY, 1977.
3. A.K.Shaha, Combusiton Engineering and Fuel Technology, Oxford & IBH Publishing Co., New Delhi, 1974

CT7009 KILNS, FURNACES AND PYROMETRY L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a thorough knowledge on the equipments involved in firing of a ceramic article and the temperature measurement methods.

OBJECTIVES

On completion of the course the students are expected to

- Have a thorough knowledge on the different burners used based on the fuel type and the types of flame produced from burners.
- Have studied the different types of furnaces and their operation.
- Have an understanding on the different factors involved in designing a furnace.
- Have a better knowledge on different types of kilns, their construction and working.
- Have a clear understanding on the temperature and heat measurement techniques in kilns and furnaces.

UNIT I LAY OUT OF FURNACE AND DESIGNING 9

Introduction, furnace layout- site selection, criteria for selection of furnace. Establishment of furnace parts- stack, draught, chimney calculation. furnace atmosphere, Reheat utility- functions of regenerators and recuperators.

UNIT II BURNERS AND FLAMES 9

Burner – classification, atomization, low pressure burner for gaseous fuel, high pressure burner for liquid fuels, advantage & disadvantage of different burners. Flames – nature of flames, laminar & turbulent, premixed & diffusion, burning velocity.

UNIT III FURNACES 9

classification – metal heating furnaces, reheating furnace, continuous furnace, sintering furnace, crucible furnaces, electric furnace, unit melters and smelters, muffle furnace, glass tank furnace. microwave furnace.

UNIT IV KILNS 9

Introduction, definition, classification – draught kiln, chamber kiln, tunnel kiln, roller kiln, rotary kiln, continuous kiln, shuttle kiln, top hat kiln, muffle kiln, Hoffman's kiln – principle, materials used in foundation and construction, working.

UNIT V PYROMETRY 9

Introduction and thermometry, thermocouples, radiation pyrometers, low temperature measurement, temperature control, heat work recorders – Segar cone, Holdcroft's bar, Buller rings, Watkin recorders.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Suryanarayana A.V.K, Fuels, Furnaces, Refractories and Pyrometry, BS Publications, 2005.
2. Robert D.Reed, Furnace Operation, Gulf Publishing Co., Paris, 1991.

REFERENCES

1. Harold E. Soisson, Instrumentation in Industry, John Wiley and Sons, NY, 1995.
2. Sarkar B.K, Thermal Engineering, Tata McGraw-Hill Publishing Co. Ltd., 1998.

CT7010 MATERIALS MANAGEMENT L T P C

3 0 0 3

AIM

The course is aimed to enable the students to have a basic knowledge about importance of material management and its applications in various sectors.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the basic concepts about materials management.
- Have studied about the importance of purchasing.

- Have studied the importance of management in warehouse and stores.
- Have studied the importance of management in inventory.
- Have studied the concepts of different material procurement procedures.

UNIT I INTRODUCTION 9

Introduction to material management, importance of integrated materials management, need for integrated materials management, concept, definition, scope and advantage- an overview, A-B-C analysis, codification, variety reduction, standardization.

UNIT II PURCHASE MANAGEMENT 9

Material planning and purchase, purchase system, procedures, price forecasting, purchasing of capital equipment, vendor development, account procedure, purchasing decisions, procurement policies.

UNIT III WARE HOUSING AND STORE MANAGEMENT 9

Store keeping principles-past and latest techniques, stores-general layout, cost aspect and productivity, problems and development, store system procedures incoming material control, store accounting and stock incoming material control, store accounting and stock verification, value analysis.

UNIT IV INVENTORY MANAGEMENT 9

Introduction, basic models, definition of commonly used terms, replenishment model, choice of system etc., inventory work in progress, safety stock, computerization in materials management control, information to materials management case study, spare parts .

UNIT V MATERIAL PROCUREMENT PROCEDURES 9

Arbitration act- octroi, central and local sales tax, excise duties- custom tariff, import, control policies, procurement from government agencies and international market- insurance, DGS and D tariff.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Goplakrishnan P and Sundraesan M, Materials Management, An Integrated Approach, Prentice Hall of India Private Ltd., New Delhi, 1982.
2. Peckam H.H, Effective Materials Management, Prentice Hall of India Private ltd., 1984.

