DEPARTMENT OF CERAMIC TECHNOLOGY

ANNA UNIVERSITY, CHENNAI

Vision:

Short Term Goal

- To develop infrastructure facilities for establishing ceramic laboratory with specialization on Traditional Ceramics, Structural Ceramics, Bio-Ceramics and Electronic Ceramics.
- To concentrate on development of research activities and generate funds through R&D projects.
- To serve as nodal centre for testing and quality analysis for catering the needs of Ceramic and Allied Industries in and around Tamilnadu.

Long Term Goal

- To develop processing and testing Centre for Excellence similar to that of CERAM, UK in the area of ceramics and cater the needs of Ceramic and Allied Industries.

Mission:

- To serve as a resource centre for Ceramic Science and Technology.
- To stimulate R&D activities in the technological and commercial development of new products and processes useful for the Ceramic and Allied Industries.
- To contribute to education in Ceramic Science and Technology.
- To conduct basic and applied programmes at the forefront of Ceramic Science and Technology which is relevant to the Indian Industry.

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ANNA UNIVERSITY: : CHENNAI: 600 025
UNIVERSITY DEPARTMENTS
B.TECH. CERAMIC TECHNOLOGY
REGULATIONS – 2019
CHOICE BASED CREDIT SYSTEM (CBCS)

1. **PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):**

I. To gain progress in manufacturing and Technology sector.
II. To have a vertical growth in managerial position and a competitive lead in an organization.
III. To provide a platform for educational advancement in career.
IV. To become a preferable consultant and a sorter to solve the practical problems of any organization.
V. To be an enterprising entrepreneur in the supply chain or a well-established executive.

2. **PROGRAMME OUTCOMES (POs):**

After going through the four years of study, our Ceramic Technology Graduates will exhibitability in:

	Graduate Attribute	Programme Outcome
PO1	Engineering knowledge	Enhance the knowledge in mathematics, basic science and engineering science.
PO2	Problem analysis	Capable of Identifying engineering problems and formulating tools to solve the same.
PO3	Design/development of solutions	Design a system or process to improve its performance within the constraints
PO4	Conduct investigations of complex problems	Ability to conduct experiments and collecting data, analyzing and drawing inferences.
PO5	Usage of Modern tools	Use modern tools and techniques to improve the efficiency of the system.
PO6	The Engineer and society	Ability to have Professional excellence and strive for societies upliftment
PO7	Environment and sustainability	Designto be environment consciouss and growth oriented
PO8	Ethics	To boost the industry, business and society in a professional and ethical manner.
PO9	Individual and team work	Composition of an integratedteam.
PO10	Communication	Proficiency in oral and written Communication.
PO11	Project management and finance	To be innovatively progressive within resources
PO12	Life-long learning	Continue professional development and learning as a life-long activity.

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3. PROGRAM SPECIFIC OUTCOMES (PSOs):

By the completion of Ceramic Technology program the student will have the following Program specific outcomes.

1. Foundation of Basic Engineering and Computer Programming: Ability to understand the Engineering principles and computer programming. Students can solve basic Engineering concepts and fundamental programming in computer language.

2. Foundations of Traditional Ceramics: Ability to understand the formulation, processing and development of traditional Ceramic bodies. Possess professional skills and knowledge on manufacturing and testing of Traditional Ceramics. Familiarity and practical competence with a broad range of Traditional Ceramic products.

3. Foundation of Advanced Ceramics: Ability to understand the formulation, processing and development of Advanced Ceramics. Possess professional skills and knowledge on manufacturing properties and testing of Advanced Ceramics. Ability to apply methodologies to solve practical problems, model real world problem using appropriate Technologies.

4. Applications of Ceramics and Research Ability: Ability to use knowledge of Ceramic materials and processing in various Applications in order to identify the research gaps and hence to provide solution by new ideas and innovations

4. PEO / PO Mapping:

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
I	3	3	3	3	3			2	3			3
II			3	3		3		2	3		3	3
III	3		2	3	2							
IV				3	2	3	3	2			3	
V	3	3	3	3	2					2	3	3

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Mapping of Course Outcomes and Programme Outcomes

		CourseName	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
YEAR 1	Semester1	Technical English												
		Engineering Mathematics I												
		Engineering Physics												
		Engineering Chemistry												
		Engineering Graphics												
		Problem Solving and Python Programming												
		Basic Sciences Laboratory												
		Problem Solving and Python Programming Laboratory												
	Semester2	Professional Communication												
		Engineering Mathematics II												
		Engineering Mechanics												
		Basics of Mechanical and Civil Engineering	3	3	2									
		Basics of Chemical Engineering	3	3	2	2	2							
		Elements of Ceramics	3	3	2	2								
		Workshop Practices Laboratory												
		Basic Chemical Engineering Laboratory												

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YEAR 2	Semester 3	Probability and Statistics												
		Basics of Electrical and Electronics Engineering												
		Elective - Humanities I												
		Processing of Ceramic Raw Materials		3	2	3	2							
		Ceramic Raw Materials		2	2	2			3					
		Materials Science – I	3	3	2	2	2							
		Processing of Ceramic Raw Materials Laboratory		3	2	2								
		Ceramic Raw Materials Analysis Laboratory		3	2	2								
	Semester4	Total Quality Management												
		Environmental Science			2				3	3				
		Traditional Ceramics	3	2	2			3						
		Materials Science II	3	3	2	2	2							
		Thermodynamics of Materials	3	3	2	2	2							
		Ceramic Fabrication Processes	3	3	2	2	2							
		Audit Course - I												

		Traditional Ceramics Laboratory		3	3	3								
		Materials Science Laboratory		3	3	3								
YEAR 3	Semester5	Elective – Humanities I												
		Refractory – I		3	2	2	2							
		Glass Engineering - I		3	2	2	2							
		Professional Elective - I												
		Professional Elective - II												
		Audit Course - II												
		Glass and Coatings Laboratory		3	3	3								
		CAD Laboratory		3	3	3	3							
		Creative and Innovative Project	3	3	3	3	3	3	3	3	3	3	3	3
	Semester6	Glass Engineering - II		3	2	2	2		3					3
		Refractory – II		3	2	2	2		3					3
		Advanced Ceramic Processing		3	2	2	3		3					3
		Professional Elective - III												
		Open Elective– I												
		Refractory Laboratory		3	3	3								

		Advanced Ceramic Processing Laboratory		3	3	3	3							3
YEAR 4	Semester7	Ceramic Characterization		3	2	2	3		2					3
		Professional Elective– IV												
		Professional Elective– V												
		Open Elective– II												
		Ceramic Characterization Laboratory		3	3	3	3							3
		Comprehension	3	2								3		3
		Project I	3	3	3	3	3	3	3	3	3	3	3	3
		Internship / Training (Minimum 4 Weeks)	3	3	3	3	3	3	3	3	3	3	3	3
	Semester8	Professional Elective - VI												
		Professional Elective - VII												
		Project II	3	3	3	3	3	3	3	3	3	3	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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COURSE TITLE	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Unshaped Refractories		3	2	2	2							
Fuels and Energy Engineering	3	3	2	2	2							
Plant Equipment and Furnace Design	3	3	2	2	2							
Cement Technology		3	2	2	2							
Abrasive Technology		3	2	2	2							
Glass Ceramic Technology		3	2	2	2							
Electronic Ceramics		3	2	2	2							
Fuel Cells and Sensors		3	2	2	2							
Materials for Energy Devices	3	3	2	2	2							
Sol-Gel Science	3	3	2	2	2							
Nuclear and Space Ceramics	3	3	2	2	2							
Thin Film Coating Technology	3	3	2	2	2							
Bio Ceramics		3	2	2	2							
Nano Ceramics												
Functional Ceramics		3	2	2	2							
Fiber and Composites		3	2	2	2							
Machining and Joining of Ceramics	3	3	2	2	2							
Microwave processing of Ceramics	3	3	2	2	2							

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Non Destructive Material Testing	3	3	2	2	2							
Materials and Metallurgy		3	2	2	2							
Phase Equilibria of Ceramics	3	3	2	2	2							
Sintering of Ceramics	3	3	2	2	2							
Ceramic Waste Recovery & Management	3	3	2	2	2							
Mechanical Behavior of Ceramics												
Glazing and Enameling												

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UNIVERSITY DEPARTMENTS
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REGULATIONS – 2019
CHOICE BASED CREDIT SYSTEM
CURRICULUMAND SYLLABI FOR I TO VIII SEMESTERS

SEMESTER I

SI. NO.	CODE NO.	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	HS5151	Technical English	HSMC	4	0	0	4	4
2.	MA5158	Engineering Mathematics I	BSC	3	1	0	4	4
3.	PH5151	Engineering Physics	BSC	3	0	0	3	3
4.	CY5151	Engineering Chemistry	BSC	3	0	0	3	3
5.	GE5151	Engineering Graphics	ESC	1	0	4	5	3
6.	GE5153	Problem Solving and Python Programming	ESC	3	0	0	3	3
PRACTICALS								
7.	BS5161	Basic Sciences Laboratory	BSC	0	0	4	4	2
8.	GE5161	Problem Solving and Python Programming Laboratory	ESC	0	0	4	4	2
			TOTAL	**17**	**1**	**12**	**30**	**24**

SEMESTER II

SI. NO.	CODE NO.	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	HS5251	Professional Communication	HSMC	4	0	0	4	4
2.	MA5252	Engineering Mathematics II	BSC	3	1	0	4	4
3.	GE5152	Engineering Mechanics	ESC	4	0	0	4	4
4.	GE5201	Basics of Mechanical and Civil Engineering	ESC	3	0	0	3	3
5.	CT5201	Basics of Chemical Engineering	PCC	3	1	0	4	4
6.	CT5202	Elements of Ceramics	PCC	3	0	0	3	3
PRACTICALS								
7.	GE5162	Workshop Practices Laboratory	ESC	0	0	4	4	2
8.	CT5211	Basic Chemical Engineering Laboratory	PCC	0	0	2	2	1
			TOTAL	**20**	**2**	**6**	**28**	**25**

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SEMESTER III

SI. NO.	CODE NO.	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA5354	Probability and Statistics	BSC	3	1	0	4	4
2.	EE5251	Basics of Electrical and Electronics Engineering	ESC	3	0	0	3	3
3.		Elective - Humanities I	HSMC	3	0	0	3	3
4.	CT5301	Processing of Ceramic Raw Materials	PCC	3	0	0	3	3
5.	CT5302	Ceramic Raw Materials	PCC	3	0	0	3	3
6.	CT5303	Materials Science – I	PCC	3	0	0	3	3
PRACTICALS								
7.	CT5311	Processing of Ceramic Raw Materials Laboratory	PCC	0	0	4	4	2
8.	CT5312	Ceramic Raw Materials Analysis Laboratory	PCC	0	0	4	4	2
			TOTAL	**18**	**2**	**8**	**28**	**23**

SEMESTER IV

SI. NO.	CODE NO.	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	GE5451	Total Quality Management	HSMC	3	0	0	3	3
2.	GE5251	Environmental Sciences	BSC	3	0	0	3	3
3.		Audit Course - I*	AC	3	0	0	3	0
4.	CT5401	Traditional Ceramics	PCC	3	0	0	3	3
5.	CT5402	Materials Science - II	PCC	3	0	0	3	3
6.	CT5403	Thermodynamics of Materials	PCC	2	1	0	3	3
7.	CT5404	Ceramic Fabrication Processes	PCC	3	0	0	3	3
PRACTICALS								
8.	CT5411	Traditional Ceramics Laboratory	PCC	0	0	4	4	2
9.	CT5412	Materials Science Laboratory	PCC	0	0	4	4	2
			TOTAL	**17**	**1**	**8**	**26**	**22**

***** Audit Courseis optional

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SEMESTER V

SI. NO.	CODE NO.	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Elective - Humanities I	HSMC	3	0	0	3	3
2.		Audit Course - II*	AC	3	0	0	3	0
3.	CT5501	Refractory – I	PCC	3	0	0	3	3
4.	CT5502	Glass Engineering -I	PCC	3	0	0	3	3
5.		Professional Elective - I	PEC	3	0	0	3	3
6.		Professional Elective - II	PEC	3	0	0	3	3
PRACTICALS								
7.	CT5511	Glass and Coatings Laboratory	PCC	0	0	4	4	2
8.	CT5512	CAD Laboratory	PCC	0	0	2	2	1
9.	CT5513	Creative and Innovative Project	EEC	0	0	4	4	2
			TOTAL	**18**	**0**	**10**	**28**	**20**

***** Audit Courseis optional

SEMESTER VI

SI. NO.	CODE NO.	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	CT5601	Glass Engineering - II	PCC	3	0	0	3	3
2.	CT5602	Refractory – II	PCC	3	0	0	3	3
3.	CT5603	Advanced Ceramic Processing	PCC	3	0	0	3	3
4.		Professional Elective - III	PEC	3	0	0	3	3
5.		Open Elective– I	OEC	3	0	0	3	3
PRACTICALS								
6.	CT5611	Refractory Laboratory	PCC	0	0	4	4	2
7.	CT5612	Advanced Ceramic Processing Laboratory	PCC	0	0	4	4	2
8.	CT5714	Internship / Training (Minimum 4 Weeks)*	EEC	-	-	-	-	-
			TOTAL	**15**	**0**	**8**	**23**	**19**

***** Students have to undergo Internship / Training for a period of 4 weeks during summer and assessments will be done during VII semester.

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SEMESTER VII

SI. NO.	CODE NO.	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	CT5701	Ceramic Characterization	PCC	3	0	0	3	3
2.		Professional Elective - IV	PCC	3	0	0	3	3
3.		Professional Elective– V	PEC	3	0	0	3	3
4.		Open Elective– II	OEC	3	0	0	3	3
PRACTICALS								
5.	CT5711	Ceramic Characterization Laboratory	PCC	0	0	4	4	2
6.	CT5712	Comprehension	EEC	0	0	2	2	1
7.	CT5713	Project I	EEC	0	0	6	6	3
8.	CT5714	Internship / Training (Minimum 4 Weeks)	EEC	-	-	-	-	2
			TOTAL	**12**	**0**	**12**	**24**	**20**

SEMESTER VIII

SI. NO.	CODE NO.	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective - VI	PEC	3	0	0	3	3
2.		Professional Elective - VII	PEC	3	0	0	3	3
PRACTICALS								
3.	CT5811	Project II	EEC	0	0	16	16	8
			TOTAL	**6**	**0**	**16**	**22**	**14**

TOTAL CREDITS :167

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PROFESSIONAL ELECTIVE

SI. NO.	CODE NO.	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CT5001	Unshaped Refractories	PEC	3	0	0	3	3
2.	CT5002	Fuels and Energy Engineering	PEC	3	0	0	3	3
3.	CT5003	Plant Equipment and Furnace Design	PEC	3	0	0	3	3
4.	CT5004	Cement Technology	PEC	3	0	0	3	3
5.	CT5005	Abrasive Technology	PEC	3	0	0	3	3
6.	CT5006	Glass Ceramic Technology	PEC	3	0	0	3	3
7.	CT5007	Electronic Ceramics	PEC	3	0	0	3	3
8.	CT5008	Fuel Cells and Sensors	PEC	3	0	0	3	3
9.	CT5009	Materials for Energy Devices	PEC	3	0	0	3	3
10.	CT5010	Sol-Gel Science	PEC	3	0	0	3	3
11.	CT5011	Nuclear and Space Ceramics	PEC	3	0	0	3	3
12.	CT5012	Thin Film Coating Technology	PEC	3	0	0	3	3
13.	CT5013	Bio Ceramics	PEC	3	0	0	3	3
14.	CT5014	Nano Ceramics	PEC	3	0	0	3	3
15.	CT5015	Functional Ceramics	PEC	3	0	0	3	3
16.	CT5016	Fiber and Composites	PEC	3	0	0	3	3
17.	CT5017	Machining and Joining of Ceramics	PEC	3	0	0	3	3
18.	CT5018	Microwave processing of Ceramics	PEC	3	0	0	3	3
19.	CT5019	Non Destructive Material Testing	PEC	3	0	0	3	3
20.	CT5020	Materials and Metallurgy	PEC	3	0	0	3	3
21.	CT5021	Phase Equilibria of Ceramics	PEC	3	0	0	3	3
22.	CT5022	Sintering of Ceramics	PEC	3	0	0	3	3
23.	CT5023	Ceramic Waste Recovery & Management	PEC	3	0	0	3	3
24.	CT5024	Mechanical Behavior of Ceramics	PEC	3	0	0	3	3
25.	CT5025	Glazing and Enameling	PEC	3	0	0	3	3

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HUMANITIES AND SOCIAL SCIENCES (HSMC) – MANAGEMENT AND OTHERS						
Sl. No.	**Course No.**	**Course Title**	**L**	**T**	**P**	**C**
1.	HS5151	Technical English	4	0	0	4
2.	HS5251	Professional Communication	4	0	0	4
3.	GE5451	Total Quality Management	3	0	0	3
					Total Credits	**11**

HSMC– ELECTIVES – HUMANITIES I (ODD SEMESTER)

Sl. No	Course Code	Course Title	Periods per week			Credits
			Lecture	Tutorial	Practical	
1.	HU5171	Language and Communication	3	0	0	3
2.	HU5172	Values and Ethics	3	0	0	3
3.	HU5173	Human Relations at Work	3	0	0	3
4.	HU5174	Psychological Process	3	0	0	3
5.	HU5175	Education, Technology and Society	3	0	0	3
6.	HU5176	Philosophy	3	0	0	3
7.	HU5177	Applications of Psychology in Everyday Life	3	0	0	3

BASIC SCIENCE COURSE(BSC)						
Sl. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1.	MA5158	Engineering Mathematics I	3	1	0	4
2.	PH5151	Engineering Physics	3	0	0	3
3.	CY5151	Engineering Chemistry	3	0	0	3
4.	BS5161	Basic Science Laboratory	0	0	4	2
5.	MA5252	Engineering Mathematics II	3	1	0	4
6.	MA5354	Probability and Statistics	3	1	0	4
7.	GE5251	Environmental Sciences	3	0	0	3
					Total Credits	**23**

ENGINEERING SCIENCE COURSE(ESC)						
Sl. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1.	GE5151	Engineering Graphics	1	0	4	3
2.	GE5153	Problem Solving and Python Programming	3	0	0	3
3.	GE5161	Problem Solving and Python Programming Laboratory	0	0	4	2
4.	GE5152	Engineering Mechanics	3	1	0	4
5.	GE5201	Basics of Mechanical and Civil Engineering	3	0	0	3
6.	GE5162	Workshop Practices Laboratory	0	0	4	2
7.	EE5251	Basics of Electrical and Electronics Engineering	3	0	0	3
					Total Credits	**20**

PROFESSIONAL CORE COURSES (PCC)						
Sl. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1.	CT5201	Basics of Chemical Engineering	3	1	0	4
2.	CT5202	Elements of Ceramics	3	0	0	3
3.	CT5211	Basic Chemical Engineering Laboratory	0	0	2	1
4.	CT5301	Processing of Ceramic Raw Materials	3	0	0	3
5.	CT5302	Ceramic Raw Materials	3	0	0	3
6.	CT5303	Materials Science – I	3	0	0	3
7.	CT5311	Processing of Ceramic Raw Materials Laboratory	0	0	4	2
8.	CT5312	Ceramic Raw Materials Analysis Laboratory	0	0	4	2
9.	CT5401	Traditional Ceramics	3	0	0	3
10.	CT5402	Materials Science - II	3	0	0	3
11.	CT5403	Thermodynamics of Materials	2	1	0	3
12.	CT5404	Ceramic Fabrication Processes	3	0	0	3
13.	CT5411	Traditional Ceramics Laboratory	0	0	4	2
14.	CT5412	Materials Science Laboratory	0	0	4	2
15.	CT5501	Refractory – I	3	0	0	3
16.	CT5502	Glass Engineering -I	3	0	0	3
17.	CT5511	Glass and Coatings Laboratory	0	0	4	2

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18.	CT5512	CAD Laboratory	0	0	2	1
19.	CT5601	Glass Engineering - II	3	0	0	3
20.	CT5602	Refractory – II	3	0	0	3
21.	CT5603	Advanced Ceramic Processing	3	0	0	3
22.	CT5611	Refractory Laboratory	0	0	4	2
23.	CT5612	Advanced Ceramic Processing Laboratory	0	0	4	2
24.	CT5701	Ceramic Characterization	3	0	0	3
25.	CT5711	Ceramic Characterization Laboratory	0	0	4	2
					Total Credits	**64**

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

Sl. No.	CODE No.	COURSE TITLE	L	T	P	Credits
1.	CT5513	Creative and Innovative Project	0	0	4	2
2.	CT5714	Internship / Training (Minimum 4 Weeks)	0	0	0	2
3..	CT5713	Project I	0	0	6	3
4.	CT5811	Project II	0	0	16	8
5.	CT5712	Comprehension	0	0	2	1
					Total Credits	**16**

AUDIT COURSES (AC)
Registration for any of these courses is optional to students

Sl. No.	Course Code	Course Title	Periods per week			Credits	Semester
			Lecture	Tutorial	Practical		
1.	AD5091	Constitution of India	3	0	0	0	4/5
2.	AD5092	Value Education	3	0	0	0	
3.	AD5093	Pedagogy Studies	3	0	0	0	
4.	AD5094	Stress Management by Yoga	3	0	0	0	
5.	AD5095	Personality Development Through Life Enlightenment Skills	3	0	0	0	
6.	AD5096	Unnat Bharat Abhiyan	3	0	0	0	
7.	AD5097	Essence of Indian Knowledge Tradition	3	0	0	0	
8.	AD5098	Sanga Tamil Literature Appreciation	3	0	0	0	

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SUMMARY

Ceramic Technology									
S. No	**Subject Area**	**Credits per Semester**							**Credits Total**
		I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**
1.	Humanities and Social Sciences including Management Courses (HSMC)	4	4	3	3	3				**17**
2.	Basic Science Courses (BSC)	12	4	4	3					**23**
3.	Engineering Science Course (ESC)	8	9	3						**20**
4.	Professional core courses (PCC)		8	13	16	9	13	8		**64**
5.	Professional Elective Course (PEC)					6	3	6	6	**21**
6.	Open Elective Courses (OEC)						3	3		**6**
7.	Employability Enhancement Course (EEC)					2		6	8	**16**
8.	Audit Course(AC) (Non Credit)				0	0				**0**
	Total Credits	**24**	**25**	**23**	**22**	**17**	**19**	**23**	**14**	**167**

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SYLLABI

HS5151 TECHNICAL ENGLISH **L T P C**
4 0 0 4

OBJECTIVES:

The first semester English course entitled 'Technical English ' aims to,

- Familiarise first year students of engineering and technology with the fundamental aspects of technical English.
- Develop all the four language skills by giving sufficient practice in the use of the skills in real life contexts.
- Enhance the linguistic and communicative competence of first year engineering and technology students.