REFERENCES

1. Datta A.K., Materials Management Procedure, Test and Cases, Prentice Hall of India Private Ltd., New Delhi, 1984.
2. Prichard J.W and Eagle R.H., Modern Inventory Management, NY, Wiley and Breach Science Publishers, 1972.

CT7011 MECHANICAL BEHAVIOUR OF CERAMIC MATERIALS L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a detailed understanding about the behaviour of ceramic materials with different mechanical properties.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt in detail about the elastic property and brittle nature of ceramics.
- Have understood the fracture behaviour of ceramics.
- Have studied the behaviour of the materials in strength and engineering design.
- Have learnt the creep behaviour of ceramic materials.

- Have understood the thermal shock behaviour of the ceramic materials.

UNIT I ELASTIC BEHAVIOUR 7

Elastic constants – effect of atomic structure and microstructure. Response to stress – elastic deformation of isotropic and crystalline materials – measurement techniques.

UNIT II FRACTURE MECHANICS 8

Theoretical strength and stress concentrations, linear elastic fracture mechanics, micro structural aspects, fracture testing techniques.

UNIT III STRENGTH AND ENGINEERING DESIGN 10

Strength testing, statistical treatment to strength, time dependent strength behaviour – subcritical crack growth, stable crack propagation, cyclic fatigue – SPT diagram. Toughening of Ceramics.

UNIT IV CREEP BEHAVIOUR 10

Creep – definition, types – diffusion creep, dislocation creep, viscous creep. Microstructure dependence of creep, creep deformation maps.

UNIT V THERMAL BEHAVIOUR 10

Thermal stress, thermal shock resistance parameters, thermal stresses and cracking, testing technique, applications of thermal stress.

TOTAL: 45 PERIODS

TEXT BOOKS

1. John B.Wachtman, Mechanical Properties of Ceramics, John Wiley & Sons, New York, 1996.
2. Davidge R.W, Mechanical Behaviour of Ceramics, Ceramic Book Literature Service, London, 1979.

REFERENCES

1. Kingery W.D, Bowen H.K and Uhlmann D.R, Introduction to Ceramics, John Wiley & Sons, 1991.
2. Barsoum M.W, Fundamentals of Ceramics, McGraw-Hill, 1997.
3. Hasselman D.P.H and Heller R.A (eds.), Thermal Stresses in Severe Environments

CT7012 MICROWAVE PROCESSING OF CERAMICS L T P C
3 0 0 3

AIM

The course is aimed to enable the students to the basic concepts about processing the ceramic materials in microwave atmosphere.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the introduction about microwave processing.
- Have learnt the concepts of microwave heating circuit.
- Have learnt the applicator types of microwave.
- Have studied the industrial applications of microwave processing.
- Have studied the hazard and safety of microwave processing.

UNIT I INTRODUCTION 9

Dielectric Behavior of materials- power dissipation- propagation factor and skin depth- heat and mass transfer phenomena- temperature distribution- wall loss.

UNIT II MICROWAVE HEATING CIRCUIT 9

Power sources- klystron and magnetron- operating characteristics- protection system- high frequency breakdown phenomena- automatic control of the process- automation, tuning and machining.

UNIT III APPLICATION TYPES 9

Travelling wave applicators- multimode applications- power transfer- uniformity of heating.

UNIT IV INDUSTRIAL APPLICATIONS 9

Microwave drying- microwave sintering- application to laboratory models and pilot system- comparison with pilot heating.

UNIT V HAZARDS AND SAFETY 9

Exposure standards- industrial- frequency band- leakage from industrial equipment- batch system- continuous flow system- safety precautions.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Metaxas A.C and Meredith RJ, Industrial Microwave Heating, Peter Peregrinus Ltd., UK, 1983.
2. Snyder W.B, Sutton W.H, Iskander M.F and Johnson D.L (Ed), Microwave Processing of Materials, Volume I & II, MRS, Pittsburgh, 1991.

REFERENCES

1. Binner J.G.P (Ed), Advanced Ceramic Processing and Technology, Volume I, Noyes Publications, New Jersey, 1990.
2. Randall M German, Sintering Technology, Marcel Dekker, Inc, 1996.

CT7013 MONOLITHICS REFRACTORIES L T P C

3 0 0 3

AIM

The course is aimed to enable the students to have a sound knowledge about the types, properties and applications of monolithics and castables.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the types of castables, its composition and characteristics.
- Have a better understanding on the use of plastic refractories, ramming and gunning mixes as monolithic materials.
- Have studied about the composition and characteristics of mortars, coatings and dry vibratables.
- Have a clear idea on the methods of installing different monolithic materials, the application design and the lining materials used while laying monolithics.
- Have studied the wear mechanisms that cause failure in a monolithic lining and the methods to test a monolithic.