UNIT I INTRODUCING ONESELF 12

Listening: Listening and filling a form, listening to speeches by specialists from various branches of engineering and completing activities such as answering questions, identifying the main ideas of the listening text, style of the speaker (tone and tenor) – **Speaking**: Introducing oneself –introducing friend/ family - **Reading:** Descriptive passages (from newspapers / magazines)- **Writing**: Writing a paragraph (native place, school life)- **Grammar:** Simple present, present continuous – **Vocabulary Development**: One word substitution

UNIT II DIALOGUE WRITING 12

Listening: Listening to conversations (asking for and giving directions) –**Speaking:** making conversation using (asking for directions, making an enquiry), Role plays-dialogues- **Reading:** Reading a print interview and answering comprehension questions-**Writing**: Writing a checklist, Dialogue writing- **Grammar**: Simple past – question formation (Wh-questions, Yes or No questions, Tag questions)-**VocabularyDevelopment**: Stress shift, lexical items related to the theme of the given unit.

UNIT III FORMAL LETTER WRITING 12

Listening: Listening to speeches by famous people and identifying the central message of the speech – answering multiple-choice questions)-**Speaking:** Giving short talks on a given topic- **Reading:** Reading motivational essays on famous engineers and technologists (answering open-ended and closed questions)-**Writing:** Writing formal letters/ emails (Complaint letters)-**Grammar**: Future Tense forms of verbs, subject and verb agreement- **Vocabulary Development**: Collocations – Fixed expressions

UNIT IV WRITING COMPLAINT LETTERS 12

Listening: Listening to short talks (5 minutes duration and fill a table, gap-filling exercise) note taking/note making- **Speaking:** Small group discussion, giving recommendations- **Reading:** Reading problem – solution articles/essays drawn from various sources- **Writing:** Making recommendations – Writing a letter/ sending an email to the Editor- note making- **Grammar:** Modals – Phrasal verbs – cause and effect sentences- **Vocabulary Development**: Connectives, use of cohesive devices in writing, technical vocabulary.

UNIT V WRITING DEFINITIONS AND PRODUCT DESCRIPTION 12

Listening: Listening to a product description (labeling and gap filling) exercises- **Speaking:** Describing a product and comparing and contrasting it with other products- **Reading**: Reading graphical material for comparison (advertisements)-**Writing:** Writing Definitions (short and long) – compare and contrast paragraphs- **Grammar:** Adjectives – Degrees of comparison - compound nouns- **Vocabulary Development**: Use of discourse markers – suffixes (adjectival endings).

TOTAL : 60 PERIODS

Learning Outcomes

At the end of the course the students will have gained,

- Exposure to basic aspects of technical English.
- The confidence to communicate effectively I various academic situations.

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- Learnt the use of basic features of Technical English

Textbook:

1. Revised Edition of 'English for Engineers and Technologists' Volume 1 published by Orient Black Swan Limited 2019.

Assessment Pattern

- Assessments will assess all the four skills through both pen and paper and computer based tests.
- Assessments can be pen and paper based, quizzes.

MA5158	ENGINEERING MATHEMATI CS – I (Common to all branches of B.E. / B.Tech. Programmes in I Semester)	L 3	T 1	P 0	C 4

OBJECTIVES:

- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To familiarize the students with differential calculus.
  - To familiarize the student with functions of several variables. This is needed in many branches of engineering.
  - To make the students understand various techniques of integration.
  - To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

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 DIFFERENTIAL CALCULUS **12**

Limit of function – One sided limit – Limit Laws – Continuity – left and right continuity – types of discontinuities – Intermediate Value Theorem – Derivatives of a function - Differentiation rules – Chain rule – Implicit differentiation – logarithmic differentiation – Maxima and minima – Mean value theorem – (Optional: Polar coordinate system – Differentiation in polar coordinates).

UNIT III FUNCTIONS OF SEVERAL VARIABLES **12**

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 IV 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.

12

UNIT V MULTIPLE INTEGRALS

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.

TOTAL :60 PERIODS

OUTCOMES:

At the end of the course the students will be able to

- Use the matrix algebra methods for solving practical problems.
- Apply differential calculus tools n solving various application problems.
- Able to use differential calculus ideas on several variable functions.
- Apply different methods of integration in solving practical problems.
- Apply multiple integral ideas in solving areas, volumes and other practical problems.

TEXTBOOKS:

1. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, 44th Edition, New Delhi, 2017.
2. James Stewart, "Calculus with Early Transcendental Functions", Cengage Learning, 6th Edition, New Delhi,2013.
3. Joel Hass, Christopher Heil and Maurice D.Weir, "Thomas' Calculus", Pearson, 14th Edition, New Delhi, 2018.
4. Narayanan S. and Manicavachagom Pillai T. K., “Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.

REFERENCES:

1. Bali N., Goyal M. and Watkins C., “Advanced Engineering Mathematics”, Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), 7th Edition, New Delhi, 2009.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2015.
3. Greenberg M.D., “Advanced Engineering Mathematics”, Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
4. Jain R.K. and Iyengar S.R.K., “Advanced Engineering Mathematics”,Narosa Publications, 5th Edition, New Delhi, 2017.
5. Peter V.O’Neil, “Advanced Engineering Mathematics”, Cengage Learning India Pvt., Ltd, 7th Edition, New Delhi , 2012.
6. Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

PH5151 **ENGINEERING PHYSICS** **L T P C**

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

OBJECTIVE

- To make the students in understanding the importance of mechanics.
- To equip the students on the knowledge of electromagnetic waves.
- To introduce the basics of oscillations, optics and lasers.
- To enable the students in understanding the importance of quantum physics.
- To elucidate the application of quantum mechanics towards the formation of energy bands in crystalline materials.

UNIT I MECHANICS 9

Moment of inertia (M.I) - Radius of gyration - Theorems of M .I - M.I of circular disc, solid cylinder , hollow cylinder , solid sphere and hollow sphere - K.E of a rotating body – M.I of a diatomic molecule – Rotational energy state of a rigid diatomic molecule - centre of mass – conservation of linear momentum – Relation between Torque and angular momentum - Torsional pendulum.

UNIT II ELECTROMAGNETIC WAVES 9

Gauss's law – Faraday's law - Ampere's law - The Maxwell's equations - wave equation; Plane electromagnetic waves in vacuum, Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

UNIT III OSCILLATIONS, OPTICS AND LASERS 9

Simple harmonic motion - resonance - waves on a string - standing waves - traveling waves - Energy transfer of a wave - sound waves - Doppler effect - reflection and refraction of light waves - total internal reflection - interference - interferometers - air wedge experiment. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients - population inversion - Nd-YAG laser, CO_2 laser, semiconductor laser - applications.

UNIT IV BASIC QUANTUM MECHANICS 9

Photons and light waves - Electrons and matter waves - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization - Particle in a infinite potential well - Normalization, probabilities and the correspondence principle.

UNIT V APPLIED QUANTUM MECHANICS 9

The harmonic oscillator - Barrier penetration and quantum tunneling - Tunneling microscope - Resonant diode - Finite potential wells - particle in a three dimensional box - Bloch's theorem for particles in a periodic potential, Kronig-Penney model and origin of energy bands.

TOTAL: 45 PERIODS

OUTCOMES:

After completion of this course, the students should able to

- Understanding the importance of mechanics.
- Express the knowledge of electromagnetic waves.
- Know the basics of oscillations, optics and lasers.
- Understanding the importance of quantum physics.
- Apply quantum mechanical principles towards the formation of energy bands in crystalline materials.

TEXT BOOKS:

1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education, 2017.
2. D.Halliday, R.Resnick and J.Walker. Principles of Physics. John Wiley & Sons, 2015.
3. N.Garcia, A.Damask and S.Schwarz. Physics for Computer Science Students. Springer-Verlag, 2012.

REFERENCES:

1. R.Wolfson. Essential University Physics. Volume 1 & 2. Pearson, 2016.
2. D.J.Griffiths. Introduction to Electrodynamics. Pearson Education, 2015
3. K.Thyagarajan and A.Ghatak. Lasers: Fundamentals and Applications. Springer, 2012.

CY5151 ENGINEERING CHEMISTRY (COMMON TO ALL BRANCHES) **L T P C 3 0 0 3**

OBJECTIVES:

- To introduce the basic concepts of polymers, their properties and some of the important applications.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To facilitate the understanding of the laws of photochemistry, photoprocesses and instrumentation & applications of spectroscopic techniques.
- To familiarize the operating principles and applications of energy conversion, its processes and storage devices.
- To inculcate sound understanding of water quality parameters and water treatment techniques.

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. Structure, Properties and uses of: PE, PVC, PC, PTFE, PP, Nylon 6, Nylon 66, Bakelite, Epoxy; Conducting polymers – polyaniline and polypyrrole.

UNIT II NANOCHEMISTRY **9**

Basics-distinction between molecules, nanomaterials and bulk materials; size-dependent properties. Types –nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro spinning. Characterization - Scanning Electron Microscope and Transmission Electron Microscope - Principle and instrumentation (block diagram). Properties (optical, electrical, mechanical and magnetic) and Applications of nanomaterials - medicine, agriculture, electronics and catalysis.

UNIT III PHOTOCHEMISTRY AND SPECTROSCOPY **9**

Photochemistry: Laws of photochemistry - Grotthuss-Draper law, Stark-Einstein law and Lambert-Beer Law (derivation and problems). Photo physical processes – Jablonski diagram. Chemiluminescence, photo-sensitization and photoquenching – mechanism and examples. Spectroscopy: Electromagnetic spectrum - absorption of radiation - electronic, vibrational and rotational transitions. Width and intensities of spectral lines.Atomic absorption spectroscopy, UV-Vis and IR spectroscopy- principles, instrumentation (Block diagram) and applications.

UNIT IV ENERGY CONVERSIONS AND STORAGE 9

Nuclear fission - controlled nuclear fission - nuclear fusion - differences between nuclear fission and fusion - nuclear chain reactions - nuclear energy - light water nuclear power plant – fast breeder reactor.Solar energy conversion - solar cells. Wind energy. Batteries - types of batteries – primary battery (dry cell), secondary battery (lead acid, nickel-cadmium and lithium-ion-battery). Fuel cells – H_2-O_2 and microbial fuel cell. Explosives – classification, examples: TNT, RDX, Dynamite; Rocket fuels and propellants – definition and uses.

UNIT V WATER TECHNOLOGY 9

Water – sources and impurities – water quality parameters: colour, odour, pH, hardness, alkalinity, TDS, COD and BOD. Boiler feed water – requirement – troubles (scale & sludge, caustic embrittlement, boiler corrosion and priming & foaming. Internal conditioning – phosphate, calgon and carbonate treatment. External conditioning - zeolite (permutit) and ion exchange demineralization. Municipal water treatment process – primary (screening, sedimentation and coagulation), secondary (activated sludge process and trickling filter process) and tertiary (ozonolysis, UV treatment, chlorination, reverse osmosis).

TOTAL: 45 PERIODS

OUTCOMES:

- To recognize and apply basic knowledge on different types of polymeric materials, their general preparation methods and applications to futuristic material fabrication needs.
- To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.
- To identify and apply suitable spectroscopic technique for material analysis and study different forms of photochemical reactions.
- To recognize different forms of energy resources and apply them for suitable applications in energy sectors.
- To demonstrate the knowledge of water and their quality in using at different industries.

TEXT BOOKS:

1. Jain P. C. & Monica Jain., “Engineering Chemistry”, 16th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.
2. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
3. S.S.Dara, “A text book of Engineering Chemistry”, Chand Publications, 2014.

REFERENCE BOOKS:

1. Schdeva M V, “Basics of Nano Chemistry”, Anmol Publications Pvt Ltd
2. B.Sivasankar, “Instrumental Methods of Analysis”, Oxford University Press. 2012.
3. Friedrich Emich, “Engineering Chemistry”, Scientific International Ltd.
4. V RGowariker, N V Viswanathan and Jayadev Sreedhar, “Polymer Science” New AGE International Publishers, 2009.

GE5151 **ENGINEERING GRAPHICS** **L T P C**
1 0 4 3

COURSE OBJECTIVES: The main learning objective of this course is to prepare the students for:

1. Drawing free hand sketches of basic geometrical shapes and multiple views of objects.
2. Drawing orthographic projections of lines and planes.
3. Drawing orthographic projections of solids.
4. Drawing development of the surfaces of objects.
5. Drawing isometric and perspective views of simple solids.

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.

UNITI PLANE CURVES AND FREE HANDSKETCHING **14**

Basic Geometrical constructions, Curves used in engineering practices-Conics – Construction of ellipse, parabola and hyperbola by different methods – 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

UNITII PROJECTION OF POINTS, LINES AND PLANE SURFACES **15**

Orthographic projection- principles-Principle 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.

UNITIII PROJECTION OF SOLIDS **15**

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 **15**

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 **12**

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

TOTAL (L: 15 + P: 60)=75 PERIODS

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

1. Draw free hand sketching of basic geometrical shapes and multiple views of objects.
2. Draw orthographic projections of lines and planes
3. Draw orthographic projections of solids
4. Draw development of the surfaces of objects
5. Draw isometric and perspective views of simple solids.

TEXT BOOKS:

1. Bhatt, N. D.,Panchal V M and Pramod R. Ingle, "Engineering Drawing", Charotar Publishing House, 53rd Edition, 2014.
2. Parthasarathy, N. S. and Vela Murali, "Engineering Drawing", Oxford University Press, 2015

REFERENCES:

1. Agrawal, B. and Agrawal C.M., "Engineering Drawing", Tata McGraw, N.Delhi, 2008.
2. Gopalakrishna, K. R., "Engineering Drawing", Subhas Stores, Bangalore, 2007.
3. Natarajan, K. V., "A text book of Engineering Graphics", 28thEd., Dhanalakshmi Publishers, Chennai, 2015.
4. Shah, M. B., and Rana, B. C., "Engineering Drawing", Pearson, 2ndEd., 2009.
5. Venugopal, K. and Prabhu Raja, V., "Engineering Graphics", New Age,2008.

Publication of Bureau of Indian Standards:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing 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.
4. The students will be permitted to use appropriate scale to fit solution within A3 size.
5. The examination will be conducted in appropriate sessions on the same day.

GE5153 PROBLEM SOLVING AND PYTHON PROGRAMMING L T P C
3 0 0 3

OBJECTIVES:

- To know the basics of algorithmic problem solving.
- To develop Python programs with conditionals and loops.
- To define Python functions and use function calls.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

UNIT I INTRODUCTION TO COMPUTING AND PROBLEM SOLVING 9

Fundamentals of Computing – Computing Devices – Identification of Computational Problems – Pseudocodesand Flowcharts – Instructions – Algorithms – Building Blocks of Algorithms – Introduction to Python Programming – Python Interpreter and Interactive Mode – Variables and Identifiers – Arithmetic Operators– Values and Types – Statements.

Suggested Activities:

- Developing Pseudocodes and flowcharts for real life activities such as railway ticket booking using IRCTC, admission process to undergraduate course, academic schedules during a semester etc.

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- Developing algorithms for basic mathematical expressions using arithmetic operations.
- Installing Python.
- Simple programs on print statements, arithmetic operations.

Suggested Evaluation Methods:

- Assignments on pseudocodes and flowcharts.
- Tutorials on Python programs.

UNIT II CONDITIONALS AND FUNCTIONS 9

Operators – Boolean Values – Operator Precedence – Expression – Conditionals: If-Else Constructs – Loop Structures/Iterative Statements – While Loop – For Loop – Break Statement – Function Call and Returning Values – Parameter Passing – Local and Global Scope – Recursive Functions.

Suggested Activities:

- Simple Python program implementation using Operators, Conditionals, Iterative Constructs and Functions.
- Implementation of a simple calculator.
- Developing simple applications like calendar, phone directory, to-do lists etc.
- Flow charts for GCD, Exponent Functions, Fibonacci Series using conditionals and iterative statements.
- External learning - Recursion vs. Iteration.

Suggested Evaluation Methods:

- Tutorials on the above activities.
- Group Discussion on external learning.

UNIT III SIMPLE DATA STRUCTURES IN PYTHON 10

Introduction to Data Structures – List – Adding Items to a List – Finding and Updating an Item – Nested Lists – Cloning Lists – Looping Through a List – Sorting a List – List Concatenation – List Slices – List Methods – List Loop – Mutability – Aliasing – Tuples: Creation, Accessing, Updating, Deleting Elements in a Tuple, Tuple Assignment, Tuple as Return Value, Nested Tuples, Basic Tuple Operations – Sets.

Suggested Activities:

- Implementing python program using lists, tuples, sets for the following scenario:
  - Simple sorting techniques
  - Student Examination Report
  - Billing Scheme during shopping.
- External learning - List vs. Tuple vs. Set – Implementing any application using all the three data structures.

Suggested Evaluation Methods:

- Tutorials on the above activities.
- Group Discussion on external learning component.

UNIT IV STRINGS, DICTIONARIES, MODULES 10

Strings: Introduction, Indexing, Traversing, Concatenating, Appending, Multiplying, Formatting, Slicing, Comparing, Iterating – Basic Built-In String Functions – Dictionary: Creating, Accessing, Adding Items, Modifying, Deleting, Sorting, Looping, Nested Dictionaries Built-in Dictionary Function – Finding Key and Value in a Dictionary – Modules – Module Loading and Execution – Packages – Python Standard Libraries.

Suggested Activities:

- Implementing Python program by importing Time module, Math package etc.
- Creation of any package (student's choice) and importing into the application.

Suggested Evaluation Methods:

- Tutorials on the above activities.

UNIT V FILE HANDLING AND EXCEPTION HANDLING 7

Introduction to Files – File Path – Opening and Closing Files – Reading and Writing Files – File Position – Exception: Errors and Exceptions, Exception Handling, Multiple Exceptions.

Suggested Activities:

- Developing modules using Python to handle files and apply various operations on files.
- Usage of exceptions, multiple except blocks -for applications that use delimiters like age, range of numerals etc.
- Implementing Python program to open a non-existent file using exceptions.

Suggested Evaluation Methods:

- Tutorials on the above activities.
- Case Studies.

TOTAL: 45 PERIODS

OUTCOMES:

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

1. Develop algorithmic solutions to simple computational problems.
2. Develop and execute simple Python programs.
3. Write simple Python programs for solving problems.
4. Decompose a Python program into functions.
5. Represent compound data using Python lists, tuples, dictionaries etc.
6. Read and write data from/to files in Python programs.

TEXT BOOK:

1. Reema Thareja, “Python Programming using Problem Solving Approach”, Oxford University Press, 2017.
2. Allen B. Downey, “Think Python: How to Think Like a Computer Scientist”, Second Edition, Shroff/O‘Reilly Publishers, 2016. (http://greenteapress.com/wp/thinkpython/).

REFERENCES:

1. Guido van Rossum, Fred L. Drake Jr., “An Introduction to Python – Revised and Updated for Python 3.2”, Network Theory Ltd., 2011.
2. John V Guttag, “Introduction to Computation and Programming Using Python”, Revised and Expanded Edition, MIT Press , 2013
3. Charles Dierbach, “Introduction to Computer Science using Python”, Wiley India Edition, 2016.
4. Timothy A. Budd, “Exploring Python”, Mc-Graw Hill Education (India) Private Ltd., 2015.
5. Kenneth A. Lambert, “Fundamentals of Python: First Programs”, Cengage Learning, 2012

BS5161 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 and band gap determination.

LIST OF EXPERIMENTS:

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. Photoelectric effect
14. Michelson Interferometer.
15. Estimation of laser parameters.
16. Melde's string experiment

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)

OBJECTIVES:

- To inculcate experimental skills to test basic understanding of water quality parameters, such as, acidity, alkalinity, hardness, DO, chloride and copper.
- To induce the students to familiarize with electroanalytical techniques such as, pH metry, potentiometry and conductometry in the determination of impurities in aqueous solutions.
- To demonstrate the analysis of metals and polymers by spectroscopy and viscometry methods.

LIST OF EXPERIMENTS:

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.

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11. Determination of molecular weight of polyvinylalcohol using Ostwald viscometer.
12. Pseudo first order kinetics-ester hydrolysis.
13. Corrosion experiment-weight loss method.
14. Phase change in a solid.

TOTAL: 30 PERIODS

OUTCOMES:

- To analyse the quality of water samples with respect to their acidity, alkalinity, hardness and DO.
- To determine the amount of metal ions through volumetric and spectroscopic techniques
- To determine the molecular weight of polymers by viscometric method.
- To quantitatively analyse the impurities in solution by electroanalytical techniques
- To design and analyse the kinetics of reactions and corrosion of metals

TEXTBOOKS:

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

GE5161 PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To understand the problem solving approaches.
- To learn the basic programming constructs in Python.
- To articulate where computing strategies support in providing Python-based solutions to real world problems.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

EXPERIMENTS:

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same.
2. Python programming using simple statements and expressions.
3. Scientific problems using Conditionals and Iterative loops.
4. Implementing real-time/technical applications using Lists, Tuples.
5. Implementing real-time/technical applications using Sets, Dictionaries.
6. Implementing programs using Functions.
7. Implementing programs using Strings.
8. Implementing programs using written modules and Python Standard Libraries.
9. Implementing real-time/technical applications using File handling.
10. Implementing real-time/technical applications using Exception handling.
11. Exploring Pygame tool.
12. Developing a game activity using Pygame like bouncing ball, car race etc.

TOTAL: 60 PERIODS

OUTCOMES:

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

- Develop algorithmic solutions to simple computational problems
- Develop and execute simple Python programs.
- Structure simple Python programs for solving problems.
- Decompose a Python program into functions.
- Represent compound data using Python data structures.
  Apply Python features in developing software applications.

SEMESTER II

		L	T	P	C
HS5251	**PROFESSIONAL COMMUNICATION**	**4**	**0**	**0**	**4**

COURSE OBJECTIVES

The course entitles 'professional communication'aims to,

- Improve the relevant language skills necessary for professional communication.
- Develop linguistic and strategic competence in workplace context.
- Enhance language proficiency and thereby the employability of budding engineers and technologists.

UNIT I TECHNICAL COMMUNICATION 12

Listening: Listening to telephone conversations (intent of the speaker and note taking exercises)-Speaking: Role play exercises based on workplace contexts, introducing oneself- Reading: Reading the interview of an achiever and completing exercises (skimming, scanning and predicting)- Writing: Writing a short biography of an achiever based on given hints- Grammar: Asking and answering questions, punctuation in writing, prepositional phrases- Vocabulary Development: use of adjectives.

UNIT II SUMMARY WRITING 12

Listening: Listening to talks/lectures both general and technical and summarizing the main points- Speaking: Participating in debates- Reading: Reading technical essays/ articles and answering comprehension questions-Writing: Summary writing-Grammar: Participle forms, relative clauses- Vocabulary Development: Use of compound words, abbreviations and acronyms.

UNIT III PROCESS DESCRIPTION 12

Listening: Listening to a process description and drawing a flowchart-Speaking: Participating in Group Discussions, giving instructions- Reading: Reading instruction manuals- Writing: Writing process descriptions- Writing instructions- Grammar: Use of imperatives, active and passive voice, sequence words- Vocabulary Development: Technical jargon

UNIT IV REPORT WRITING 12

Listening: Listening to a presentation and completing gap-filling exercises- Speaking: Making formal presentations- Reading: Reading and interpreting charts/tables and diagrams- Writing: Interpreting charts/tables and diagrams, writing a report- Grammar: Direct into indirect speech, use of phrases- Vocabulary Development: reporting words

UNIT V WRITING JOB APPLICATIONS 12

Listening: Listening to a job interview and completing gap=filling exercises- Speaking: Mock interview, telephone interviews- Reading: Reading a job interview, SOP, company profile and completing comprehension exercises- Writing: job applications and resumes and SOPs- Grammar: Present perfect and continuous tenses- Vocabulary Development: Technical vocabulary.

TOTAL : 60 PERIODS

LEARNING OUTCOMES

At the end of the second semester the learners should be able to,

- Read and comprehend technical texts effortlessly.
- Write reports of a technical kind.
- Speak with confidence in interviews and thereby gain employability

Textbook

1. Revised Edition of 'English for Engineers and Technologists' Volume 1 published by Orient Black Swan Limited 2019.

Assessment Pattern

- Assessments will assess all the four skills through both pen and paper and computer based tests.
- Assessments can be pen and paper based, quizzes.

MA5252	ENGINEERING MATHEMATICS – II (Common to all branches of B.E. / B.Tech. Programmes in II Semester)	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To acquaint the students with the concepts of vector calculus which naturally arises in many engineering problems.
- To develop an understanding of the standard techniques of complex variable theory in particular analytic function and its mapping property.
- To familiarize the students with complex integration techniques and contour integration techniques which can be used in real integrals.
- To acquaint the students with Differential Equations which are significantly used in Engineering problems.
- To make the students 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 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 theorem, Stoke's theorem and Gauss divergence theorem – Verification and application in evaluating line, surface and volume integrals.

UNIT II ANALYTIC FUNCTION **12**

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

UNIT III 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 IV DIFFERENTIAL EQUATIONS **12**

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

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

OUTCOMES:

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

- Calculate grad, div and curl and use Gauss, Stokes and Greens theorems to simplify calculations of integrals.
- Construct analytic functions and use their conformal mapping property in application problems.
- Evaluate real and complex integrals using the Cauchy's integral formula and residue theorem.
- Apply various methods of solving differential equation which arise in many application problems.
- Apply Laplace transform methods for solving linear differential equations.

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TEXTBOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2015.
2. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, 44th Edition, New Delhi, 2017.

REFERENCES:

1. Bali N., Goyal M. and Watkins C., “Advanced Engineering Mathematics”, Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), 7th Edition, New Delhi, 2009.
2. Glyn James, “Advanced Modern Engineering Mathematics”, Pearson Education, 4th Edition, New Delhi, 2011.
3. Jain R.K. and Iyengar S.R.K., “Advanced Engineering Mathematics”, Narosa Publications, 5th Edition, New Delhi, 2017.
4. Peter V.O’Neil, “Advanced Engineering Mathematics”, Cengage Learning India Pvt., Ltd, 7th Edition, New Delhi, 2012.
5. Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

GE5152 ENGINEERING MECHANICS L T P C
3 1 0 4

COURSE OBJECTIVES: The main learning objective of this course is to prepare the students for:

1. Applying the various methods to determine the resultant forces and its equilibrium acting on a particle in 2D and 3D.
2. Applying the concept of reaction forces (non-concurrent coplanar and noncoplanar forces) and moment of various support systems with rigid bodies in 2D and 3D in equilibrium. Reducing the force, moment, and couple to an equivalent force - couple system acting on rigid bodies in 2D and 3D.
3. Applying the concepts of locating centroids/center of gravity of various sections / volumes and to find out area moments of inertia for the sections and mass moment of inertia of solids.
4. Applying the concepts of frictional forces at the contact surfaces of various engineering systems.
5. Applying the various methods of evaluating kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

UNIT I STATICS OF PARTICLES (9+3)

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.

UNITII EQUILIBRIUM OF RIGID BODIES (9+3)

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.

UNITIII DISTRIBUTED FORCES (9+3)

Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration , Theorems of Pappus-Guldinus, Distributed Loads on Beams, Centre 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 (9+3)

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

UNITV DYNAMICS OF PARTICLES (9+3)

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.

TOTAL (L: 45 + T: 15)=60 PERIODS

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

1. Apply the various methods to determine the resultant forces and its equilibrium acting on a particle in 2D and 3D.
2. Apply the concept of reaction forces (non-concurrent coplanar and noncoplanar forces) and moment of various support systems with rigid bodies in 2D and 3D in equilibrium. Reducing the force, moment, and couple to an equivalent force - couple system acting on rigid bodies in 2D and 3D.
3. Apply the concepts of locating centroids / center of gravity of various sections / volumes and to find out area moments of inertia for the sections and mass moment of inertia of solids.
4. Apply the concepts of frictional forces at the contact surfaces of various engineering systems.
5. Apply the various methods of evaluating kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

TEXT BOOKS:

1. Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, SanjeevSanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education., 11th Edition, 2017.
2. Vela Murali, "Engineering Mechanics-Statics and Dynamics", Oxford University Press, 2018.

REFERENCES:

1. Boresi P and Schmidt J, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
2. Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
3. Irving H. Shames, Krishna Mohana Rao G, Engineering Mechanics – Statics and Dynamics, 4thEdition, Pearson Education Asia Pvt. Ltd., 2005.

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4. Meriam J L and Kraige L G, Engineering Mechanics: Statics and Engineering Mechanics: Dynamics, 7th edition, Wiley student edition, 2013.
5. Timoshenko S, Young D H, Rao J V and Sukumar Pati, Engineering Mechanics, 5thEdition, McGraw Hill Higher Education, 2013

GE5201 BASICS OF MECHANICAL AND CIVIL ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

The course is aimed to

- familiarize the materials and measurements used in Civil Engineering.
- provide the exposure on the fundamental elements of civil engineering structures.
- enable the students to distinguish the components and working principle of power plant units, IC engines, and R & AC system.

UNIT I SURVEYING AND CIVIL ENGINEERING MATERIALS 9

Surveying: Objects – classification – principles – measurements of distances – angles – leveling –determination of areas– contours – examples.
Civil Engineering Materials:Bricks – stones – sand – cement – concrete – steel – timber – modern materials

UNIT II BUILDING COMPONENTS AND STRUCTURES 9

Foundations: Types of foundations – Bearing capacity and settlement – Requirement of good foundations.
Civil Engineering Structures: Brickmasonry – stonemasonry – beams – columns – lintels – roofing– flooring – plastering – floor area, carpet area and floor space index – Types of Bridges and Dams – water supply – sources and quality of water – Rain water harvesting – introduction to high way and rail way.

UNIT III INTERNAL COMBUSTION ENGINES 9

Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines - Principle of electrical and hybrid vehicles.

UNIT IV POWER PLANT ENGINEERING 9

Classification Power Plants - Working principle of steam, Gas, Diesel, Hydro – electric and Nuclear Power plants –- working principle of Boilers, Turbines, Reciprocating Pumps (single acting and double acting) and Centrifugal Pumps

UNIT V REFRIGERATION AND AIR CONDITIONING SYSTEM 9

Terminology of Refrigeration and Air Conditioning.Principle of vapour compression and absorption system–Layout of typical domestic refrigerator–Window and Split type room Air conditioner.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course students are expected to

CO1. explain the usage of construction material and proper selection of construction materials.
CO2. measure distances and area by surveying
CO3. demonstrate working principles of petrol and diesel engine
CO4. identify the components used in power plant cycle.
CO5. elaborate the components of refrigeration and Air conditioning cycle.

TEXTBOOKS:

1. Shanmugam G and Palanichamy M S,"Basic Civil and Mechanical Engineering",Tata McGraw Hill Publishing Co., NewDelhi, 2018.

REFERENCES:

1. RamamruthamS.,"Basic Civil Engineering", DhanpatRai Publishing Co.(P) Ltd.1999.
2. Palanikumar, K. Basic Mechanical Engineering, ARS Publications, 2010.
3. Seetharaman S.,"Basic Civil Engineering",AnuradhaAgencies,2005.
4. ShanthaKumarSRJ.,"Basic Mechanical Engineering", Hi-tech Publications, Mayiladuthurai, 2000.
5. Venugopal K. and Prahu Raja V., "Basic Mechanical Engineering", Anuradha Publishers,Kumbakonam,2000

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	explain the usage of construction material and proper selection of construction materials.	3	3	2	–	–	–	–	–	–	–	–	–	3	–	–	3
CO2	**measure distances and area by surveying**	3	3	2	–	–	–	–	–	–	–	–	–	3	–	–	3
CO3	**demonstrate working principles of petrol and diesel engine**	3	3	2	–	–	–	–	–	–	–	–	–	3	–	–	3
CO4	**identify the components used in power plant cycle.**	3	3	2	–	–	–	–	–	–	–	–	–	3	–	–	3
CO5	**elaborate the components of refrigeration and Air conditioning cycle.**	3	3	2	–	–	–	–	–	–	–	–	–	3	–	–	3
BASICS OF CIVIL AND MECHANICAL ENGINEERING		3	3	2	-	–	–	–	–	–	–	–	–	3	–	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5201 BASICS OF CHEMICAL ENGINEERING L T P C
3 1 0 4

OBJECTIVES:

The course is aimed to

- Impart knowledge on the fluid statics and the fluid flow phenomena.
- Introduce different equations involved in fluid flow and the changes that occur in a fluid flowing past immersed solids.
- Familiarize the concepts involved in transfer of heat by conduction and convection.
- Acquaint with the principle of heat transfer by radiation and radiative heat transfer between different surfaces.
- Explain 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 and centrifugal decanter.Fluid flow phenomena – laminar flow, rheological properties of fluids, turbulence, boundary layers.

UNIT II FLUID FLOW EQUATIONS AND FLOW PAST IMMERSED SOLID 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: 60 PERIODS

OUTCOMES:

On completion of the course students are expected to

CO1. Comprehend the rheological behaviour of fluids and its application.
CO2. Do mass balance in controlled volume and also to calculate drag force and drag coefficient for flow past objects.

CO3. Be aware of the conduction and convection involved in heat exchanger and furnace wall.

CO4. Calculate the radiation to different bodies and combined heat transfer through convection, conduction and radiation.

CO5. Have knowledge about mass transfer operations involved in ceramic technology.

TEXT BOOKS:

1. Warren L.McCabe, Julian C.Smith and Peter Harriott, Unit Operations of Chemical Engineering, 7th Edn., McGraw Hill International Edition,2013
2. SalilK.Ghosal, ShyamalK.Sanyal and Siddhartha Datta, Introduction to Chemical Engineering, Tata McGraw-Hill Publishing Co. Ltd., New Delhi,2011.
3. Richardson J F,Coulson J. M.,BackhurstJ R,HarkerJ H, 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,1988.
3. Treybal R.E, Mass Transfer Operations, 3rd Edn., McGraw-Hill, New York,1980.
4. David Shallcross, Chemical Engineering Explained: Basic Concepts for Novices, CPI Group, UK, 2013
5. David M.H, James B. Riggs,Basic Principles and Calculations in Chemical Engineering, 8th edition, Prentice Hall,2012.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	**Comprehend the rheological behaviour of fluids and its application.**	3	3	3	2	2	–	–	–	–	–	–	–	3	–	–	3
CO2	**Do mass balance in controlled volume and also to calculate drag force and drag coefficient for flow past objects.**	3	3	3	2	2	–	–	–	–	–	–	–	3	–	–	3
CO3	**Be aware of the conduction and convection involved in heat exchanger and furnace wall.**	3	3	3	2	2	–	–	–	–	–	–	–	3	–	–	3
CO4	**Calculate the radiation to different bodies and combined heat transfer through convection, conduction and radiation.**	3	3	3	2	2	–	–	–	–	–	–	–	3	–	–	3
CO5	**Have knowledge about mass transfer operations involved in ceramic technology.**	3	3	3	2	2	–	–	–	–	–	–	–	3	–	–	3
BASICS OF CHEMICAL ENGINEERING		3	3	3	2	2	–	–	–	–	–	–	–	3	–	–	3

1, 2 and 3 are correlation levels with weightingsas Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5202 **ELEMENTS OF CERAMICS** **L T P C**
3 0 0 3

OBJECTIVES:
The course is aimed to

- Introduce various traditional and advanced ceramic products and industries that manufacture them.
- Familiarize the ceramic products which the students come across in their day to day life.
- Serve as a preparatory course for the subjects which the students will be learning in the subsequent years.

UNIT I WHITEWARES **9**

Introduction, definition, triaxial bodies, general flow sheet for whiteware preparation, types of whitewares, different applications of whitewares. Major Whiteware industries in India and the World.Market scenario of whiteware industry.

UNIT II REFRACTORIES **9**

Introduction, definition, classification of refractories - based on temperature and chemical nature. Definition of some important refractory properties - PCE, RUL, creep, HMOR, CCS, TSR, slag attack resistance, CO resistance, abrasion resistance, thermal conductivity. General flow sheet for manufacture of conventional and fused cast refractory.Examples for refractory applications - blast furnace, rotary kiln.Major refractory industries in India and the World.Market scenario of refractory industry.

UNIT III GLASS **9**

Introduction, definition, difference between glass and crystalline materials, types of glasses, general flow sheet for glass preparation, brief description on different glass shaping methods, importance of annealing and tempering. Major glass industries in India and the World. Market scenario of glass industry.

UNIT IV OTHER CONVENTIONAL CERAMIC PRODUCTS **9**

Introduction, definition, major raw materials and process flow sheet for - enamels, coated abrasives, bonded abrasives, cement. Major abrasives and cement industries in India and the World. Market scenario of abrasives and cement industry.

UNIT V ADVANCED CERAMICS **9**

Introduction, properties and applications of oxides - ZrO_2, Al_2O_3; non-oxides - carbides - SiC, WC; nitrides - Si_3N_4, BN. Properties and applications of ceramic products - ceramic fibers, glass ceramics. Major manufacturers of advanced ceramics in India and in the World.Market scenario of advanced ceramics.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course students are expected to

CO1. Be aware of the traditional and advanced ceramic products.
CO2. Have knowledge on basic preparatory methods for the various ceramic products.
CO3. Have overall idea about the industries manufacturing various ceramic products and the market scenario.

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TEXT BOOKS:

1. Singer.F and Singer.S, Industrial Ceramics, Oxford and IBH Publishing Co., 1991.
2. Norton F.H, Fine Ceramics: Technology and Applications, McGraw – Hill Co., NY, 1978.

REFERENCES:

1. Bormans.P, Ceramic are More than Clay Alone, Cambridge International Science Publications, 2004.
2. Heinz G. Pfaender, Schott Guide to Glass, Chapman and Hall, 1996.
3. Nandi D.N, Handbook of Refractories, Tata McGraw – Hill Publishing Co., New Delhi,1991
4. SudhirSen, Ceramic White ware, Oxford and IBH Publishing Co., New Delhi, 1992.
5. Noborou Ichinose, Introduction to Fine Ceramics: Applications in Engineering, John Wiley and Sons Ltd., 1987.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	**Be aware of the traditional and advanced ceramic products.**	3	2	2	1	–	–	–	–	–	–	–	–	–	3	–	3
CO2	**Have knowledge on basic preparatory methods for the various ceramic products.**	3	3	3	2	–	–	–	–	–	–	–	–	–	3	–	3
CO3	**Have overall idea about the industries manufacturing various ceramic products and the market scenario.**	1	1	2	2	–	–	–	–	–	–	–	–	–	3	–	3
ELEMENTS OF CERAMICS		3	3	3	2	–	–	–	–	–	–	–	–	–	3	–	3

1, 2 and 3 are correlation levels with weightingsas Slight (Low), Moderate (Medium) and Substantial (High) respectively

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GE5162 **WORKSHOP PRACTICES LABORATORY** **LT P C**

(Common to all Branches of B.E. / B.Tech. Programmes) **0 0 4 2**

COURSE OBJECTIVES: The main learning objective of this course is to provide hands on training to the students in:

1. Drawing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planing; making joints in wood materials used in common household wood work.
2. Wiring various electrical joints in common household electrical wire work.
3. Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts; Assembling simple mechanical assembly of common household equipments; Making a tray out of metal sheet using sheet metal work.
4. Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.

GROUP – A (CIVIL & ELECTRICAL)

PART I CIVIL ENGINEERING PRACTICES 15

PLUMBING WORK:

a) Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
b) Preparing plumbing line sketches.
c) Laying pipe connection to the suction side of a pump
d) Laying pipe connection to the delivery side of a pump.
e) Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.