UNIT I CASTABLES 10

Introduction, types – conventional castables, low cement castables, ultra low cement castables, cement free castables – composition, characteristics, applications. Other castables – insulating castables, pumpable castables – composition, characteristics, applications.

UNIT II PLASTIC REFRACTORIES, RAMMING AND GUNNING MIXES 10

Plastic refractories – introduction, composition, properties and applications. Ramming mix – introduction, binder systems, characteristics and applications. Gunning mix – introduction, binder systems, characteristics and applications.

UNIT III MORTARS, COATINGS AND DRY VIBRATABLES 7

Mortars – introduction, classification, characteristics. Coatings – introduction, characteristics. Dry vibratables – introduction, principle and applications.

UNIT IV MONOLITHIC INSTALLATION 10

Methods of installations of castables, plastic refractories, ramming mis and gunning mix.
Drying and heating up of installed monolithic lining. Application designs – blast furnace trough design, trough lining, and form design, tundish, steel ladle, electric arc furnace. Linings in installation – anchors, steel fibre reinforcements.

UNIT V WEAR MECHANISMS AND TESTING 8

Wear mechanisms – introduction, abrasion, penetration, corrosion, spalling. Tests done on monolithics – chemical analysis, density, porosity, strength, high temperature properties, corrosion, erosion.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Subrata Banerjee, Monolithic Refractories, World Scientific Publishing Co. Pte. Ltd., 1998.
2. Taikabutsu Overseas Vol.9 No.1, Recent Progress in Castable Refractories, Techno Japan, Fuji Marketing Research Co. Ltd., Japan, 1995.

REFERENCES

1. Charles A.Schacht, Refractories Handbook, Marcel Dekker Inc, New York, 2004.
2. Norton F.H, Refractories, 4th Edn., McGraw Hill Book Co., 1968.
3. Nandi D.N, Handbook of Refractories, Tata McGraw-Hill Publishing Co., New Delhi, 1991.
4. Akira Nishikawa, Technology of Monolithic Refractories, Plibrico, Japan Co. Ltd., Tokyo, 1984.

CT7014 NON DESTRUCTIVE TESTING AND EVALUATION L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a basic knowledge about the various non-destructive methods of testing.

OBJECTIVES

On completion of the course the students are expected to

- Have studied the basic concepts of non-destructive testing and surface NDT methods
- Have learnt about small business and preparation of feasibility chart.
- Have a basic knowledge about establishment of a business.
- Have learnt about how to manage a business unit.
- Have some basic concepts about promotion of entrepreneurship and practical knowledge about some case studies.

UNIT I INTRODUCTION 7

Non destructive Test and Evaluation Technology – an overview, Materials, Manufacturing Process and Non destructive testing methods, Designs and Non Destructive Testing, Industrial applications of non destructive evaluation – railways, nuclear, non nuclear and chemical industries, automotive industries.

UNIT II RADIOGRAPHIC TESTING 12

Sources of –ray and gamma rays and their interaction with matter, equipment, general radiographic procedure, radiographic technique and acceptance standard, special radiographic techniques, safety aspects of industrial radiography.

UNIT III ULTRASONIC TESTING 11

Principles of wave propagation, Reflection, Refraction,Diffraction, Mode conversion and Attenuation, Sound field, Piezoelectric effect, Ultrasonic transducers and their characteristics, Ultrasonic equipment, A, B,C scan presentation of Test Indications and Interpretations, Ultrasonic Testing, Effective applications and Limitations of Ultrasonic Testing.

UNIT IV EDDY CURRENT TESTING 8

Introduction- principles of eddy current, Eddy current test system, Applications of Eddy Current Testing, Effectiveness of eddy current testing.

UNIT V OTHER METHODS 7

Liquid Penetrant Test basic concepts, liquid penetrant system, Test Procedure, effective applications and Limitations, Magnetic Particle Test – Magnetic Materials, Magnetic Particle Test – Principle, Equipment, Procedure, Interpretation and Evaluation, Effective applications and limitations, other methods – thermal infrared testing, acoustic emission .