WOOD WORK:

a) Sawing,
b) Planning and
c) Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.

Wood Work Study:

a) Studying joints in door panels and wooden furniture
b) Studying common industrial trusses using models.

PART II ELECTRICAL ENGINEERING PRACTICES 15

WIRING WORK:

a) Wiring Switches, Fuse, Indicator and Lamp etc. such as in basic household,
b) Wiring Stair case light.
c) Wiring tube – light.
d) Preparing wiring diagrams for a given situation.

Wiring Study:

a) Studying an Iron-Box wiring.
b) Studying a Fan Regulator wiring.
c) Studying an Emergency Lamp wiring.

GROUP – B (MECHANICAL AND ELECTRONICS)

PART III MECHANICAL ENGINEERING PRACTICES 15

WELDING WORK:

a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
b) Practicing gas welding.

BASIC MACHINING WORK:

a) (simple)Turning.
b) (simple)Drilling.
c) (simple)Tapping.

ASSEMBLY WORK:

a) Assembling a centrifugal pump.
b) Assembling a household mixer.
c) Assembling an air conditioner.

SHEET METAL WORK:

a) Making of a square tray

FOUNDRY WORK:

a) Demonstrating basic foundry operations.

PART IV ELECTRONIC ENGINEERING PRACTICES 15

SOLDERING WORK:

a) Soldering simple electronic circuits and checking continuity.

ELECTRONIC ASSEMBLY AND TESTING WORK:

a) Assembling and testing electronic components on a small PCB.

ELECTRONIC EQUIPMENT STUDY:

a) Studying a FM radio.
b) Studying an electronic telephone.

TOTAL (P: 60) = 60 PERIODS

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

1. Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.
2. Wire various electrical joints in common household electrical wire work.
3. Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical assembly of common household equipments; Make a tray out of metal sheet using sheet metal work.
4. Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

CT5211 BASIC CHEMICAL ENGINEERING LABORATORY L T P C
0 0 2 1

OBJECETIVES:

The course is aimed to

- impart knowledge on concepts of fluid mechanics
- teach concepts of heat and mass transfer

EXPERIMENTS:

1. Determination of pressure drop in a fluid passing through Orificemeter and Venturimeter
2. Determination of liquid viscosity using Oswald Viscometer
3. Estimation of settling velocity of particles in fluid
4. Separation of solid from suspension by sedimentation
5. Estimation of thermal conductivity of composite 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 :30 PERIODS

OUTCOMES:

On completion of the laboratory course, the students are expected to

CO1. be thorough with the use of manometers and viscometers
CO2. measure particle size of the given powder using sedimentation principle
CO3. estimate LMTD in heat transfer
CO4. calculate humidity and drying rate
CO5. crystallize solids from super saturated solution

EQUIPMENTS REQUIRED:

1. Manometer
2. Orificemeter
3. Venturimeter
4. Ostwald viscometer
5. Dryer
6. Electronic balance
7. Hotplate
8. Concentric tube heat exchanger
9. Crystalliser
10. Compound wall Thermal conductivity Measurement equipment

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome														
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	be thorough with the use of manometers and viscometers	–	3	3	2	–	–	–	–	–	–	–	–	3	–	–	3
CO2	measure particle size of the given powder using sedimentation principle	–	3	3	2	–	–	–	–	–	–	–	–	3	–	–	3
CO3	estimate LMTD in heat transfer	–	3	3	2	–	–	–	–	–	–	–	–	3	–	–	3
CO4	calculate humidity and drying rate	–	3	3	1	–	–	–	–	–	–	–	–	3	–	–	3
CO5	crystallize solids from super saturated solution	–	3	3	2	–	–	–	–	–	–	–	–	3	–	–	3
BASIC CHEMICAL ENGINEERING LABORATORY		–	3	3	2	–	–	–	–	–	–	–	–	3	–	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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MA5354 **PROBABILITY AND STATISTICS** **L T P C**
3 1 0 4

OBJECTIVES

- To understand the basics of random variables with emphasis on the standard discrete and continuous distributions.
- To understand the basic probability concepts with respect to two dimensional random variables along with the relationship between the random variables and the significance of the Central Limit theorem.
- To apply the small/ large sample tests through Tests of hypothesis.
- To understand the concept of analysis of variance and use it to investigate factorial dependence.
- To monitor a process and detect a situation when the process is out of control.

UNIT I RANDOM VARIABLES 12

Discrete and continuous random variables – moments – moment generating functions – binomial, poisson, geometric, uniform, exponential, gamma, weibull and normal distributions – functions of a random variable.

UNIT II TWO-DIMENSIONAL RANDOM VARIABLES 12

Joint distributions – marginal and conditional distributions – covariance – correlation and linear regression – transformation of random variables – central limit theorem (for independent and identically distributed random variables).

UNIT III TESTS OF SIGNIFICANCE 12

Type I and Type II errors – tests for single mean, proportion, difference of means (large and small samples) – tests for single variance and equality of variances – chi-square test for goodness of fit – independence of attributes – non-parametric tests: test for randomness and rank – sum test (wilcoxon test).

UNIT IV DESIGN OF EXPERIMENTS 12

Completely randomized design – randomized block design – latin square design – factorial design – taguchi's robust parameter design.

UNIT V STATISTICAL QUALITY CONTROL 12

Control charts for measurements ($\bar{X}$ and R charts) – control charts for attributes (p, c and np charts) tolerance limits – acceptance sampling.

TOTAL: 60 PERIODS

OUTCOMES

CO1 To analyze the performance in terms of probabilities and distributions achieved by the determined solutions

CO2 To be familiar with some of the commonly encountered two dimensional random variables and be equipped for a possible extension to multivariate analysis

CO3 To apply the basic principles underlying statistical inference(estimation and hypothesis testing)

CO4 To demonstrate the knowledge of applicable large sample theory of estimators and tests To obtain a better understanding of the importance of the methods in modern industrial processes.

TEXT BOOKS:

1. Devore, J.L. "Probability and Statistics for Engineering and the Sciences", Cengage Learning, 9th Edition, Boston, 2017.
2. Johnson, R.A. and Gupta, C.B. "Miller and Freund's Probability and Statistics for Engineers", Pearson India Education, Asia, 9th Edition, New Delhi, 2017.
3. Walpole, R.E., Myers R.H., Myres S.L., and Ye, K. "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 9th Edition, New Delhi, 2011.

REFERENCES:

1. Krishnaiah, K. and Shahabudeen, P. “Applied Design of Experiments and Taguchi Methods”, Prentice Hall of India, New Delhi, 2012.
2. Milton, J.S. and Arnold, J.C. “Introduction to Probability and Statistics”, Tata McGraw Hill, 4th Edition, 3rd Reprint, New Delhi, 2008.
3. Ross, S.M. “Introduction to Probability and Statistics for Engineers and Scientists”, Elsevier, 5th Edition, New Delhi, 2014.
4. Spiegel, M.R., Schiller, J., Srinivasan, R.A. and Goswami, D., “Schaum’s Outline of Theory and Problems for Probability and Statistics”, McGraw Hill Education, 3rd Edition, Reprint, New Delhi, 2017.

EE5251 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING **L T P C**
3 0 0 3

OBJECTIVES:

- To understand the basic concepts of electric circuits, magnetic circuits and wiring.
- To understand the operation of AC and DC machines.
- To understand the working principle of electronic devices and circuits.

UNIT I BASIC CIRCUITS AND DOMESTIC WIRING 9

Electrical circuit elements (R, L and C)-Dependent and independent sources – Ohm’s Law- Kirchhoff’s laws - mesh current and node voltage methods (Analysis with only independent source) - Phasors – RMS-Average values-sinusoidal steady state response of simple RLC circuits. Types of wiring- Domestic wiring - Specification of Wires-Earthing-Methods-Protective devices.

UNIT II THREE PHASE CIRCUITS AND MAGNETIC CIRCUITS 9

Three phase supply – Star connection – Delta connection –Balanced and Unbalanced Loads- Power in three-phase systems – Comparison of star and delta connections – Advantages-Magnetic circuits-Definitions-MMF, Flux, Reluctance, Magnetic field intensity, Flux density, Fringing, self and mutual inductances-simple problems.

UNIT III ELECTRICAL MACHINES 9

Working principle of DC generator, motor-EMF and Torque equation-Types –Shunt, Series and Compound-Applications.Working principle of transformer-EMF equation-Operating principles of three phase and single phase induction motor-Applications.Working principles of alternator-EMF equation-Operating principles of Synchronous motor, stepper motor-Applications.

UNIT IV BASICS OF ELECTRONICS 9

Intrinsic semiconductors, Extrinsic semiconductors – P-type and N-type, P-N junction, VI Characteristics of PN junction diode, Zener effect, Zener diode, Zener diode Characteristics-Rectifier circuits-Wave shaping.

UNIT V CURRENT CONTROLLED AND VOLTAGE CONTROLLED DEVICES 9

Working principle and characteristics - BJT, SCR, JFET, MOSFET.

TOTAL: 45 PERIODS

OUTCOMES:

CO1 To be able to understand the concepts related with electrical circuits and wiring.
CO2 To be able to study the different three phase connections and the concepts of magnetic circuits.
CO3 Capable of understanding the operating principle of AC and DC machines.
CO4 To be able to understand the working principle of electronic devices such as diode and zener diode.
CO 5 To be able to understand the characteristics and working of current controlled and voltage controlled devices.

TEXT BOOKS:

1. Kothari DP and I.J Nagrath, “Basic Electrical and Electronics Engineering”, McGrawHill Education, 2014
2. Del Toro, “Electrical Engineering Fundamentals”, Second edition, Pearson Education, New Delhi, 1989.
3. John Bird, “Electrical Circuit theory and technology”, Routledge; 5th edition, 2013

REFERENCES:

1. Thomas L. Floyd, ‘Electronic Devices’, 10th Edition, Pearson Education, 2018.
2. Albert Malvino, David Bates, ‘Electronic Principles, McGraw Hill Education, 7th edition, 2017
3. Kothari DP and I.J Nagrath, “Basic Electrical Engineering”, McGraw Hill, 2010.
4. Muhammad H.Rashid, “Spice for Circuits and electronics”, 4th ed.,Cengage India,2019.

CT5301 PROCESSING OF CERAMIC RAW MATERIALS L T P C
3 0 0 3

OBJECTIVES:

The course is aimed to

- Introduce the methods of material recovery by quarrying
- Describe the various processes involved in making the quarried raw material into fine, fractioned powders
- Discuss the means of mixing, conveying and storage of the processed raw materials.

UNITI 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.

UNITII 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.

UNITIII 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. Applications - requirements and market scenario - Industries.

UNITIV 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.

UNITV CONVEYING AND STORAGEOF 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

Attested

TOTAL: 45 PERIODS

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OUTCOMES:

On completion of the course, the students are expected to

CO1. Know the different quarrying methods to extract materials and its purification

CO2. Select a proper size reduction method for the given input size and for the expected final size

CO3. Discuss different size separation methods

CO4. Identify a suitable method of mixing and conveying for the given material

CO5. Discern different storage methods

TEXT BOOKS:

1. Warren L.McCabe, Julian C.Smith and Peter Harriott, Unit Operations of Chemical Engineering, 7thEdn., McGraw Hill International Edition,2013.
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 KeishiGotoh, Powder Technology Handbook, Marcel Dekker Inc.,1997.
4. Singer F.and SingerS., Industrial Ceramics, Oxford and IBH Publishing Co.,1991.
5. Mohamed N.Rahaman, Ceramic Processing, CRC Press, 2thEdn.,2017.
6. Tooley F.V, Handbook of Glass Manufacture, VollandII, Ogden Publishing Co., NY, 1960.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3	PSO 4
CO1	Know the different quarrying methods to extract materials and its purification	-	3	2	2	2	–	–	–	–	–	–	–	–	3	–	3
CO2	Select a proper size reduction method for the given input size and for the expected final size	-	3	1	3	1	–	–	–	–	–	–	–	–	3	–	3
CO3	Discuss different size separation methods	-	3	2	3	2	–	–	–	–	–	–	–	–	3	–	3
CO4	Identify a suitable method of mixing and conveying for the given material	-	3	2	2	2	–	–	–	–	–	–	–	–	3	–	3
CO5	Discern different storage methods	-	3	1	3	1	–	–	–	–	–	–	–	–	3	–	3
PROCESSING OF CERAMIC RAW MATERIALS		-	3	2	3	2	–	–	–	–	–	–	–	–	3	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

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CT5302 **CERAMIC RAW MATERIALS** **L T P C**
3 0 0 3

OBJECTIVES:
The course is aimed to

- Introduce the basics of rock formation, its types, and mineral formation and its physical and optical properties.
- Impart knowledge about various natural and synthetic ceramic raw materials.
- Explain the various testing methods of ceramic raw materials.

UNITI GENERAL GEOLOGYAND MINEROLOGY 9

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, Rocks – formation, characteristics, classification into igneous, sedimentary and metamorphic. Some important rocks – granite, sandstone, marble - Availability, Industries and Demand.

UNITII ALUMINO SILICATE MATERIALS 10

Occurrence, properties ,industrial importance of fluxes, uses of natural fluxes – feldspar group, nephelinesyenite, Cornish stone. 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 sillimanite group – physical and chemical properties, applications - Availability, Industries and Demand.

UNITIII ALUMINA AND SILICA 9

Alumina – natural raw materials. Preparation, properties and applications of synthetic alumina raw materials – calcined alumina, fused alumina, tabular alumina, reactive alumina, bubble aluminaSilica – occurrence, structure, polymorphic transformation, physical and chemical properties. Silicate minerals – quartz, quartzite – properties and uses.Availability, Industries and Demand

UNITIV OTHER RAW MATERIALS 7

Occurrence, properties,industrial importance of Wollastonite, Magnesite, dolomite, chromite, limestone, rutile, zircon, beryllia, gypsum minerals, lithium containing minerals, Preparation / Occurrence, properties and uses of Silicon carbide, Tungsten carbide, Silicon nitride, Aluminium nitride, Boron nitride, Plaster of Paris, Bone ash, cullet, slag, Fly ash.

UNITV 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, Plaster of Paris setting timeand strength; Testing of clay plasticity, thixotropy, shrinkage, water absorption. Theory and procedure for chemical estimation of silica, alumina, alkali and alkaline earth oxides in a given ceramic raw material.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. Recognize different rocks and minerals
CO2. Describe various types of natural and synthetic ceramic minerals
CO3. Define the properties and applications of natural and synthetic ceramic minerals
CO4. Employ the testing methods to analyse the raw materials.

TEXT BOOKS:

1. Parbin Singh, Engineering and General Geology, S.K.Kataria and Sons, New Delhi,2001.
2. Christopher W.Sinton, Raw Materials for Glass and Ceramics: Sources, Processes and Quality Control, John Wiley and Sons, Inc., 2006

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 ZussmanJ, Rock Forming Minerals, Longmans, London,1967.
4. Ryan .W, Properties of Ceramic Raw Materials, Pergamon Press, 2nd Edn.,1978.
5. Worrall W.E, Ceramic Raw Materials, Pergamon Press, NY,1992.
6. Venkat Reddy D, Engineering Geology, Vikas Publishing House Pvt. Ltd., New Delhi,2010.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Recognize different rocks and minerals	–	2	2	2	–	–	3	–	–	–	–	–	–	3	–	3
CO2	Describe various types of natural and synthetic ceramic minerals	–	2	2	2	–	–	2	–	–	–	–	–	–	3	–	3
CO3	Define the properties and applications of natural and synthetic ceramic minerals	–	2	2	2	–	–	3	–	–	–	–	–	–	3	–	3
CO4	Employ the testing methods to analyse the raw materials.	–	2	2	2	–	–	3	–	–	–	–	–	–	3	–	3
CERAMIC RAW MATERIALS		–	2	2	2	–	–	3	–	–	–	–	–	–	3	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5303 **MATERIALS SCIENCE - I** **L T P C**
3 0 0 3

OBJECTIVES:

The course is aimed to

- Give basic knowledge of science behind materials and introduce the concept of structure property relations.
- Lay the groundwork for studies in fields such as imperfections, microstructure, diffusion and phase diagram.
- Develop intuitive understanding of the subject to present a wealth of real world engineering examples to give students a feel of how material science is useful in engineering practices.

UNIT I STRUCTURE AND PROPERTY **9**

Material Science – Structure and Property Relation – Classification of Materials – Property – Material Design and Selection - Atomic Structure – Electronic Structure – Periodic variation in atomic size, ionization energy and electron affinity – Bonding – Primary, Secondary, Mixed – Crystal Structure – fundamental concepts, crystalline and non crystalline materials, metallic, ceramic and polymer structures, density calculations, polymorphism, crystal structure analysis.

UNIT II IMPERFECTIONS **9**

Point imperfections – vacancies, interstitials, point imperfections in molecular crystals, mobility of point imperfections, solid solutions, point imperfections in ionic crystals – Line imperfections – dislocations characteristics, slip systems, dislocation motion, dislocation loops, critical resolved shear stress, surface imperfections – surface tension and surface free energy, geometry of grain structures, structure of crystalline interfaces – stacking fault, amiphase boundaries, grain boundaries, interface grain boundaries, magnetic domain walls, walls in liquid crystals, imperfections and symmetry breaking.

UNIT III MICROSTRUCTURE **9**

Structural hierarchies – Metal forging, semi-crystalline polymers, microstructure arising from special processing – deformation microstructure – deformation processing and crystallographic structure, microstructure of deformed polycrystalline material, characterization of textures, transformation microstructure – solidification microstructures, solid-solid Transformation microstructures, Composite microstructure, Experimental techniques for identification of microstructure and defects – microscopic techniques, grain size determination.

UNIT IV DIFFUSION **9**

Introduction – Rate processes in solids – Atomic diffusion in solids – Types of diffusion - diffusion mechanism, Activation energy for diffusion, steady state diffusion, Non-steady state diffusion, factors influencing diffusion, other diffusion paths, diffusion in ionic and polymeric materials.

UNIT V PHASE DIAGRAMS **9**

Introduction - Basic concepts – solubility limit, Phase, Microstructure, Phase Equillibria, One component system – iron, water, Carbon, Binary system - isomorphous system, Eutectic, Peritectic diagrams – Interpretation and microstructure developments, Basic Concepts of Phase transformation.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. Analyze the structure of the materials
CO2. Identify the effect of imperfections in a structure
CO3. Understand and Identify the microstructures in a material
CO4. Understand the process of diffusion and its mechanism
CO5. Identify phase diagrams and reactions.

TEXTBOOKS:

1. William D Callister.Jr, “Materials Science and Engineering – An Introduction”, Willey , 9 th Edition.
2. William F. Smith, “Foundations of Materials Science and Engineering”, McGraw Hill Publisher, Fifth Edition, 2010.

REFERENCES:

1. RajputR.K., “A Textbook of Material Science and Engineering” S.K.Katariaand Sons.
2. .UpadhyayaG.S, AnishUpadhaya, “Materials Science and Engineering”, Viva Books Private Limited, 2006.
3. KhurmiR.S., SedhaR.S., “Materials Science”, S.Chand and Company Limited, 2018.
4. Allen,S.M., and Thomas E.L. “The Structure of Materials” New York, J.Wileyand Sons, 1999.
5. Rohrer, G. “Structure and Bonding in Crystalline Materials” New York, Cambridge University Press, 2001.
6. RaghavanV., Materials Science and Engineering: A First Course, Fifth Edition, PHI Learning Pvt. Ltd., 2011

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3	PSO 4
CO1	Analyze the structure of the materials	3	2	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO2	Identify the effect of imperfections in a structure	3	3	1	1	1	–	–	–	–	–	–	–	3	–	–	3
CO3	Understand and Identify the microstructures in a material	3	3	2	2	1	–	–	–	–	–	–	–	3	–	–	3
CO4	Understand the process of diffusion and its mechanism]	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO5	Identify phase diagrams and reactions.	2	2	1	1	2	–	–	–	–	–	–	–	3	–	–	3
MATERIALS SCIENCE - I		3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5311 PROCESSING OF CERAMIC RAW MATERIALS LABORATORY L T P C
0 0 4 2

OBJECTIVES:

The course is aimed to

- Enable students to learn purification of different raw materials
- Make students understand the effect of various parameters on size reduction
- Teach various size separation and mixing techniques

EXPERIMENTS:

1. Clay purification
2. Non-plastic Raw material purification by froath flotation
3. Size reduction by Jaw Crusher
4. Size reduction in ball milling with respect to time, speed and grinding media size
5. Size separation by Sieves
6. Calculating screen effectiveness of sieves
7. Separation of solids by sedimentation method
8. Separation of solid from liquid by filter press
9. Granule formation by spray drying
10. Separating magnetic particles by magnetic separator
11. Solid mixing by pan mixer
12. Liquid mixing by agitators

TOTAL :60 PERIODS

OUTCOMES:

On completion of this Laboratory Course, the students are expected to

CO1. purify various raw materials and reduce them to required size using appropriate technique.