TOTAL: 45 PERIODS

TEXT BOOKS

1. B.Hull and V.John, Non Destructive Testing, McMillan Education Ltd, 1968.
2. Mc Gonnagle, W.J, Non-destructing testing methods, Mc Graw Hill Co., NY, 1961.
3. J Prasad and C G K Nair, Non Destructive Test and Evaluation of Materials,

REFERENCES

1. Metals Handbook, Volume 2, 8th Edn, ASTM, Metals Park, Ohio.
2. Dainty, Laser Speckle & Related Phenomena, Springer – Verlag, New York, 1984.

CT7015 PLANT EQUIPMENT AND FURNACE DESIGN L T P C

3 0 0 3

AIM

The course is aimed to enable the students to have a sound knowledge about designing the layout of the plant and designing of furnaces.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the factors for selection of a plant layout.
- Have studied the ways of assembling the various sections in the plant for proper functioning.
- Have studied the principles of designing equipments**.**
- Have studied the principle and designing of furnaces.
- Have studied the construction of furnaces.

UNIT I PLANT DESIGN 9

Proper location of the plant- factors to be considered, factory buildings- layouts with necessary details.

UNIT II ASSEMBLING 9

Assembling of economics, engineering and industrial data, calculations and data necessary for the process route- electrical, piping instruments, motors, compressors etc- flow diagrams- process, design and overall technical report.

UNIT III EQUIPMENT DESIGN **9**

Design principles- crushers, filter press, sieves, pugmill and different types of pug moulds- tunnel, chamber and electrical.

UNIT IV FURNACE DESIGN **9**

Design of furnaces- tank furnace, tunnel kiln, chamber kiln, rotary kiln, muffle furnace, blast furnace, open hearth furnace, stack calculations- chimney foundations. Essential operations- firing, charging, melting, preheating- air, gas, fuel, flame systems, furnace high temperature measurements and temperature control instruments.

UNIT V FURNACE CONSTRUCTION **9**

Furnace life and selection of proper refractories, thermal currents and atmosphere, safe firing schedule. Basic knowledge about furnace construction, capacity, fuel and firing efficiencies- design, construction and thermal calculation of one of the furnaces.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Sule D.R., Manufacturing Facilities: Location, Planning and Design, PWS- kent, Boston, 1988.
2. Karbandha O.P., Process, Plant and Equipment Costing, Savek Publishers, Bombay, 1977.

REFERENCES

1. Robert D Reed, Furnace Operation, Gulf Publishing Co., Paris, 1991.
2. Harold E Soissson, Instrumentation in Industry, John Wiley & Sons, NY, 1995.
3. Brownhell L.E. and Young E.H., Chemical Plant Design, McGraw Hill, 1950.

CT7016 PROCESS AUTOMATION **L T P C**
3 0 0 3

AIM

The course is aimed to enable the students to have a basic knowledge about the control instruments and its applications in various fields.

OBJECTIVES

On completion of the course the students are expected to

- Have studied the principle and classification of process control equipments.
- Have learnt basic concepts on process control.
- Have learnt the basics about advanced control instruments.
- Have learnt about digital control instruments.
- Have learnt the optimal control instruments.

UNIT I INTRODUCTION **9**

Principles of measurement and classification of process control instruments; temperature, pressure fluid flow, liquid level, velocity, fluid density, viscosity, conductivity etc., instrument scaling; sensors; transmitters and control valves; instrumentation symbols and labels.

UNIT II PROCESS AUTOMATION **9**

Basic Concepts; terminology and techniques for process control; control modes; tuning process controllers.

UNIT III ADVANCED CONTROL 9

Advanced control techniques, feed forward and ratio control; controller design; adaptive control system; statistical process control; expert system; multivariable control techniques; supervisory control.

UNIT IV DIGITAL CONTROL 9

Digital control techniques; z transforms; sampling and filtering; response of discrete time systems; sampled data control systems; design of digital controllers.

UNIT V OPTIMAL CONTROL 9

Optimization and simulation; optimization techniques; single and multivariable constrained optimization; dynamic simulation of distillation columns and reactors.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Nakara, B.C & ChoudaryK.K., Instrumentation and Analysis, Tata McGraw Hill, New Delhi, Eighth Reprint, 1993.
2. Stephanopoulos G., Chemical Process Control, Tata McGraw Hill, New Delhi, 1993.