CO2. evaluate screen effectiveness of sieves.

CO3. be able to separate solid from other solids or liquids using suitable method

EQUIPMENTS REQUIRED:

1. Blunger
2. Froath flotation equipment
3. Jaw Crusher
4. Ball mill
5. Sieve set
6. Sieve shaker
7. Magnetic separator
8. Filter press
9. Pan mixer
10. Agitator
11. Spray drier

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	purify various raw materials and reduce them to required size using appropriate technique.	–	–	3	3	3	–	–	–	–	–	–	–	–	3	–	3
CO2	evaluate screen effectiveness of sieves.	–	–	3	3	3	–	–	–	–	–	–	–	–	3	–	3
CO3	be able to separate solid from other solids or liquids using suitable method	–	–	3	3	3	–	–	–	–	–	–	–	–	3	–	3
PROCESSING OF CERAMIC RAW MATERIALS LABORATORY		–	–	3	3	3	–	–	–	–	–	–	–	–	3	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5312 CERAMIC RAW MATERIALS ANALYSIS LABORATORY L T P C
0 0 4 2

OBJECTIVE:

The course is aimed to

- Enable students to analyze the given ceramic raw material for its chemical composition and estimate its physical properties

EXPERIMENTS:

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, K and Li by flame photometry
7. Determination of CaO,MgO by complexometry
8. Determination of particle size by Hydrometer
9. Determination of particle size by Andreasen Pipette
10. Determination of plasticity of ceramic materials by Pfefferkorn test
11. Determination of plasticity of ceramic materials by Atterberg test
12. Determination of rheological properties like fluidity and thixotropy by torsion viscometer
13. Determination of setting time of Plaster of Paris
14. Determination of setting temperature of Plaster of Paris

TOTAL: 60 PERIODS

OUTCOMES:

On completion of this Laboratory Course, the students are expected to

CO1. qualitatively determine the chemical components in the given ceramic raw material.

CO2. evaluate plasticity of clay and rheological properties of clay slurry.

CO3. evaluate setting time and temperature of plaster of Paris

EQUIPMENTS REQUIRED:

1. Flame Photometer
2. Hot Plate
3. Hot Air Oven
4. Electronic Balance
5. Furnace
6. Atterberg Apparatus
7. Pfefferkorn Apparatus
8. Torsion Viscometer
9. Vickat's apparatus

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Qualitatively determine the chemical components in the given ceramic raw material.	–	3	3	3	–	–	–	–	–	–	–	–	–	3	–	3
CO2	evaluate plasticity of clay and rheological properties of clay slurry.	–	3	3	3	–	–	–	–	–	–	–	–	–	3	–	3
CO3	evaluate setting time and temperature of plaster of Paris	–	3	3	3	–	–	–	–	–	–	–	–	–	3	–	3
CERAMIC RAW MATERIALS ANALYSIS LABORATORY		–	3	3	3	–	–	–	–	–	–	–	–	–	3	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

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GE5451 **TOTAL QUALITY MANAGEMENT** **L T P C**
3 0 0 3

OBJECTIVES:

- Teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
- Explain the TQM Principles for application.
- Define the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
- Describe Taguchi's Quality Loss Function, Performance Measures and apply Techniques like QFD, TPM, COQ and BPR.
- Illustrate 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 - 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 benchmark, Benchmarking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, Learning from the data, Using the findings, Pitfalls and Criticisms of Benchmarking - FMEA - Intent , 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:

CO1: Ability to apply TQM concepts in a selected enterprise.

CO2: Ability to apply TQM principles in a selected enterprise.

CO3: Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.

CO4: Ability to understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.

CO5: Ability to apply QMS and EMS in any organization.

TEXT BOOK:

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Bester field,Mary B.Sacre,Hemant Urdhware she and RashmiUrdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.

REFERENCES:

1. Joel.E. Ross, “Total Quality Management – Text and Cases”,Routledge.,2017.
2. Kiran.D.R, “Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.
3. Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.
4. Suganthi,L and Anand Samuel, “Total Quality Management”, Prentice Hall (India) Pvt. Ltd., 2006

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GE5251 ENVIRONMENTAL SCIENCES L T P C
3 0 0 3

OBJECTIVES:

- To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation.
- To impart knowledge on the causes, effects and control or prevention measures of environmental pollution and natural disasters.
- To facilitate the understanding of global and Indian scenario of renewable and non-renewable resources, causes of their degradation and measures to preserve them.
- To familiarize the influence of societal use of resources on the environment and introduce the legal provisions, National and International laws and conventions for environmental protection.
- To inculcate the effect of population dynamics on human and environmental health and inform about human right, value education and role of technology in monitoring human and environmental issues.

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 – bio geographical 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 47 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 protection 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:

- To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.
- To identify the causes, effects and environmental pollution and natural disasters and contribute to the preventive measures in the immediate society.
- To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.
- To recognize different forms of energy and apply them for suitable applications in for technological advancement and societal development.
- To demonstrate the knowledge of societal activity on the long and short term environmental issues and abide by the legal provisions, National and International laws and conventions in professional and personal activities and to identify and analyse effect of population dynamics on human value education, consumerism and role of technology in environmental issues.

TEXT BOOKS:

1. Anubha Kaushik and C. P. Kaushik's "*Perspectives in Environmental Studies", 6th*Edition,New Age International Publishers (2018).
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, (2016).
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education (2004).

REFERENCE BOOKS:

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).
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. (2013).

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CT5401 **TRADITIONAL CERAMICS** **L T P C**
3 0 0 3

OBJECTIVES:

The course is aimed to

- explain the composition and types of various traditional ceramic bodies.
- introduce design body compositions and formulate bodies
- describe the testing and properties of traditional ceramic bodies

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 - Industries - Market Scenario - Demand.

UNIT III WHITEWARE PRODUCTS 9

Manufacturing process and 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 - Industries - Market Scenario - Demand.

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 - Industries - Market Scenario - Demand.

UNIT V PROPERTIES and TESTING 9

Tests on unfired body –bulk density, green MOR, Shrinkage. Tests on fired body - strength, density, porosity, moisture absorption, abrasion resistance, chemical durability, thermal expansion, thermal shock resistance and electrical properties - dielectric strength, dielectric constant, power and loss factor, volume resistivity.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students are expected to

CO1. Have a basic knowledge about whiteware and heavy clayware, their classification and formulation.
CO2. Be capable of classifying the various whiteware and heavy clayware products and know the body formulation and properties.
CO3. Be able to test ceramic bodies and glazes

TEXT BOOKS:

1. SingerF.andSingerS, Industrial Ceramics, Oxford and IBH Publishing Co, 1991.
2. Ryan W.and RadfordC., Whitewares Production, Testing and Quality Control, Pergamon Press, NY, 1987.

REFERENCES:

1. Rexford Newcomb Jr, Ceramic Whitewares : History, Technology and Applications, Pitman Publishing Corporation, 1947.
2. AlenDinsdale, Pottery Science : Materials, Processes and Products, Ellis Horwood Ltd, 1986.
3. SudhirSen, Ceramic Whitewares : Production, Testing and Quality Control, Pergamon Press, 1987.
4.Bryan Sentance, Ceramics: A World Guide to Traditional Techniques, Thames and Hudson, 2004.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Have a basic knowledge about whiteware and heavy clayware, their classification and formulation.	3	2	2	3	–	–	2	–	–	–	–	–	–	3	–	3
CO2	Be capable of classifying the various whiteware and heavy clayware products and know the body formulation and properties.	3	2	2	3	–	–	3	–	–	–	–	–	–	3	–	3
CO3	Be able to test ceramic bodies and glazes	3	2	2	3	–	–	3	–	–	–	–	–	–	3	–	3
TRADITIONAL CERAMICS		3	2	2	3	–	–	3	–	–	–	–	–	–	3	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5402 **MATERIALS SCIENCE - II** **L T P C**
3 0 0 3

OBJECTIVES:

The course is aimed to

- discuss the basics of materials science with the objective of rationalizing, predicting, modifying and describing the mechanical, electrical, magnetic, thermal, optical and environmental behavior of materials.
- correlate between structure-property-performance of materials.

UNIT I MECHANICAL PROPERTIES 9

Introduction – Static Mechanical Properties – Tensile Strength, Compressive Strength, Ductility, Malleability, Stiffness, Toughness, Creep Strength, Hardness – Dynamics Mechanical Properties – Impact Strength, Fatigue Strength, Rebound Hardness – Structure – Mechanical Property Relationship.

UNIT II ELECTRICAL PROPERTIES 9

Introduction – Ohm's Law – Electrical Conductivity – Electronic and Ionic Conduction – Energy Band Structures in solids, Conduction in terms of Band and Atomic Bonding models, electron mobility, Electrical Resistivity of Metals, Semiconductivity – Intrinsic Semiconductor, Extrinsic Semiconductor, The Hall Effect– Conduction in ionic materials, Electrical Properties of Ceramics – Basic Properties of Dielectric, polarization, Types of Polarization, Frequency dependence of the Dielectric constant, Dielectric Strength, Dielectric Materials - Ferroelectricity, Piezoelectricity.

UNIT III MAGNETIC PROPERTIES 9

Introduction – Basic Concepts – Diamagnetism and Para-magnetism, Ferromagnetism, Anti-ferromagnetism and ferrimagnetism- The influence of temperature on Magnetic Behavior – Domains and Hysteresis, Magnetic Anisotropy, Soft Magnetic materials, Hard Magnetic Materials, Magnetic Storage, Superconductivity

UNIT IV THERMAL AND OPTICAL PROPERTIES 9

Thermal – Introduction – Heat Capacity – Thermal Expansion – Thermal Conductivity – Thermal Stresses – Optical – Introduction – Basic Concepts – Optical Properties of Non Metals – Refraction, reflection, Absorption, Transmission, Color, Opacity and Translucency.

UNIT V CORROSION AND DEGRADATION 9

Introduction – Types of Corrosion, Corrosion of Metals – Electrochemical Considerations, Corrosion rates, Prediction of Corrosion Rates, Passivity, Environmental Effects, forms of Corrosion, Corrosion Environments, Corrosion Prevention, Oxidation – Degradation of Polymers – Swelling and dissolution, bond rupture, weathering.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the studentsare expected to

CO1. Understand and evaluate the mechanical properties of the material Predict the electrical properties of the materials

CO2. Interpret the behavior of the materials when subjected to magnetic field

CO3. Evaluate the property changes of the materials with respect to temperature and light interactions

CO4. Analyze the degradation of the materials due to environmental changes.

TEXTBOOKS:

1. William D Callister.Jr, “Materials Science and Engineering – An Introduction”, Willey , 9 th Edition.
2. William F. Smith “Foundations of Materials Science and Engineering”, McGraw Hill Publisher, Fifth Edition, 2010.

REFERENCES:

1. RajputR.K., “A Textbook of Material Science and Engineering” S.K.Katariaand Sons.
2. UpadhyayaG.S., AnishUpadhaya, “Materials Science and Engineering”, Viva Books Private Limited, 2006.
3. KhurmiR.S., SedhaR.S., “Materials Science”, S.Chand and Company Limited, 2018.
4. Allen,S.M., and Thomas E.L. “The Structure of Materials” New York, J.Wileyand Sons, 1999.
5. Rohrer, G. “Structure and Bonding in Crystalline Materials” New York, Cambridge University Press, 2001.
6. RaghavanV., Materials Science and Engineering: A First Course, Fifth Edition, PHI Learning Pvt. Ltd., 2011

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Understand and evaluate the mechanical properties of the materials.	3	3	2	1	2	–	–	–	–	–	–	–	3	–	–	3
CO2	Predict the electrical properties of the materials	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO3	Interpret the behavior of the materials when subjected to magnetic field	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO4	Evaluate the property changes of the materials with respect to temperature and light interactions	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO5	Analyze the degradation of the materials due to environmental changes.	2	3	2	1	2	–	–	–	–	–	–	–	3	–	–	3
MATERIALS SCIENCE - II		3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5403 **THERMODYNAMICS OF MATERIALS** **L T P C**
2 1 0 3

OBJECTIVES:

The course is aimed to

- Outline the basics concepts of thermodynamics.
- Impart knowledge about thermodynamic relations, phase equilibria and Ideal gas mixtures.

UNIT I LAW'S OF THERMODYNAMICS **10**

Zeroth law of thermodynamics; concepts of heat and work, different modes of work, and various forms of energy, concept of temperature. internal energy, enthalpy; specific heats; first law applied to elementary processes, Limitations of the first law of thermodynamics, concepts of heat engines and heat pumps/refrigerators, Kelvin-Planck and Clausius statements and their equivalence; reversible and irreversible processes; Carnot cycle and Carnot principles/theorems; thermodynamic temperature scale; Clausius inequality and concept of entropy; T-s diagrams; third law of thermodynamics.

UNIT II PROPERTIES OF PURE SUBSTANCES **7**

Thermodynamic properties of pure substances in solid, liquid and vapor phases; P-v-T behaviour of simple compressible substances, phase rule, ideal and real gases, ideal gas equation of state and van der Waals equation of state; law of corresponding states, compressibility factor and generalized compressibility chart, Joule-Thomson coefficient.

UNIT III FUNDAMENTAL EQUATION AND THEIR RELATIONS **10**

Molar heat capacities at constant volume and pressure, theoretical calculation of heat capacity, entropy and disorder on an atomic scale, statistical interpretation of entropy. T-ds relations, Enthalpy, Helmholtz free energy, Gibbs free energy, Chemical potential, the fundamental equation for a closed system, Thermodynamical relations, Maxwell relations, Examples of the applications of Maxwell relations.

UNIT IV PHASE EQUILIBRIUM IN ONE COMPONENT SYSTEM **9**

Variation of Gibbs free energy with temperature at constant pressure, Gibbs free energy as a function of temperature and pressure, Equilibrium between the vapour phase and condensed phase, Graphical representation of vapour phase and condensed phase equilibria, solid-solid equilibria, Gibbs Phase Rule and Phase diagram of Unary system.

UNIT V IDEAL GAS MIXTURES **9**

Dalton's and Amagat's laws, properties of ideal gas mixtures, air-water vapor mixtures and simple thermodynamic processes involving them; specific and relative humidities, dew point and wet bulb temperature, adiabatic saturation temperature, psychrometric chart.

TOTAL : 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. be clear with the basic concepts and laws of thermodynamics
CO2. recall the properties of pure substances
CO3. formulate relations between thermodynamic variables
CO4. have clear knowledge on ideal gas mixtures

TEXT BOOKS:

1. ZeemanskyW.and DittmanH., Heat and thermodynamics, 8th edition, McGRAW-HILL companies, 2017.
2. NarayananK. V., A textbook of Chemical engineering thermodynamics, PHI learning privated limited, 2013
3. David R. Gaskell and David E. Laughlin, Introduction to the Thermodynamics of materials, 6th edition, CRC Press, 2018

REFERENCES:

1. VenkataramanG., A hot story, Universities (India) press private limited, 1993.
2. David Halliday, Robert Resnick, Jearl Walker, Fundamentals of Physics Extended, 10th Edition, Wiley 2013.
3. Nag P.K, Engineering Thermodynamics, Third Edition, Tata McGraw Hill Publishing Company Ltd., 2006.
4. Rajput R.K., Engineering Thermodynamics, Laxmi Publications (P) Ltd., 2016.
5. Brian Smith E., Basic Chemical Thermodynamics, Sixth Edition, Imperial College Press, 2013.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	be clear with the basic concepts and laws of thermodynamics	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO2	recall the properties of pure substances	3	3	1	2	2	–	–	–	–	–	–	–	3	–	–	3
CO3	formulate relations between thermodynamic variables	3	3	2	2	1	–	–	–	–	–	–	–	3	–	–	3
CO4	have clear knowledge on ideal gas mixtures	2	2	2	2	2	–	–	–	–	–	–	–	3	–	–	3
THERMODYNAMICS OF MATERIALS		3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5404 **CERAMIC FABRICATION PROCESSES** **L T P C**
3 0 0 3

OBJECTIVES:

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.

UNIT I SLIP PREPARATION **9**

General Ceramic Forming Techniques and Additives. Slip- selection of materials, preparation, slip properties – density, fluidity, particle size measurement, viscosity, thixotrophy, surfactant concentration, binders, pH, zeta potential, settling, solid recovery, slip recovery, slip conditioning and storage.

UNIT II SLIP CASTING PROCESS **9**

Mould preparation, Slip Casting practice and Mechanics, Types of slip casting - Drain Casting and solid casting- Casting Defects, Casting control, - Deflocculant, particle size, shape and surface effects, Finishing. Other casting techniques - Gel casting. Tape Casting – Process, Defects, Applications.

UNIT III PLASTIC FORMING PROCESS **9**

Preparation of plastic mass by pugging. Shaping of Plastic Bodies , Extrusion and plastic deformation forming – Equipment and Material Variables, Mechanics, Control of Extrusion Defects, Applications. Hand Modelling and Hand Moulding –The Potter's Wheel, Jiggering and Jolleying, Batting, Turning, Scalloping, Roll Forming. Plastic Pressing, Injection Molding – Equipment and Material Variables, Mechanics of flow, Defects and Their control.

UNIT IV PRESSING **9**

Powder preparation from slurry. Granulation, Powder filling and Die Filling, Compaction Behaviour, Ejection and Transfer, Die Wall Effects and pressure Transmission, Control of Compact Defects, Isostatic Compaction. Hot pressing –Heating to softening point, Hot pressing and sintering.

UNIT V DRYING AND FIRING **9**

Changes during heat treatment - Water smoking period, Oxidation and Decomposition reactions. Drying – systems, Modes of Drying, Mechanisms in Drying, process, shrinkage and defects, Types of dryers. Firing –Systems, pre sintering processes, Calculating the heat requirements for firing ware, firing schedule – Heating, cooling. Types of kilns. Control of conventional sintering, sintering problems.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. be thorough with the additives and process of slip preparation
CO2. differentiate the different consistencies and identify corresponding shaping methods
CO3. know the possible defects and their remedies during shaping
CO4. discern the methods to dry and fire the prepared articles
CO5. discuss the changes that happen in articles during drying and firing

TEXT BOOKS:

1. James S. Reed, Principles of Ceramic Processing, 2nd Edn, John Wiley and Sons, NY, 1995.
2. F. Singer and S. Singer, Industrial Ceramics, Oxford and IBH Publishing Co., 2013.

REFERENCES:

1.David W. Richerson and William E.Lee, Modern Ceramic Engineering: Properties, Processing and Use in Design, 4th Edn., CRC Press, 2018.
2. Mohamed N.Rahaman, Ceramic Processing, Taylor and Francis, 2017.
3. Alan G. King, Ceramic Technology and Processing, Noyes Publication, USA, 2002.
4. Roy W.Rice, Ceramic Fabrication Technology, Marcel Dekker Inc., 2002.
5. Kingery W.D., Ceramic Fabrication Processes, Technology Press of Massachusetts Institute of Technology, 1960.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	be thorough with the additives and process of slip preparation	3	3	2	2	2	–	–	–	–	–	–	–	–	3	–	3
CO2	differentiate the different consistencies and identify corresponding shaping methods	3	3	2	2	2	–	–	–	–	–	–	–	–	3	–	3
CO3	know the possible defects and their remedies during shaping	3	3	2	2	2	–	–	–	–	–	–	–	–	3	–	3
CO4	discern the methods to dry and fire the prepared articles	3	3	2	2	2	–	–	–	–	–	–	–	–	3	–	3
CO5	discuss the changes that happen in articles during drying and firing	3	3	2	2	2	–	–	–	–	–	–	–	–	3	–	3
CERAMIC FABRICATION PROCESSES		3	3	2	2	2	–	–	–	–	–	–	–	–	3	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5411 **TRADITIONAL CERAMICS LABORATORY** **L T P C**
0 0 4 2

OBJECTIVES:

The course is aimed to

- Enable students to prepare casting slip and analyze its various properties
- Prepare articles through different shaping methods
- Teach various physical property estimation techniques

EXPERIMENTS:

1. Plaster Mould Making
2. Preparation of Ceramic Slip with variable raw materials in a Pot Mill
3. Determination of Slip specific gravity
4. Effect of Deflocculant on Viscosity of Slip.
5. Determination of Residue in a Slip.
6. Determination of rheological properties of slip.
7. Forming of Solid Slip Cast Article.
8. Forming of Drain Slip Cast Article.
9. Forming of Ceramic Article by Potter Wheel
10. Forming of Ceramic Article by Jigger and jolly
11. Preparation of ceramic article by extrusion
12. Biscuit Firing
13. Determination of green and fired shrinkage
14. Determination of bulk density, apparent porosity and water absorption

TOTAL :60 PERIODS

OUTCOMES:

On completion of this Laboratory Course, the students are expected to

- prepare ceramic casting slip and analyse its properties
- prepare ceramic articles using slip and plastic mass
- evaluate physical properties of the prepared ware

EQUIPMENTS REQUIRED:

1. Electronic weighing balance
2. Pot Mill
3. Hot Air Oven
4. Sieves
5. Moulds
6. Gibbs Viscometer
7. Furnace
8. Jiggering Machine

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	prepare ceramic casting slip and analyse its properties	–	3	3	3	–	–	–	–	–	–	–	–	–	3	–	3
CO2	prepare ceramic articles using slip and plastic mass	–	3	3	3	–	–	–	–	–	–	–	–	–	3	–	3
CO3	evaluate physical properties of the prepared ware	–	3	3	3	–	–	–	–	–	–	–	–	–	3	–	3
TRADITIONAL CERAMICS LABORATORY		–	3	3	3	–	–	–	–	–	–	–	–	–	3	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5412 MATERIALS SCIENCE LABORATORY L T P C
0 0 4 2

OBJECTIVES:

The course is aimed to

- Enable students to understand various crystal structures and imperfections
- Teach various mechanical and thermal property estimation techniques
- Enable students to construct simple phase diagrams

EXPERIMENTS:

1. Determination of Crystal Structure and Imperfections using ball models
2. Identification of Crystalline and Non-Crystalline Materials
3. Construction of Phase Diagrams
4. Analyze the microstructure of materials by various sample preparation methods.
5. Analyze the microstructure of materials by various processing techniques
6. Determination of grain size using microstructural analysis
7. Determination of tensile properties using UTM
8. Determination of compressive strength using UTM
9. Determination of hardness of the material.
10. Determination of band gap in semiconductor materials
11. Determination of B-H curve of materials
12. Determination of glass transition temperature of material.

TOTAL: 60 PERIODS

OUTCOMES:

On completion of this Laboratory Course, the students are expected to

CO1. understand various crystal structures and imperfections
CO2. analyze microstructure of materials
CO3. determine mechanical and thermal properties of materials
CO4. construct simple phase diagram

EQUIPMENTS REQUIRED:

1. B-H Curve unit
2. Universal Testing Machine
3. LCR meter
4. Optical microscope
5. Vicker's hardness tester
6. Melting Furnace
7. Band Gap Apparatus

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	understand various crystal structures and imperfections	–	3	3	3	–	–	–	–	–	–	–	–	3	–	–	3
CO2	analyze microstructure of materials	–	3	3	3	–	–	–	–	–	–	–	–	3	–	–	3
CO3	determine mechanical and thermal properties of materials	–	3	3	3	–	–	–	–	–	–	–	–	3	–	–	3
CO4	construct simple phase diagram	–	3	3	3	–	–	–	–	–	–	–	–	3	–	–	3
MATERIALS SCIENCE LABORATORY		–	3	3	3	–	–	–	–	–	–	–	–	3	–	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5501 **REFRACTORY - I** **L T P C**

3 0 0 3

OBJECTIVES:

The course is aimed to

- Outline the basics about refractories and itsdemand.
- Impart knowledge about various refractory materials
- Discuss the properties and applications of various refractory materials

UNIT I INTRODUCTION 9

Definition, Demand and growth of refractories in India, Layout of a refractory plant, Classification of refractory, Fundamental properties of refractories and their testing – physical properties, mechanical properties, thermal properties, chemical properties; Importance of aggregrate size, pore size and glassy phase content on refractory properties, Factors for selection and use of refractories.

UNIT II SILICA AND ALUMINA - SILICA REFRACTORIES 9

Silica refractories - Raw materials and composition – manufacturing process steps – phase transformation of quartzite - properties andapplications – types.

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

UNIT III BASIC REFRACTORIES 9

Raw materials, manufacturing process, properties and applications of magnesite, forsterite, dolomite, chrome based and spinel refractories - Manufacturing Sectors - Market Scenario - Demand**.**

UNIT IV SPECIAL REFRACTORIES 9

Manufacture, properties and applications of different Carbide and nitride refractories, carbonaceous and carbon based refractory, zirconia, beryllia, thoria refractory, fused cast refractories, cermets- Manufacturing Sectors - Market Scenario - Demand.

UNIT V INSULATING REFRACTORIES 9

Types of insulating materials – preparation of insulating refractories, ceramic fibers, ceramic fibre products – purpose of insulation – ceramic coatings to minimize heat loss.

TOTAL : 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. Comprehend different refractory properties and their inter relations
CO2. Garner knowledge on the types of refractories and their significance
CO3. Recall the steps involved in the preparation of various refractory materials
CO4. Interpret the properties and applications of the refractory materials
CO5. Acquire awareness on the purpose on insulation and insulating materials

TEXT BOOKS:

1. Charles A.Schacht, Refractories Handbook, Marcel Dekker Inc., 2004.
2. Chesters J.H, Refractories: Production and Properties, Iron and Steel Institute, London,1973.

REFERENCES:

1. RitwikSarkar, Refractory Technology: Fundamentals and Applications, CRC Press, 2017
2. CoopeB.M.and DicksonE.M., Raw Materials for the Refractories Industries, An Industrial Minerals Consumer Survey, 1981.
3. Shaw K, Refractories and Their Uses, App,Science Publishers,UK,1972.
4. SurendranathanA. O., An Introduction to Ceramics and Refractories, CRC Press,2014.
5. NandiD.N., Handbook of Refractories, Tata McGraw Hill Publishing Co, New Delhi,1991.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Comprehend different refractory properties and their inter relations	–	3	3	2	2	–	–	–	–	–	–	–	–	3	–	3
CO2	Garner knowledge on the types of refractories and their significance	–	3	3	3	2	–	–	–	–	–	–	–	–	3	–	3
CO3	Recall the steps involved in the preparation of various refractory materials	–	3	3	3	2	–	–	–	–	–	–	–	–	3	–	3
CO4	Interpret the properties and applications of the refractory materials	–	3	3	3	2	–	–	–	–	–	–	–	–	3	–	3
CO5	Acquire awareness on the purpose on insulation and insulating materials	–	2	3	3	2	–	–	–	–	–	–	–	–	3	–	3
REFRACTORY-I		–	3	3	3	2	–	–	–	–	–	–	–	–	3	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5502 GLASS ENGINEERING–I L T P C
3 0 0 3

OBJECTIVES:

The course is aimed to

- Describe the principle behind glass formation and structures of different glasses.
- List about the raw materials for glass making and describe formation of glass
- Explain about the thermo-dynamical, thermal, mechanical, electrical and other properties ofglass.
- Describe the defects found in a flat ware and a hollow ware, and the quality control procedure for a coatedglass.

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-Al_2O_3-SiO_2, Na_2O-CaO-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 and rise of bubbles, refining agents. Homogenization – sources of inhomogenity, rate of homogenization in relation to diffusion kinetics, conventional currents and rise of bubbles.

UNIT IV PROPERTIES AND TESTING OF GLASS 8

Thermodynamic and thermal properties – density, surface tension, thermal expansion, specific heat, thermal conductivity.Mechanical properties – viscosity, elastic properties, hardness, strength.Electrical and 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 - Industries - Market Scenario - Demand.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. Have thoroughly understood the science behind glass formation
CO2. Enumerate the various raw materials used for glass preparation and the purpose of its usage
CO3. Formulate glass compositions from batch composition and vice versa.
CO4. Explain various glass properties and their testing methods
CO5. Know the defects that occurs in glass and quality control in different glasses.

TEXT BOOKS:

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

REFERENCES:

1. GanguliD., KumarS., Elements of Ceramics –VolII, 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, VolIandII, Ogden Publishing Co., NY, 1960.
4. Charles A Harper, Handbook of Ceramic Glasses and Diamonds, McGraw Hill,2001.
5. Glass Furnaces-Design, Construction and Operation, Wolfgang Trier, Society of Glass Technology, 2000.
6. Narottam P Banral, R.H.Doremus, Handbook of Glass Properties, Academic Press, Inc,1986.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	**Have thoroughly understood the science behind glass formation**	–	3	2	2	2	–	–	–	–	–	–	–	–	3	–	3
CO2	**Enumerate the various raw materials used for glass preparation and the purpose of its usage**	–	3	2	2	2	–	–	–	–	–	–	–	–	3	–	3
CO3	**Formulate glass compositions from batch composition and vice versa.**	–	3	2	2	2	–	–	–	–	–	–	–	–	3	–	3
CO4	**Explain various glass properties and their testing methods**	–	3	2	2	2	–	–	–	–	–	–	–	–	3	–	3
CO5	**Know the defects that occurs in glass and quality control in different glasses.**	–	2	2	2	2	–	–	–	–	–	–	–	–	3	–	3
GLASS ENGINEERING–I		–	3	2	2	2	–	–	–	–	–	–	–	–	3	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5511 **GLASS AND COATINGS LABORATORY** **L T P C**
0 0 4 2

OBJECTIVES:

The course is aimed to

- Enable students to prepare different glass compositions and products
- Enable students to prepare and apply glaze and enamel over wares
- Teach techniques for estimation of glass properties

EXPERIMENTS:

1. Preparation of Soda Lime Glass with varying Cullet Percentage
2. Preparation of Amber Glass
3. Determination of Density, Thermal Expansion, Refractive Index and Chemical Durability of glass
4. Preparation of laminated glass
5. Determination of hardness of a toughened glass
6. Glass fusion and shaping
7. Glaze application over ware by spraying, dipping and pouring
8. Glost firing
9. Sheet metal preparation
10. Ground and cover coat application on metal
11. Design application on glass
12. Glaze crazing test using autoclave
13. Chemical Treatment on glass and glaze
14. Thermo-mechanical treatment on glass and glaze

TOTAL: 60 PERIODS

OUTCOMES:

On completion of this Laboratory Course, the students are expected to

CO1. prepare and fabricate different glasses
CO2. prepare and apply glaze over articles
CO3. prepare and apply enamel over articles
CO4. evaluate properties of glass and glaze

EQUIPMENTS REQUIRED:

1. Sieve Shaker
2. Hot Plate
3. Hot Air Oven
4. Furnace
5. Electronic balance
6. Dilatometer
7. Spectrometer
8. Optical microscope
9. Vicker's hardness tester
10. Autoclave
11. Pneumatic Spray gun
12. Three point bending test apparatus

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	prepare and fabricate different glasses	–	3	3	3	–	–	–	–	–	–	–	–	–	–	3	3
CO2	prepare and apply glaze over articles	–	3	3	3	–	–	–	–	–	–	–	–	–	–	3	3
CO3	prepare and apply enamel over articles	–	3	3	3	–	–	–	–	–	–	–	–	–	–	3	3
CO4	evaluate properties of glass and glaze	–	3	3	3	–	–	–	–	–	–	–	–	–	–	3	3
GLASS AND COATINGS LABORATORY		–	3	3	3	–	–	–	–	–	–	–	–	–	–	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5512 **CAD LABORATORY** **L T P C**

0 0 2 1

OBJECTIVES:

The course is aimed to

- impart CAD modelling and design of Ceramic components using CAD software.
- model and analyse simple Ceramic components using Finite Element Analysis Software.

EXERCISES:

1. Basic Training on CAD Software Tools.
2. Modelling of Crucible Mould.
3. Modelling of Crucible for suitable dimensions and Materials Properties.
4. Modelling of Cup and Saucer using Assembly Design.
5. Modelling of Vase with handles using shell and Rib command.
6. Basic Training of FEA Software Tools.
7. Stress Analysis of beams with point load.
8. Stress Analysis of beams with varying load.
9. 1-D Conduction problem with single wall.
10. 1-D Conduction problem with multi wall.
11. Coupled Structural / Thermal Analysis.
12. Fatigue Problems.

TOTAL: 30 PERIODS

OUTCOMES:

On completion of this Laboratory Course, the students are expected to

CO1. develop CAD Model of Ceramic Products.

CO2. evaluate Stress Analysis on modelled Ceramic components.

CO3. evaluate Thermal studies on simple Ceramic components.

FACILITIES REQUIRED:

15No's of higher end Pentium PC with minimum 64bit,

4GB RAM with Suitable Finite Element Analysis and CAD Software.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	develop CAD Model of Ceramic Products.	–	3	3	3	3	–	–	–	–	–	–	–	3	–	–	3
CO2	evaluate Stress Analysis on modelled Ceramic components.	–	3	3	3	3	–	–	–	–	–	–	–	3	–	–	3
CO3	evaluate Thermal studies on simple Ceramic components.	–	3	3	3	3	–	–	–	–	–	–	–	3	–	–	3
CAD LABORATORY		–	3	3	3	3	–	–	–	–	–	–	–	3	–	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5513 **CREATIVE AND INNOVATIVE PROJECT** **L T P C**
0 0 4 2

OBJECTIVES:

The course is aimed to

- help students to identify innovative projects that promotes and imbibe creativity.
- enable students to be familiar with current thinking in their field, and able to apply the concepts to relevant research problems or practical applications related to Ceramic Technology.

Each batch comprising of a maximum of 3 students will choose problem related to research or industrial task that has been difficult for them to “solve.” Batch is expected to solve the task by fabricating or developing suitable working model / process / product. At the end of the semester, each student or group of students have to submit a report for evaluation.

TOTAL: 60 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. learn concepts, models, frameworks, and tools that a Ceramic Engineer need in a world where creativity and innovation is fast becoming a pre- condition for competitive advantage.

CO2. develop a working model using the knowledge they have gained theoretically

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	learn concepts, models, frameworks, and tools that a Ceramic Engineer need in a world where creativity and innovation is fast becoming a pre-condition for competitive advantage.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	develop a working model using the knowledge they have gained theoretically	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CREATIVE AND INNOVATIVE PROJECT		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5601 GLASS ENGINEERING – II L T P C
3 0 0 3

OBJECTIVES:

The course is aimed to

- Describe different furnaces used for glass melting, their design and operation.
- Elaborate the fabrication methods of glass flat ware and hollow ware.
- Discuss the importance and process of annealing of glass products.
- Define 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 andconstruction. Electric tank furnace – design and operation, electrodes used, electric boosting in tankfurnace. Forehearthand Feeder section in tank furnace.

UNIT II OPERATION OF TANK FURNACE 10

Heating process – temperature distribution, efficiencies, heat balance, thermal insulation andcooling.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 and blow, blow and blow, IS machine, bulbs and tubes.

UNIT IV ANNEALING 9

Introduction, nature of generation and release of strain, temporary and permanent strain, dependence ofstrain on cooling rate, detection and 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, temperedglass, decorated glasses, vycorand micro porous glass, sealing glass, neutral glass, photosensitiveglass, glass ceramic, glass fibers - Manufacturing Sector.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. Describe different glass melting furnace
CO2. Explain the operation of tank furnace with the means to control its operation
CO3. Recall different fabrication processes of glass
CO4. Recognize the importance of annealing a glassware
CO5. State various value adding processes in glass

TEXT BOOKS:

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

REFERENCES:

1. Tooley F.V, Handbook of Glass Manufacture, Vol IandII, Ashlee Publishing Company., 1984.
2. Alexis G.Pincus, Melting Furnace Operation in the Glass Industry, Magazines forIndustry 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 and Technology, The Royal Society of Chemistry, 1997.
5.BasudebKarmakar, Functional Glasses and Glass-Ceramics: Processing, Properties and Applications, Elesiver, UK, 2017.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Describe different glass melting furnace	–	3	2	2	2	–	3	–	–	–	–	–	–	3	–	3
CO2	Explain the operation of tank furnace with the means to control its operation	–	3	2	1	2	–	3	–	–	–	–	–	–	3	–	3
CO3	Recall different fabrication processes of glass	–	2	1	2	2	–	3	–	–	–	–	–	–	3	–	3
CO4	Recognize the importance of annealing a glassware	–	3	2	2	2	–	3	–	–	–	–	–	–	3	–	3
CO5	State various value adding processes in glass	–	3	2	2	2	–	3	–	–	–	–	–	–	3	–	3
GLASS ENGINEERING – II		–	3	2	2	2	–	3	–	–	–	–	–	–	3	–	3

1, 2 and 3 are correlation levels with weightingsas Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5602REFRACTORY - II **L T P C**

3 0 0 3

OBJECTIVES:

The course is aimed to

- Explain the application of refractories in different industries
- Describe the design and installation of refractories

UNIT I REFRACTORIES FOR IRON andSTEEL INDUSTRY **9**

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

UNIT II REFRACTORIES FOR NON-FERROUSandNON-METALLIC INDUSTRIES **9**

Refractories for non-ferrous industries – copper, aluminum, zinc, lead. Refractories for non-metallic industries – hydrocarbon industry, fertilizer industry, cementindustry.

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 SPACE and 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.

UNIT V REFRACTORY LINING DESIGN AND INSTALLATION **9**

Design with shaped dense and heat-insulating materials – standard shapes, holding anchors, joints, some examples of design. Design with monolithic refractory material – general, anchors, joints, some examples of design. Example for heat flux calculation through multilayer refractory wall and subsequent wall design. Installation of shaped and unshaped refractory materials, and ceramic fiber products- industries, market scenario.`

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. Cognize the design and refractory usage in various furnaces

CO2. Know the refractory usage in space and nuclear applications

CO3. Reason out the purpose of using a particular refractory in its application area

CO4. Design refractory linings and develop installation methods

TEXT BOOKS:

1. Ehler Nowak, Refractory Engineering: Materials-Design-Construction, 2nd Edn., Tech Books International, New Delhi, 2007
2. Shaw K, Refractories and Their Uses, App,Science Publishers,UK,1972

REFERENCES:

1. RitwikSarkar, Refractory Technology: Fundamentals and Applications, CRC Press, 2017
2. Chesters J.H, Steel Plant Refractories, 2nd Edn, United Steel Company Limited, UK,1973
3. Stephen Caniglia , Gordon L. Barna, Handbook of Industrial Refractories Technology: Principles, Types, Properties and Applications, Noyes Publications,1992
4. NandiD.N, Handbook of Refractories, Tata McGraw Hill Publishing Co, New Delhi,1991
5. Charles A.Schacht, Refractories Handbook, Marcel Dekker Inc., 2004.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Cognize the design and refractory usage in various furnaces	–	3	2	2	2	–	3	–	–	–	–	–	–	3	–	3
CO2	Know the refractory usage in space and nuclear applications	–	3	2	1	2	–	3	–	–	–	–	–	–	3	–	3
CO3	Reason out the purpose of using a particular refractory in its application area	–	2	1	2	2	–	3	–	–	–	–	–	–	3	–	3
CO4	Design refractory linings and develop installation methods	–	3	2	2	2	–	3	–	–	–	–	–	–	3	–	3
REFRACTORY - II		–	3	2	2	2	–	3	–	–	–	–	–	–	3	–	3

1, 2 and 3 are correlation levels with weightingsas Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5603 ADVANCED CERAMIC PROCESSING **L T P C**
3 0 0 3

OBJECTIVES:

This course is aimed to impart knowledge in

- Preparation of ceramic powders
- Surface interaction between powders
- Consolidation and fabrication of final ceramic products

UNIT I POWDER SYNTHESIS **9**

Powder Characteristics – Powder Preparation – Mechanical, Chemical – Solid state,Liquid state and Vapour Phase reactions – Nano scale powders- SiO_2, TiO_2, Al_2O_3, $BaTiO_3$,ZrO_2, CeO_2, Si_3N_4, $MoSi_2$, SiC.