REFERENCES

1. Karl J.Astrom & Bjorn Willermans; Computer Controlled Systems, Prentice Hall of India Pvt.Ltd. 1994.
2. Chemical Engineering Refreshers series on Process Automation, McGraw Hill Publications, New York, 1991.

CT7017 QUALITY CONTROL IN CERAMIC INDUSTRIES L T P C
3 0 0 3

AIM

To impart knowledge on various quality control aspects and issues followed in ceramic industries.

OBJECTIVES

At the end of the course the students would

- Be aware on the basic concepts of standardization.
- Have a comprehensive insight in the Indian standard specifications.
- Have a basic knowledge on the concepts of quality control in ceramic industries.
- Have learnt the statistical methods of quality control.
- Have a basic knowledge about the reliability and maintainability of quality concept.

UNIT I CONCEPTS OF STANDARDISATION 9

Historical development of standards – aims, techniques, management, formulation, implementation of company standards- economic benefits of standardization.

UNIT II INDIAN STANDARDS FOR CERAMIC MATERIALS 9

IS Specification- Specification for different raw materials- test procedures- products- tiles- sanitary ware- insulators- chemical resistant wares- structural ceramic materials- refractories.

UNIT III CONCEPTS OF QUALITY 9

Quality engineering- planning for quality and reliability- quality standards- specification of inspection methods, setting of standard quality levels- introduction to ISO 9000- design of quality experiments using statistics- analysis of variance.

UNIT IV STATISTICAL QUALITY CONTROL 9

Introduction to taguchi methods and 6 sigma concepts- objectives of statistical quality control- inspection and its importance- difference between inspection and quality control, basic statistical methods- techniques of quality control- control charts for attributed- control charts for variables.

UNIT V DECORATION 9

Definition of reliability, factors affecting reliability- MTTF- MTBF- evaluation of reliability, quality management- organizing for quality- economy of quality- techniques of ABC analysis- quality management education- zero defects concept-

TOTAL: 45 PERIODS

TEXT BOOKS

1. H.Lal, Total Quality Management- A Practical Approach, Wiley Eastern, 1990.
2. Juran J.M and Gryna F.M, Quality Control Handbook, McGraw Hill Book Co., 1988.

REFERENCES

1. Jerome D West and Ferdinand K Leoy, A Management Guide to PERT/CPM.
2. Guide on Company Standardization by Institute of Standards & Engineers, 1989.
3. International Organization for Standardization, 1992, Case Postal 56, CH-1211-Geneva 20- Switzerland- ISO- 9000 Compendium – Vision 2000- ISBN92- 67- 101722.

CT7019 REFRACTORY ENGINEERING AND MANAGEMENT L T P C
3 0 0 3

OBJECTIVE

To enable the students to have a basic knowledge about Refractory lining and the structural and mechanical behavior of refractory linings

OUTCOME

On completion of the course the students are expected to

- Have learnt the basics of structural and mechanical behavior of refractory linings
- Have a sound knowledge about heat transfer in refractory linings

6. Have learnt about the wear of refractory linings.
7. Have a knowledge about basic principles of thermal design

UNIT I INTRODUCTION 9

Introduction-types of loading-Stress controlled and strain controlled loads –Design philosophy of structures based on load types –Material properties required for structural analysis.

UNIT II CRITERIA FOR SELECTION OF REFRACTORY MATERIALS 9

ASTM strength tests– Choosing best refractory for thermomechanical application – Verification from field test study- static compressive stress strain data-Creep data -Influence of stress state on the strength of refractories –Thermal expansion data

UNIT III REFRACTORY LININGS JOINTS 9

Joints –Refractory mortar joint fundamentals- finite element analysis of a mortar joint – behavior of structural masonry mortar joint-Influence of mortar joint thickness on mortar joint behavior - mechanical behavior of dry joint – Fundamental of refractory Hinges- Aspects of Hinge behavior -An

analytical study of Hinge joint

UNIT IV FUNDAMENTALS OF DIFFERENT LINING DESIGNS 9

Basics of refractory brick arch behavior – Fundamentals of brick lined cylindrical shells – Brick dome behavior –fundamentals of flat brick linings -Cylindrical refractory-lined vessel analysis –Refractory sprung arch – spherical refractory silica brick dome. Dos and Don'ts in Refractory lining design

UNIT V STRUCTURE –PROPERTY- PERFORMANCE STUDY 9

Correlation between structure and property-correlation between property and performance of refractories.-Postmortem studies – microstructural studies.