UNIT II COLLOIDAL PROCESSING **9**

Colloids – Types – Surface forces – Stabilisation – Colloidal suspension – Electrostatic, steric and electrosteric – structure and Rheology of colloidal suspensions

UNIT III FORMING **9**

Additives – Solvents , Dispersants, Binders , Plasticizers. Forming Methods – Dry and semidry pressing – Die compaction and Isostatic compaction. Casting – pressure casting and tape casting. Plastic forming – extrusion and injection molding. Solid free form fabrication – Particle filled polymer, Powder consolidation and suspension methods

UNIT IV SINTERING **9**

Mechanisms – Grain growth and coarsening – Solid state sintering – Grain boundary effect, stages and sintering models. Liquid state sintering – stages, kinetic and thermodynamic effects – Sintering practice – Isothermal, Multistage, Fast firing, Microwave, Plasma Assisted , Flash. Pressure Assisted sintering – Hot Pressing, Sinter Forging, HIP

UNIT V CERAMIC FABRICATION AND APPLICATIONS **9**

Film, Monoliths, Fibers – CVD, Directed Metal Oxidation , Reaction Bonding , sol –gel Processing. Fabrication of Cutting tools, Ceramic Liners, bearings, Turbine blade, Biological implants, Ceramic capacitors- case studies - Industries

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, students are expected to

CO1. evaluate suitable method for ceramic powder preparation
CO2. identify science of interaction between colloidal state of powders
CO3. select suitable forming and sintering method
CO4. identify fabrication method of ceramic components

TEXT BOOKS:

1. Mohamed N.Rahaman, Ceramic Processing, Taylor and Francis, 2007.
2. David W. Richerson, Modern Ceramic Engineering, 3rd Edn., Taylor and 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 and Francis, 2005.
5. ChawlaK.K., Ceramic Matrix Composites, 2nd Edition, Springer Science - Business Media, B.V.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome														
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	evaluate suitable method for ceramic powder preparation	–	3	2	2	3		3	–	–	–	–	3	–	–	3	3
CO2	identify science of interaction between colloidal state of powders	–	3	2	1	2		3	–	–	–	–	3	–	–	3	3
CO3	select suitable forming and sintering method	–	3	2	2	2		2	–	–	–	–	3	–	–	3	3
CO4	identify fabrication method of ceramic components	–	3	1	2	3		3	–	–	–	–	3	–	–	3	3
ADVANCED CERAMIC PROCESSING		–	3	2	2	3		3	–	–	–	–	3	–	–	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

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CT5611 **REFRACTORY LABORATORY** **L T P C**
0 0 4 2

OBJECTIVES:

The course is aimed to

- Enable students to prepare different refractories
- Teach estimation of properties of refractories

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 :60PERIODS

OUTCOMES:

On completion of this Laboratory Course, the students are expected to

CO1. design composition and prepare different refractories
CO2. estimation of properties of different refractories
CO3. compare properties of different refractories

EQUIPMENTS REQUIRED:

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

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	design composition and prepare different refractories	–	3	3	3	–	–	–	–	–	–	–	–	–	3	–	3
CO2	estimation of properties of different refractories	–	3	3	3	–	–	–	–	–	–	–	–	–	3	–	3
CO3	compare properties of different refractories	–	3	3	3	–	–	–	–	–	–	–	–	–	3	–	3
REFRACTORY LABORATORY		–	3	3	3	–	–	–	–	–	–	–	–	–	3	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5612 ADVANCED CERAMIC PROCESSING LABORATORY L T P C
0 0 4 2

OBJECTIVES:

The course is aimed to

- Enable students to prepare ceramic powders by different methods and consolidate them through various techniques
- Teach various sintering techniques and surface treatment methods

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. Coating over substrate by Spray Pyrolysis
13. Surface Grinding and Roughness estimation

TOTAL: 60 PERIODS

OUTCOMES:

On completion of this Laboratory Course, the students are expected to

CO1. prepare ceramic powders by top-down and bottom up approaches
CO2. prepare ceramic articles by advanced casting and other shaping methods
CO3. fire ceramic articles by advanced sintering techniques
CO4. modify and study the surface of ceramic articles by coatings or grinding

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. Magnetic stirrer
10. Tape casting Equipment
11. Surface Grinding Machine
12. Surface Roughness Tester Machine

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3	PSO 4
CO1	prepare ceramic powders by top-down and bottom up approaches	–	3	3	3	3	–	–	–	–	–	–	3	–	–	3	3
CO2	prepare ceramic articles by advanced casting and other shaping methods	–	3	3	3	3	–	–	–	–	–	–	3	–	–	3	3
CO3	fire ceramic articles by advanced sintering techniques	–	3	3	3	3	–	–	–	–	–	–	3	–	–	3	3
CO4	modify and study the surface of ceramic articles by coatings or grinding	–	3	3	3	3	–	–	–	–	–	–	3	–	–	3	3
ADVANCED CERAMIC PROCESSING LABORATORY		–	3	3	3	3	–	–	–	–	–	–	3	–	–	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5701 **CERAMIC CHARACTERIZATION** **L T P C**
3 0 0 3

OBJECTIVES:

The course is aimed to

- Enable students to be thorough in different materials characterizations techniques which are dependent on their composition, phase, crystal, particulate and microstructure properties and applications.

UNIT I THERMAL ANALYSIS **9**

Principles of Differential thermal analysis (DTA), Thermogravimetric analysis (TGA) and Differential scanning calorimetry (DSC), Dilatometer - their applications in processing and Characterization of ceramics, glasses, and glass Ceramics.

UNIT II X – RAY DIFFRACTION **9**

Characteristics X – rays, Fundamental principles of X-ray diffraction (XRD); Brag's Law, Determination of Crystal Structure and particle size from XRD, Atomic Scattering and geometrical structure factors and their application in intensity calculation. Single crystal and powder diffraction.

UNIT III SPECTROSCOPY **9**

Basic laws of spectrophotometry and its application in elemental analysis in UV/ Visible range, Construction and working principle of spectrophotometer, Beer-Lambert's law-limitations, deviations. Additive rule of absorbance in multiple analysis of materials. General aspects of IR spectroscopy and its application in structural analysis of ceramic systems.Optical systems and operation of FTIR spectrophotometers.Raman spectroscopy.

UNIT IV SURFACE CHARACTERIZATIONS **9**

Construction and operation of optical microscope; Principle of electron microscopy: electrostatic and magnetic lens systems; Generation of electron beam (Electron gun); Interaction of electron beam with material. Construction and operation of Transmission Electron Microscope and Scanning, Electron Microscope.Mechanism of image formation in SEM and its processing.Electron microprobe analysis (EDAX and WDS).Preparation of ceramic samples for TEM and SEM electron microscopic studies. Characteristics of microstructure; Quantitative microstructure and phase analysis: Study of the morphology, size and aggregation of ceramic materials. BET, Atomic force microscopy, Auger electron spectroscopy.

UNIT V ELECTRICAL, MAGNETIC CHARACTERIZATIONS **9**

Electrical resistivity in bulk and thin films(2-probe method and 4-probe method), Hall effect, Impedance spectroscopy, Vibrating sample magnetometer(VSM), Magnetic PE loop.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. Know the techniques to characterize a material right from raw material stage to final product stage

CO2. Explain the principle of various characterization techniques

CO3. Select a suitable characterization technique to analyze a property

CO4. Be able to design a material with required properties with the aid of characterization techniques

TEXT BOOKS:

1. Antony R. West , Solid State Chemistry and its applications, Second edition, John WileyandSons, 2014.
2. ZhangS, Li L.and Ashok Kumar, Materials Characterization Techniques, CRC Press, 2008.

REFERENCES:

1. CullityB. D., Elements of X-ray diffraction, Second edition, Addition-Wesley publication, 2001.
2. Yoshio Waseda, Kozo Shinoda, Eiichiro Matsubara, X-Ray Diffraction Crystallography: Introduction, Examples and Solved Problems, Springer, 2011.
3. Characterization of materials (Materials Science and Technology: A comprehensive treatment, Vol 2A and 2B, VCH (1992)

4.https://nptel.ac.in/courses/113106034/

5. https://nptel.ac.in/courses/115103030/

6.https://chem.libretexts.org/

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Know the techniques to characterize a material right from raw material stage to final product stage	–	3	2	2	2		2	–	–	–	–	3	3	–	–	3
CO2	Explain the principle of various characterization techniques	–	2	2	2	3		1	–	–	–	–	3	3	–	–	3
CO3	Select a suitable characterization technique to analyze a property	–	3	1	2	2		2	–	–	–	–	3	3	–	–	3
CO4	Be able to design a material with required properties with the aid of characterization techniques	–	2	2	1	3		2	–	–	–	–	3	3	–	–	3
CERAMIC CHARACTERIZATION			3	2	2	3		2	–	–	–	–	3	3	–	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5711 CERAMIC CHARACTERIZATION LABOATORY L T P C
0 0 4 2

OBJECTIVES:

The course is aimed to

- Enable students to characterize ceramic powders and products for various properties

EXPERIMENTS:

1. Elemental analysis using atomic emission spectrometer - Flame Photometer
2. Thermal Analysis of ceramic and glass materials by TGA, DTA, DSC.
3. Determination of Viscosity of slip by Brookfield Viscometer.
4. Particle Size Analysis of ceramic powders by Laser Diffraction technique.
5. Study the surface morphology of ceramic systems by microscopy techniques – Optical Microscopy and SEM.
6. Hardness estimation using Vicker's Hardness/Nano Indenter.
7. Creep, Wear and Abrasion Resistance analysis.
8. Study the thermal expansion behaviour of ceramic material using dilatometer.
9. Determination of dielectric constant of unknown ceramic system by parallel plate capacitor method.
10. Temperature and frequency dependence of dielectric constant of ferroelectric material by impedance spectroscopy.
11. Indexing the X ray diffraction pattern of ceramic system.
12. B-H loop
13. Construction of phase diagram of ceramic material.

TOTAL :60 PERIODS

OUTCOMES:

On completion of this Laboratory Course, the students are expected to

CO1. analyze ceramic raw materials for their particle size and other properties
CO2. estimate various mechanical, thermal, electronic and magnetic properties of ceramic products

EQUIPMENTS REQUIRED:

1. Flame photometer
2. Thermo gravimetric analyzer
3. Brookfield viscometer
4. Laser particle size analyser
5. Optical microscope
6. Scanning electron microscope
7. Vicker's hardness tester / Nano Indenter
8. Pin on disc wear tester
9. Dilatometer
10. Impedence spectroscopy
11. LCR meter
12. B-H Loop equipment
13. X-ray diffractometer

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	analyze ceramic raw materials for their particle size and other properties	–	3	3	3	–	–	–	–	–	–	–	3	3	–	–	3
CO2	estimate various mechanical, thermal, electronic and magnetic properties of ceramic products	–	3	3	3	–	–	–	–	–	–	–	3	3	–	–	3
CERAMIC CHARACTERIZATION LABOATORY		–	3	3	3	–	–	–	–	–	–	–	3	3	–	–	3

1, 2 and 3 are correlation levels with weightingsas Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5712	COMPREHENSION	L T P C 0 0 2 1

OBJECTIVES:

The course is aimed to

- enable students to revise and recollect the courses completed by them earlier

In this course, comprehension test on the courses completed by the students till their Sixth Semester will be conducted twice a week. This will serve to recollect and rectify the doubts in those courses. The marks obtained by the students during the periodic tests will be considered to award the grade to the students.

TOTAL: 30 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. recollect the courses completed by them till their sixth semester

CO2. rectify any doubts they happen to have in those courses

CO3. have better understanding of the courses

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	recollect the courses completed by them till their sixth semester	3	3	–	–	–	–	–	–	–	3	–	3	3	–	–	3
CO2	rectify any doubts they happen to have in those courses	2	3	–	–	–	–	–	–	–	2	–	3	3	–	–	3
CO3	have better understanding of the courses	3	3	–	–	–	–	–	–	–	3	–	3	3	–	–	3
COMPREHENSION		3	3	–	–	–	–	–	–	–	3	–	3	3	–	–	3

1, 2 and 3 are correlation levels with weightingsas Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5713	PROJECT - I	L T P C
		0 0 6 3

OBJECTIVES:

The course is aimed to design and fabrication of ceramic product and to develop a pilot system design of Ceramic Machineries

The students should carryout following assignments and have to submit project report as per University norms.

(1) Design and Construction of Kilns/ Muffle furnace/Vacuum furnace/ceramic furniture/Ceramic liners
(2) Design and Construction of Spray drier/Cyclone separator/Filter press/Pug Mill
(3) Fabrication ceramic components such as Ceramic Sheath/Ceramic Burner/crucible/grinding media/feed through/container

TOTAL: 90 PERIODS

OUTCOMES:

On completion of the course the students are expected

CO1. to make newer ceramic components
CO2. to have experience on principle of ceramic machineries
CO3. to develop a custom built ceramic machinery

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	to make newer ceramic components	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	to have experience on principle of ceramic machineries	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	to develop a custom built ceramic machinery	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
PROJECT - I		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5714	INTERNSHIP / INDUSTRIAL TRAINING (Minimum 4 weeks)	L T P C 0 0 0 2

OBJECTIVES:

The course is aimed to

- Give practical exposure to students in industries or in research institute
- Enable students to relate their theoretical knowledge to practical situation
- Train students to the industry / research environment

All the students have to undergo practical industrial training / internship of minimum four week (total) duration in recognized establishments during vacations in their third year (vacation during V semester and / or VI Semester),at the end of which they have to submit a report.

OUTCOMES:

On completion of the course, the students are expected to

CO1. Employ their theoretical skills
CO2. Be clarified with the components and working of industry / research institute.
CO3. Be trained in the different divisions of the industry / institute
CO4. Face the real life situation in industry / institute with ease on placement.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Employ their theoretical skills	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	Be clarified with the components and working of industry / research institute.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	Be trained in the different divisions of the industry / institute	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	Face the real life situation in industry / institute with ease on placement.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
INTERNSHIP / INDUSTRIAL TRAINING		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5811	PROJECT -II	L T P C
		0 0 16 8

OBJECTIVES:

The course is aimed to

- train the students on systematic analysis of a problem
- enable students to bring out a solution to the problem

Each student / batch with a maximum of 3 students are required to use concepts of ceramic engineering and technology to develop a pilot model or to suggest a suitable process to solve industrial and/or societal related problems. At the end of the course, they have 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, the actual analysis and the development done by the student on the given project.

TOTAL: 240 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. analyze a given problem systematically
CO2. make use of the knowledge gained at various stages of the degree course to bring out solution to the problem
CO3. be trained in methodical approach to problem solving

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	analyze a given problem systematically	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	make use of the knowledge gained at various stages of the degree course to bring out solution to the problem	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	be trained in methodical approach to problem solving	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
PROJECT - II		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5001 **UNSHAPED REFRACTORIES** **L T P C**
3 0 0 3

OBJECTIVES:

The course is aimed to

- Describe various types of monolithic materials
- Discuss the installation methods of different monolithic materials
- Deliberate the wear mechanisms of the installed materials and their testing methods

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, pumpablecastables – 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 mix 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

OUTCOMES:

On completion of the course the students are expected to

CO1. Recall the types of unshaped / monolithic refractory materials, their composition andcharacteristics.

CO2. Prepare monolithic materials with appropriate bond systems

CO3. Discern the methods of installing different monolithic materials, the application design and the lining materials used while laying monolithics.

CO4. Have studied the wear mechanisms that cause failure in a monolithic lining and the methods to test a monolithic.

TEXT BOOKS:

1. Subrata Banerjee, Monolithic Refractories, World Scientific Publishing Co. Pt. Ltd.,1998.
2. Taikabutsu Overseas, Recent Progress in Castable Refractories, Techno Japan, Vol.9 No.1, 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, 4thEdn., 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.
5. SurendranathanA. O., An Introduction to Ceramics and Refractories, CRC Press, NY, 2015.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Recall the types of unshaped / monolithic refractory materials, their composition andcharacteristics.	–	3	2	2	2	–	–	–	–	–	–	–	–	3		3
CO2	Prepare monolithic materials with appropriate bond systems	–	2	2	2	2	–	–	–	–	–	–	–	–	3		3
CO3	Discern the methods of installing different monolithic materials, the application design and the lining materials used while laying monolithics.	–	3	1	2	1	–	–	–	–	–	–	–	–	3		3
CO4	Have studied the wear mechanisms that cause failure in a monolithic lining and the methods to test a monolithic.	–	3	2	2	2	–	–	–	–	–	–	–	–	3		3
UNSHAPED REFRACTORIES		–	3	2	2	2	–	–	–	–	–	–	–	–	3		3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectivel

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CT5002 **FUELS AND ENERGY ENGINEERING** **L T P C**
3 0 0 3

OBJECTIVES:

The course is aimed to

- List out the various types of fuels and their characteristics
- Describe about the combustion of different fuels
- Discuss the modes of heat transfer and means of heat recovery

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 - Manufacturers

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 - Manufacturers

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 gaseousfuel.

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.Methods to protect environment from heat

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. Recall various types of fuels, their advantages and disadvantages
CO2. Calculate air requirement for combustion process and know how to control combustion
CO3. Explain modes of heat transfer
CO4. Describe methods of heat recovery

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. HolmanJ.P., Heat Transfer, McGraw – Hill, 1997. 3. J.D.Gilchrist, Fuels, Furnaces and Refractories, Pergamon Press, NY,1977.
3. ShahaA.K., Combusiton Engineering and Fuel Technology, Oxford and IBH Publishing Co., New Delhi,1974
4. Jain andJain., Engineering Chemistry,15 th Edition. Dhanput Publication,2017
5. John HadlettHarkerand BackhurstJ. R., Fuel and energy, Academic Press, 1981

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	**Recall various types of fuels, their advantages & disadvantages**	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO2	**Calculate air requirement for combustion process and know how to control combustion**	3	2	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO3	**Explain modes of heat transfer**	3	3	1	2	2	–	–	–	–	–	–	–	3	–	–	3
CO4	**Describe methods of heat recovery**	3	2	2	2	1	–	–	–	–	–	–	–	3	–	–	3
FUELS AND ENERGY ENGINEERING		3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5003 PLANT EQUIPMENT AND FURNACE DESIGN L T P C
3 0 0 3

OBJECTIVES:

The course is aimed to

- Discuss the factors for selection of a plantlayout.
- Describe the ways of assembling the various sections in the plant for properfunctioning.
- List the principles of designing equipments and furnaces.
- Enable the construction of furnaces.

UNIT I PLANT DESIGN 9

Proper location of the plant- factors to be considered, factory buildings- layouts with necessarydetails.Feasibility study, market survey, Raw material, Manpower , Power and water availability. Economy of plant design Electrical, Diagram for movement of flow , Gangways for material handling. Exhaust and powder waste management

UNIT II EQUIPMENT DESIGN 9

Design principles- crushers, filter press, sieves, pugmill and different types of pug mill die design ,Design of Jiggering and Jolley machine ,Roller machinesHydraulic power pack design for presses , Bearings and drives for linear motion, Tonnage calculation for hydraulic press, Simple Electrical circuit for automation

UNIT III DRIER DESIGN 9

Design of Spray drier , Design of pumps of spray drier, Energy calculation for drier, chamber Drier, Energy calculation for continuous drier Tunnel drier Heat loss calculation, Materials used for Drier construction ,Fans and Air flow arrangement Measurement of humidity and control of Humidity, Solar drier design

UNIT IV FURNACE DESIGN 9

Energy calculation of furnace, Design of insulation, Identification of suitable refractories. Design of gas flow , Material properties Stack analysis calculation of Draught,Burner design,Flue gas analysis, Energy balance, Waste heat recovery systems. Gobar gas generation and use in furnace - Manufacturers.

UNIT V FURNACE CONSTRUCTION 9

Construction of Chamber kiln, Tunnel kiln , Roller kiln, Blast furnace, Glass tank furnace, Shuttle kiln - Manufacturers.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. Recall the parameters for setting up the plant
CO2. Fabricate the machinery
CO3. Design a drier and a furnace
CO4. Construct a furnace

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 and Sons, NY,1995.
3. Brownhell L.E. and Young E.H., Chemical Plant Design, McGraw Hill,1950.
4. Glinkov M.A., and Glinkov G.M., A General Theory of Furnaces, MIR Publishers, Moscow, 1980.
5. Barrie Jenkins and PeterMullinger, Industrial and Process Furnaces: Principles, Design and Operation, 2TH Editon, Elesiver, UK, 2014.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Recall the parameters for setting up the plant	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO2	Fabricate the machinery	3	2	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO3	Design a drier and a furnace	3	2	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO4	Construct a furnace	2	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
PLANT EQUIPMENT AND FURNACE DESIGN		3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5004	CEMENT TECHNOLOGY	L T P C
		3 0 0 3

OBJECTIVES:

The course is aimed to

- Describe the process of cement clinker manufacture and its testing
- Elaborate on preparation and properties of Portland cement
- Discuss different blended and special cements
- Familiarize the environmental impact and the testing methods of cement

UNIT I PRODUCTION OF CEMENT CLINKER 9

Introduction, Composition of Portland cement, Raw materials, Preparation of kiln feed. Manufacturing process- Wet, Dry, Semidry, Preheating and precalcining process, Working of rotary kiln and shaft kiln.

UNIT II CLINKER STUDY 9

Solid state reactions, Sintering and Clinkering, Constitution of Portland Cement clinker, Study of important system in phase formation, Effect of impurities and role of minor components, Quality control 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 ofPortland cement, Hydration at elevated temperature. Quality control of Cement- Chemical Composition, Setting time, Compressive strength, Workability, Soundness and Heat of hydratio n- Manufacturers.

UNIT IV BLENDED CEMENTS AND SPECIAL CEMENTS 9

Introduction, Type I – Type V Portland Cements; Cement with mineral constituents – pozzolanic materials, Blast furnace slag and fly ash; Problem in of blended cements. Composition, Properties and Applications of Special cements - high alumina cement, white and coloured cement, oil well cement, hydrophobic cement, water proof cement, super sulphate cement, sulphate resisting cement - Manufacturers.

UNIT V ENVIRONMENTAL IMPACTAND CEMENT TESTING 9

Introduction, plant layout, emission to air, water, environmental aspects of alternative fuels, Environmental monitoring- Greenhouse gas emissions, Carbon foot printing.