TOTAL: 45 PERIODS

TEXT BOOKS

1. C. A. Schacht, Refractory Linings: Thermo-mechanical Design and Applications, CRC Press, 1995.
2. S. C. Caniglia and G. L. Barna, Handbook of Industrial Refractories Technology, William Andrews Publishing, NY, 1992.

REFERENCES

1. C. A. Schacht, Refractories Handbook, CRC Press. , NY, 2004
2. S. Banerjee, The Changing Refractories Industry: New Technologies, Materials and Markets, Business Communication Co, 1999.

CT7020 SPECIAL COATING TECHNOLOGY L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a complete knowledge about the advanced ceramic coating technology processes, properties and applications.

OBJECTIVES

On completion of the course the students are expected to

- Have studied the classification and raw materials used for the special coatings.
- Have learnt in detail about enamel coating.
- Have studied the concept of vapour phase coatings.
- Have studied about the various special coating techniques.
- Have studied the properties and applications of special coatings.

UNIT I COATINGS – FUNDAMENTALS 9

Definition of thin film and coatings, preparation of substrate- Role of substrate- substrate selection- nucleation and thin film growth- residual stress, thickness measurements.

UNIT II VAPOUR PHASE COATINGS 9

PVD - basic evaporation process - evaporation techniques - sputtering – ion plating- CVD process- CVD reactor- CVD kinetics- product and process route.

UNIT III SPECIAL COATINGS 9

Plasma spray- pack coating- slurry coating- sol gel coating- hot dip coating- electrophoresis- electro chemical coating- corrosion resistant coating and other coatings.

UNIT IV SURFACE ANALYTICAL METHODS 9

XRD – glancing incidence, x-ray diffraction- electron microscopy techniques- auger electron spectroscopy, secondary ion mass spectroscopy, photoelectron spectroscopy.

UNIT V PROPERTIES AND APPLICATIONS 9

Thermal, mechanical. Optical and chemical properties- hardness- wear and erosion resistance- high temperature properties- applications- defects and remedies.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Hocking M.G.Vasantasree V Sidky PS, Metallic and Ceramic coatings, Longman, 1989.
2. Boriosenko Al, HighTemperature Protective Coatings,American Publishing Co., New Delhi, 1986.

REFERENCES

1. Lisa C Klien (Ed),Sol Gel Technique for Thin Films, Fibres, Performs, Electronis and Speciality Shapes, Noyes publications, New Jersy, 1988.
2. Orlando Auciello and Rainer Waser, Science and Technology of Electro ceramic Thin film, NATO ASI series- Kluwer Academic publishers, 1995.

CT7008 FUNCTIONAL GLASSES L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a thorough knowledge about the special applications of glasses in various fields.

OBJECTIVES

On completion of the course the students are expected to

- Have a clear understanding on the types and properties of heat resistant and safety glasses.
- Have studied the manufacture, types and applications of optical glasses.
- Have studied the composition of glass fibres and optical fibres, and their applications.
- Have learnt the composition, preparation and properties of glass ceramics.
- Have a knowledge on the methods and types of coatings on glass, their applications and quality control.

UNIT I HEAT RESISTANT AND SAFETY GLASSES 9

Borosilicate glasses – pyrex glass and jona type, composition – fabrication of laboratory ware – vycor glass. Safety glasses – toughened glass, laminated glass.

UNIT II OPTICAL GLASSES 9

Manufacture of crown and flint glass – ophthalmic glass filters – photo chromic glass – laser glass – electro chromic glass – GRIN lenses and components – chalcogenide, chalcohallide and halide glasses – applications in optical components.

UNIT III GLASS FIBRES 9

Composition for fibre glass, glass wool, manufacturing process and applications. Optical fibres – optical properties of fibres, silica based glass fibres – applications in optical communication.

UNIT IV GLASS CERAMICS 9

Glass composition, heat treatment schedule, crystal nucleation in glass, nucleating agent, microstructure and properties, applications, machinable glass ceramics.

UNIT V COATED GLASS 9

Coating methods – physical vapour deposition, chemical vapour deposition. Types of coatings, characteristics of coated glass, applications of coated glasses, quality control of coated glass.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Lewis M.H, Glasses and Glass Ceramics, Chapman and Hall, London, 1989.

2. Cable M and Parker M.J, High Performance Glasses, Chapman and Hall, NY, 1992.

REFERENCES

1. Heinz G.Plaender, Schott Guide to Glass, Chapman and Hall, 1996.
2. Hans Bach, Low Thermal Expansion Glass Ceramics, Springer, 1995.
3. Philips C.J, Glass, Its Industrial Applications, Reinhold Publishing Co., NY, 1960.

GE7073 FUNDAMENTALS OF NANOSCIENCE L T P C
3 0 0 3

OBJECTIVES:

To learn about basis of nanomaterial science, preparation method, types and application

UNIT I INTRODUCTION 8

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering-Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thinfilms-multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT II GENERAL METHODS OF PREPARATION 9

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III NANOMATERIALS 12

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, 92 Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides-ZnO, TiO_2,MgO, ZrO_2, NiO, nanoalumina, CaO, $AgTiO_2$, Ferrites, Nanoclays-functionalization and applications-Quantum wires, Quantum dotspreparation, properties and applications

UNIT IV CHARACTERIZATION TECHNIQUES 9

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation

UNIT V APPLICATIONS 7

NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nano biotechology: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will familiarize about the science of nanomaterials
- Will demonstrate the preparation of nanomaterials
- Will develop knowledge in characteristic nanomaterial

TEXT BOOKS

1. A.S. Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia, 1996.
2. N John Dinardo, "Nanoscale characterization of surfaces & Interfaces", 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000

REFERENCES

1. G Timp (Editor), "Nanotechnology", AIP press/Springer, 1999.
2. Akhlesh Lakhtakia (Editor),"The Hand Book of Nano Technology,Nanometer Structure, Theory, Modeling and Simulations". Prentice-Hall of India (P) Ltd, New Delhi, 2007.

GE7652 TOTAL QUALITY MANAGEMENT L T P C
3 0 0 3

AIM

To provide comprehensive knowledge about the principles, practices, tools and techniques of Total quality management.

OBJECTIVES

- To understand the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
- To understand the TQM Principles.
- To learn and apply the various tools and techniques of TQM.
- To understand and apply QMS and EMS in any organization.

UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality –Definition of TQM-- Basic concepts of TQM –-Gurus of TQM (Brief introduction) -- TQM Framework- Barriers to TQM –Benefits of TQM.

UNIT II TQM PRINCIPLES 9

Leadership--The Deming Philosophy, Quality council, Quality statements and Strategic planning--Customer Satisfaction –Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal--Continuous process improvement –Juran Trilogy, PDSA cycle, 5s and Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating and Relationship development.

UNIT III TQM TOOLS & TECHNIQUES I 9

The seven traditional tools of quality – New management tools – Six-sigma Process Capability– Bench marking – Reasons to bench mark, Bench marking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, Learning from the data, Using the findings, Pitfalls and Criticisms of Bench Marking – FMEA – Intent of FMEA, FMEA Documentation, Stages, Design FMEA and Process FMEA.

UNIT IV TQM TOOLS & TECHNIQUES II 9

Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures-- Cost of Quality - BPR.

UNIT V QUALITY MANAGEMENT SYSTEM 9

Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements—Implementation—Documentation—Internal Audits—Registration--**ENVIRONMENTAL MANAGEMENT SYSTEM:** Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001—Benefits of EMS.

TOTAL : 45 PERIODS

OUTCOMES:

- Ability to apply TQM concepts in a selected enterprise.
- Ability to apply TQM principles in a selected enterprise.
- Ability to apply the various tools and techniques of TQM.
- Ability to apply QMS and EMS in any organization.

TEXT BOOK:

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield,Mary B.Sacre,Hemant Urdhwareshe and Rashmi Urdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.

REFERENCES:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", (6th Edition), South-Western (Thomson Learning), 2005.
2. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.
3. Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006 .
4. Janakiraman,B and Gopal, R.K, "Total Quality Management – Text and Cases",Prentice Hall (India) Pvt. Ltd., 2006.

GE7071 DISASTER MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability,
- disasters, disaster prevention and risk reduction
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- To enhance awareness of institutional processes in the country and
- To develop rudimentary ability to respond to their surroundings with potential
- disaster response in areas where they live, with due sensitivity

UNIT I INTRODUCTION TO DISASTERS 9

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.

UNIT II APPROACHES TO DISASTER RISK REDUCTION (DRR) 9

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-

holders- Institutional Processes and Framework at State and Central Level- State Disaster Management Authority(SDMA) – Early Warning System – Advisories from Appropriate Agencies.

UNIT III INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT 9

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT IV DISASTER RISK MANAGEMENT IN INDIA 9

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

UNIT V DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS 9

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

TOTAL: 45 PERIODS

OUTCOMES:

On Completion of the course, the students should be able to:

- Differentiate the types of disasters, causes and their impact on environment and society
- Assess vulnerability and various methods of risk reduction measures as well as mitigation.
- Draw the hazard and vulnerability profile of India, Scenarios in the Indian context, Disaster damage assessment and management

TEXTBOOKS:

1. Singhal J.P. “Disaster Management”, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
2. Tushar Bhattacharya, “Disaster Science and Management”, McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10:** 1259007367, **ISBN-13:** 978-1259007361]
3. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011
4. Kapur Anu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, New Delhi, 2010.

REFERENCES:

1. Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005
2. Government of India, National Disaster Management Policy,2009.

GE7074 HUMAN RIGHTS L T P C
3 0 0 3

OBJECTIVE:

To sensitize the Engineering students to various aspects of Human Rights.

UNIT I 9

Human Rights – Meaning, origin and Development. Notion and classification of Rights – Natural, Moral and Legal Rights. Civil and Political Rights, Economic, Social and Cultural Rights; collective / Solidarity Rights.

UNIT II **9**

Evolution of the concept of Human Rights Magana carta – Geneva convention of 1864. Universal Declaration of Human Rights, 1948. Theories of Human Rights.

UNIT III **9**

Theories and perspectives of UN Laws – UN Agencies to monitor and compliance.

UNIT IV **9**

Human Rights in India – Constitutional Provisions / Guarantees.

UNIT V **9**

Human Rights of Disadvantaged People – Women, Children, Displaced persons and Disabled persons, including Aged and HIV Infected People. Implementation of Human Rights – National and State Human Rights Commission – Judiciary – Role of NGO's, Media, Educational Institutions, Social Movements.

TOTAL : 45 PERIODS

OUTCOME:

- Engineering students will acquire the basic knowledge of human rights.

REFERENCES:

1. Kapoor S.K., "Human Rights under International law and Indian Laws", Central Law Agency, Allahabad, 2014.
2. Chandra U., "Human Rights", Allahabad Law Agency, Allahabad, 2014.
3. Upendra Baxi, The Future of Human Rights, Oxford University Press, New Delhi.

GE7072	FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the global trends and development methodologies of various types of products and services
- To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
- To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification
- To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
- To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

UNIT I FUNDAMENTALS OF PRODUCT DEVELOPMENT 9

Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends **- Introduction to Product Development Methodologies and Management -** Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies **-** Product Life Cycle – Product Development Planning and Management.

UNIT II REQUIREMENTS AND SYSTEM DESIGN 9

Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - **System Design & Modeling -** Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.

UNIT III DESIGN AND TESTING 9

Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – **Challenges in Integration of Engineering Disciplines** - Concept Screening & Evaluation - **Detailed Design -** Component Design and Verification – **Mechanical, Electronics and Software Subsystems** - High Level Design/Low Level Design of S/W Program **-** Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – **Prototyping -** Introduction to Rapid Prototyping and Rapid Manufacturing - **System Integration, Testing, Certification and Documentation**

UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT 9

Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - **Sustenance -**Maintenance and Repair – Enhancements - **Product EoL -** Obsolescence Management – Configuration Management - EoL Disposal

UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY 9

The Industry - Engineering Services Industry - Product Development in Industry versus Academia –**The IPD Essentials -** Introduction to Vertical Specific Product Development processes -Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of the course, the students will be able to:

- Define, formulate and analyze a problem
- Solve specific problems independently or as part of a team
- Gain knowledge of the Innovation & Product Development process in the Business Context
- Work independently as well as in teams
- Manage a project from start to finish

TEXTBOOKS:

1. Book specially prepared by NASSCOM as per the MoU.
2. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011.
3. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.

REFERENCES:

1. Hiriyappa B, “Corporate Strategy – Managing the Business”, Author House, 2013.
2. Peter F Drucker, “People and Performance”, Butterworth – Heinemann [Elsevier], Oxford, 2004.
3. Vinod Kumar Garg and Venkita Krishnan N K, “Enterprise Resource Planning – Concepts”, Second Edition, Prentice Hall, 2003.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013