Cement testing – Determination of consistency, setting time and unsoundness in cement. Effect of aggregates on the consistency and setting time of cement. Determination of strength of cement blocks.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. Know the process of cement clinker manufacture
CO2. Recall the various tests done on clinker
CO3. Describe Portland cement manufacturing process
CO4. Discern the types of cements
CO5. Test the cement for its properties

TEXT BOOKS:

1. Gerry Bye, “Portland Cement”, Third Edition, Institution of Civil Engineers Publication, 2011.
2. Peter C.Hewlett (Editor), Lea’s Chemistry of Cement and Concrete, 4th Edn., Elsevier, 1998.

REFERENCES:

1. Neville A.M.and BrooksJ.J., Concrete Technology, Pearson Education, 1987.
2. Kumar P. Mehta and Paulo MonteiroJ.M., Concrete – Microstructure, Propertiesand Materials, 3rdEdn., Tata McGraw Hill, 2006.
3. Deborah DL. Chung, Multifunctional Cement Based Materials, Marcel Dekker Inc.,2003.
4. BenstedJ.and Barnes P. (Editors), Structure and Performance of Cements, 2nd Edn.,Spon Press,2002.
5. NevilleA.M, Properties of Concrete, 4th Edn., Pearson Education, 1995.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Know the process of cement clinker manufacture	–	3	2	2	2	–	–	–	–	–	–	–	–	3	–	3
CO2	Recall the various tests done on clinker	–	2	2	2	2	–	–	–	–	–	–	–	–	3	–	3
CO3	Describe Portland cement manufacturing process	–	3	2	2	2	–	–	–	–	–	–	–	–	3	–	3
CO4	Discern the types of cements	–	3	2	1	2	–	–	–	–	–	–	–	–	3	–	3
CO5	Test the cement for its properties	–	3	2	2	2	–	–	–	–	–	–	–	–	3	–	3
CEMENT TECHNOLOGY		–	3	2	2	2	–	–	–	–	–	–	–	–	3	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5005 ABRASIVE TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

The course is aimed to

- Discuss basics on abrasives, backings and adhesives
- Describe manufacturing process of coated and bonded abrasives
- Explain the fundamentals of grinding operation, grinding aids and aboutpolishing

UNIT I ABRASIVES, ADHESIVES and BACKINGS 9

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

UNIT II MANUFACTURE OF COATED ABRASIVES 10

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- Manufacturers.

UNIT III BACKUPS 10

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 OFBONDED ABRASIVES 8

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 - Industries.

UNIT V BASICS OF GRINDING AND POLISHING 8

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

OUTCOMES:

On completion of the course the students are expected to

CO1. Recall different types of abrasive grains, backings, adhesives and their characteristics.

CO2. Know the stages involved in the manufacturing of coated and bonded abrasives.

CO3. Describe the effect of different back ups on the grinding characteristics of coated belts.

CO4. Choose a specific bonded wheels for a given grinding operations.

CO5. Identify different grinding fluids and wheel wear

CO6. Discuss types of grinding and polishing operations.

TEXT BOOKS:

1. Coated Abrasives – Modern Tool of Industry, Coated Abrasive Manufacturer's Institute, Cleaveland, Ohio,1982.
2. Kenneth B.Lewis, William F.Schleicher, The Grinding Wheel, The Grinding Wheel Institute, Cleaveland, Ohio,1976

REFERENCES:

1. Coes L Jr., Abrasive, Springer Verlag, New York,1971.
2. Metzger J.L, Super Abrasive Grinding, Butterworths, UK,1986.
3. Francis T.Farago, Abrasive Methods Engineering, Vol.2, Industrial Press Inc., NY,1980.
4. Edwards R, Cutting tools, The Institute of Materials, Cambridge,1993.
5. Fred B.Jacobs, The Abrasives, The Penton Publishing Co., Cleveland, USA,1928.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3	PSO 4
CO1	Recall different types of abrasive grains, backings, adhesives and their characteristics.	–	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO2	Know the stages involed in the manufacturing of coated and bonded abrasives	–	3	2	1	2	–	–	–	–	–	–	–	–	–	3	3
CO3	Describe the effect of different back ups on the grinding characteristics of coated belts	–	3	2	1	2	–	–	–	–	–	–	–	–	–	3	3
CO4	Identify different grinding fluids and wheel wear	–	3	1	1	2	–	–	–	–	–	–	–	–	–	3	3
CO5	Discuss types of grinding and polishing operations	–	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
ABRASIVE TECHNOLOGY		–	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5006 GLASS CERAMIC TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

The course is aimed to

- Introduce the science of glass-ceramics formation.
- Describe glass ceramic material preparation.
- Discuss about various composition system for glass ceramics
- Elaborate properties of glass ceramic materials.
- List different applications of glass ceramics.

UNIT I INTRODUCTION 8

Glass ceramic materials – characteristics; phase equilibria in glass forming system; Glass formation; Glass crystallization – nucleation and crystal growth in glass, overall glass crystallization kinetics.

UNIT II PREPARATION OF GLASS CERAMIC MATERIALS 8

Raw materials, preparation of the glass batch, melting, forming, heat treatment, special methods for preparing glass ceramic materials.

UNIT III VARIOUS COMPOSITION SYSTEMS FOR GLASS CERAMICS 11

Alkali and alkaline earth silicates – SiO_2-Li_2O;Aluminosilicates - SiO_2-Al_2O_3, SiO_2-Al_2O_3-Li_2O,SiO_2-Al_2O_3-Na_2O, SiO_2-Al_2O_3-CaO; Flurosilicates - SiO_2-Al_2O_3-MgO-CaO-ZrO_2-F;Silicophosphates - SiO_2-CaO-Na_2O-P_2O_5; Iron silicates - SiO_2-Fe_2O_3-CaO;Phosphates – P_2O_5-Al_2O_3-CaO.

UNIT IV PROPERTIES OF GLASS CERAMIC MATERIALS 9

Density;mechanical properties – strength and elasticity, hardness and abrasion resistance; thermal properties; electrical property.

UNIT V APPLICATIONS 9

Medical – CERABONE, CERAVITAL, BIOVERIT and dental applications; electrical and electronic applications – insulator, electronic packaging; energy applications – components for lithium batteries joining materials for solid oxide fuel cell components; consumer and technical applications - Industries - Market Demand.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students are expected to

CO1. Know phase equilibria in glass forming system, nucleation, crystal growth and overall glass crystallization kinetics.
CO2. Recognize the process involved in the preparation of glass ceramic materials.
CO3. Recall various composition systems for glass ceramics.
CO4. Discern the properties of glass ceramic materials.
CO5. Identify the application of glass ceramics in various fields.

TEXT BOOKS:

1. Z. Strnad, Glass Ceramics materials, Glass Science and Technology 8, Elsevier 1986
2. Wolfram Holand and George H. Beall, Glass – Ceramic Technology, second edition,2012.

REFERENCES:

1. Bach.Krause (Eds), Low Thermal Expjansion Glass Ceramics, Second edition, Springer 2005
2. BasudebKarmaker, Functional Glasses and Glass-Ceramics: Processing, Properties and Applications, Butterworth-Heinemann, 2017.
3. Wolfram Holand and George H. Beall, Nucleation and Crystallisation of Glasses and Glass-Ceramics, Frontiers in Materials, 2017.
4. NIIR Board of Consultants and Engineers,The Complete Book on Glass and Ceramics Technology, Asian Pacific Business Press, 2005.
5. James E Shelby, Introduction to Glass Science and Technology, 2TH Edition, TJ International LTD, UK, 2005.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3	PSO 4
CO1	Know phase equilibria in glass forming system, nucleation, crystal growth and overall glass crystallization kinetics.	–	3	2	2	1	–	–	–	–	–	–	–	–	3	–	3
CO2	Recognize the process involved in the preparation of glass ceramic materials.	–	2	1	2	2	–	–	–	–	–	–	–	–	3	–	3
CO3	Recall various composition systems for glass ceramics.	–	3	2	2	1	–	–	–	–	–	–	–	–	3	–	3
CO4	Discern the properties of glass ceramic materials.	–	3	1	1	2	–	–	–	–	–	–	–	–	3	–	3
CO5	Identify the application of glass ceramics in various fields.	–	3	2	1	2	–	–	–	–	–	–	–	–	3	–	3
GLASS CERAMIC TECHNOLOGY		–	3	2	2	2	–	–	–	–	–	–	–	–	3	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5007	ELECTRONIC CERAMICS	L T P C 3 0 0 3

OBJECTIVES:

The course is aimed to

- Introduce the use of ceramic materials as insulators and capacitors and their properties.
- Describe the processing, properties and various applications of ferroelectric and magnetic ceramics and its applications.
- Provide 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, conduction – electronic and ionic.

UNIT II CERAMIC CAPACITORS 7

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

UNIT III FERROELECTRIC CERAMICS 11

Origin of ferroelectricity in ceramic system, Classification – Ferroelectricity, Anti-ferroelectricity, relaxor ferroelectrics, Piezo-electricity, multiferroics, processing and fabrication of ferroelectric material – mixed oxide and chemical precipitation processes. $BaTiO_3$, PZT, PLZT, Phase diagram of PZT – Dielectric and elctromechanical properties, Piezoelectric based sensor/actuators, Thermoelectric materials.

UNIT IV MAGNETIC CERAMICS 9

Origin of magnetism in ceramic system, Classification of magnetic materials – Ferromagnetic, Antiferromagnetic, Ferrimagnetic - domain theory – Bloch wall – M-H loop – Spinel ferrites – structure, types of ferrites – manganese, zinc ferrites – hexagonal ferrites – garnets, Magneto resistance - GMR-CMR.

UNIT V VARISTORS AND FUEL CELLS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. Recall the science of dielectric, ferroelectric and magnetic systems in ceramics

CO2. Describe the preparations of ferroelectric and magnetic materials by various method

CO3. Identify applications of various electronic ceramic materials

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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. PillaiS. O., Solid State Physics. New age International Publishers, India, 2018.
2. Setter N and Colla SL, Ferroelectric Ceramics, BirkhauserVer Lag, 1993.
3. SomiyaS., AldingerF., ClausenN., SprigsRM, UchinoK., KoumotoK., KanenoM., Handbook of Advanced Ceramics : Vol.II, Processing and their applications, Academic Press, 2003.
4. Buchanan RC, Ceramic Materials for Electronics, Marcel Dekker Inc., NY, 1991.
5. Levinson, Electronic Ceramics: Properties: Devices, and Applications, Merckel Dekker INC, NY, 1987.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Recall the science of dielectric, ferroelectric and magnetic systems in ceramics	–	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO2	Describe the preparations of ferroelectric and magnetic materials by various method	–	3	2	2	1	–	–	–	–	–	–	–	–	–	3	3
CO3	Identify applications of various electronic ceramic materials	–	3	1	2	2	–	–	–	–	–	–	–	–	–	3	3
ELECTRONIC CERAMICS		–	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5008 **FUEL CELLS AND SENSORS** **L T P C**
3 0 0 3

OBJECTIVES:

The course is aimed to

- Enable the students to have a basic knowledge about the various types of fuel cells and their characterization
- Describe the different sensors and their applications.

UNIT I FUEL CELLS **9**

Introduction.A simple fuel cell.Fuel cell components.Basic fuel cell operation.Fuel cell Performance.Advantages and disadvantages. Types of fuel cells- Phosphoric acid fuel cell (PAFC), Polymer electrolyte fuel cell (PEMFC), Alkaline Fuel cell (AFC), Molten carbonate fuel cell (MCFC) and Solid-oxide fuel cell.

UNIT II REACTION KINETICS **9**

Electrode kinetics. Activation energy Vs charge transfer reaction and reaction rate. Calculating net rate of reaction.rate of reaction at equilibrium.Potential of reaction at equilibrium.Butler – Volmer equation.Improvement of kinetic performance.Tafel equation.Different kinetics in different fuel cells. Catalyst – electrode design.

UNIT III SOLID OXIDE FUEL CELLS **9**

Introduction.Schematic design of conventional SOFC.Tubular SOFC. Planar SOFC – Sealings, bipolar plates. Stresses in planar SOFCs, Monolithic SOFCs. Varieties of SOFCs – single chamber SOFCs, direct flame SOFCs, Ammonia SOFCs. Types of solid electrolytes – Zirconia and Ceria electrolytes.Materials for electrodes – Anode and cathode materials. Factors influencing the life time of SOFCs - Manufacturers - Demand.

UNIT IV FUEL CELL CHARACTERIZATION **9**

Ex situ characterizations – Porosity determination, surface area measurements, gas permeability, structure determination, chemical determination. In situ characterizations (electrochemical) - current - voltage measurement, current interrupt measurement, electrochemical impedance spectroscopy, cyclic voltammetry.

UNIT V SENSORS **9**

Introduction, some sensor materials – ZrO_2 , PZT and SiC. Types – gas sensors- Auto exhaust and Oxygen sensors. Humidity sensors, Vibration sensors, fiber optic sensors as chemical sensors and biosensors.IR sensors - Manufacturers.

TOTAL : 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. Have learnt the basics about fuel cells and sensors.
CO2. Have knowledge about fuel cell kinetics.
CO3. Have a sound knowledge about solid oxide fuel cells.
CO4. Have learnt about characterization techniques to characterize Fuel cells.
CO5. Have learnt about the various basic sensors.

TEXT BOOKS:

1. Viladimir S. Bagotsky, “Fuel cells problems and solutions” second edition, Wiley, John Wiley and Sons, inc., publication. 2012.
2. Ryan O’Hayre, “fuel cell fundamentals” third edition, Wiley, John Wiley and Sons, inc., publication. 2016.

REFERENCES:

1. Buchanan RC, Ceramic Materials for Electronics, Marcel Dekker Inc., NY, 1991.
2. San Ping jiang, “materials for high temperature fuel cells” wiley – VCH, 2013
3. Duncan W. Bruce., “Energy materials”, Wiley, John Wiley and Sons, UK. 2011.
4. Jacob Fraden, Handbook of Modern Sensors: Physics, Design and Applications, Fifth Edition, Springer, 2016.
5. Subhas C Mukhopadhyay and Joe-Air Jiang, Wireless Sensor Networks and Ecological Monitoring, Springer, NY, 2013.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3	PSO 4
CO1	Have learnt the basics about fuel cells and sensors.	–	3	2	1	2	–	–	–	–	–	–	–	–	–	3	3
CO2	Have knowledge about fuel cell kinetics.	–	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO3	Have a sound knowledge about solid oxide fuel cells.	–	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO4	Have learnt about characterization techniques to characterize Fuel cells.	–	3	1	2	1	–	–	–	–	–	–	–	–	–	3	3
CO5	Have learnt about the various basic sensors.	–	2	2	1	2	–	–	–	–	–	–	–	–	–	3	3
FUEL CELLS AND SENSORS		–	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5009 MATERIALS FOR ENERGY DEVICES L T P C
3 0 0 3

OBJECTIVES:

The course is aimed to

- list out various energy materials.
- discuss about fabrication and performance of various energy storage devices

UNIT I ENERGY MATERIALS 9

Introduction- characteristics of energy materials – Significance of energy materials- various Types of energy materials - Materials for energy harvesting - solar energy, Materials for energy transport and storage – Superconductors, batteries and super capacitors, Materials for energy conversion - Fuel cells and thermoelectric materials. Ferroelectric based energy materials – piezoelectric, thermoelectric and pyroelectric materials.

UNIT II SOLAR ENERGY MATERIALS 9

Introduction –The solar spectrum. Solar cells: materials, issues and cell architectures. Development of PV Technology – first generation silicon based materials - Polysilicon ,crystalline silicon. Second generation - Cadmium telluride thin film PV and Copper indium diselenide thin film PV. Third Generation: photo electrochemical cells for hydrogen generation.

UNIT III ENERGY TRANSPORT AND STORAGE MATERIALS 9

Superconducting materials – properties of superconductors, types of superconductors, pervoskite superconductivity, Application – electric generators, electric power transmission.Energy Storage Applications - The Role of Batteries, lithium-Ion Battery – anode and cathode materials. Nickel-Metal Hydride Battery, Applications batteries.

UNIT IV FUEL CELL MATERIALS 9

Introduction.A simple fuel cell.Fuel cell components.Basic fuel cell operation.conventional SOFC electrolytes, conventional Anodes, conventional cathode. Next generation SOFC material – Novel electrolyte material, novel cathodes, sulphur tolerant anodes. proton conducting ceramic fuel cells-Material for proton conducting SOFC.

UNIT V FERROELECTRIC BASED ENERGY MATERIALS 9

Introduction to ferroelectrics, anti ferroelectric and piezoelectric, pyroelectric systems, materials. Electromechanical coupling, figures of merit, piezoelectric energy harvesting system, electrocaloric effect, energy storage capacitors

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. Have learnt the basics about energy materials.
CO2. Have knowledge about solar energy materials.
CO3. Have a sound knowledge about energy transport and storage materials.
CO4. Have learnt about the fuel cell materials.
CO5. Have learnt about ferroelectric materials for energy application.

TEXT BOOKS:

1. Duncan W. Bruce., “Energy materials”, Wiley, John Wiley and Sons, UK. 2011.
2. John kilner “Functional materials for sustainable energy applications”, Woodhead Publishing Limited, UK. 2012.

REFERENCES:

1. Arumugam. M, “Physics II” Anuradha agencies, 2005
2. Setter N and Colla SL, Ferroelectric Ceramics, BirkhauserVer Lag, 1993.
3. SomiyaS., AldingerF., ClausenN., SprigsRM, UchinoK., KoumotoK., KanenoM., Handbook of Advanced Ceramics : Vol.II, Processing and their applications, Academic Press, 2003.
4. Buchanan RC, Ceramic Materials for Electronics, Marcel Dekker Inc., NY, 1991.
5. G Libowitz, Materials Science in Energy Technology, Academic Press, NY, 1979.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Have learnt the basics about energy materials.	3	2	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO2	Have knowledge about solar energy materials.	3	3	1	2	2	–	–	–	–	–	–	–	–	–	3	3
CO3	Have a sound knowledge about energy transport and storage materials.	3	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO4	Have learnt about the fuel cell materials.	3	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO5	Have learnt about ferroelectric materials for energy application	3	2	2	1	2	–	–	–	–	–	–	–	–	–	3	3
MATERIALS FOR ENERGY DEVICES		3	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5010 **SOL-GEL SCIENCE** **L T P C**
3 0 0 3

OBJECTIVES:

The course is aimed to

- Introduce the various parameters influencing sol gel process
- Describe the chemistry of precursor solution
- Impart knowledge on different types of gels and processing from gel
- Discuss different material preparation by sol gel process

UNIT I INTRODUCTION TO SOL GEL PROCESS 9

Introduction to sol, gel. Gel formation, various parameters involved in sol gel process, hydrolysis, condensation, gelation, pH, aging, drying, densification, processing. Types of gel - aero gel,xerogel.

UNIT II CHEMISTRY OF PRECURSOR SOLUTION 9

Solvent- basic of precursor's transformation solution- metal salt solution-Alkoxides solution- other precursor-precursor mixing-non oxide solution.

UNIT III APPROACHES IN PARTICULATE AND POLYMERIC GEL 9

Introduction to particulate gel- Single component system- steps involved in single component systems multi component systems-steps involved in multi component system, Introduction to polymeric gel, approaches of polymeric gel.

UNIT IV RHEOLOGICAL PROPERTIESOF GEL 9

Rheological properties of gel- gelation- aging of gel-drying of gel-conventional drying-stages in drying- osmotic pressure- disjoining forces-constant rate period-falling rate period-cracking during drying- avoidance of cracking-structural changes during drying- gel densification during sintering.

UNIT V PREPARATION OF MATERIAL 9

Silica, Alumina, Zirconia, Mullite, Hap preparation- Application of solgel processing-coating and thin film, fibers.Solgel catalysts- Filtration membranes –merits and demerits, techniques - Manufacturers.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. Recall the parameters influencing sol gel process
CO2. State the chemistry of precursor solution
CO3. Interpret the gel formation, its types and properties
CO4. Prepare different materials through sol gel process
CO5. Identify suitable application areas for sol gel process

TEXT BOOKS:

1. Rahman.Ceramic processing and sintering second edition 2016
2. JeffreyandC., George W.Scherer -sol-gel science The physics and chemistry of Sol-gel processing, Academic press inc 1990

REFERENCES:

1. Alain C.Pierre ,"Introduction to solgel processing –springer1990
2. John D.Wright, Nico A.J.M Sommerdijk, Sol-Gel Materials: Chemistry and Applications, CRC Press, 2001
3. SumioSakka, Handbook of Sol-Gel Science and Technology: Processing, Characterization and Applications, Kluwer Academic Publishers, 2004.
4. Ajay Kumar Mishra, Sol-Gel Based Nano Ceramic Materials, Springer, 2017.
5. SumioSakka,Sol-Gel Science and Technology: Topics in Fundamental Research and Applications,Springer, US, 2011.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Recall the parameters influencing sol gel process	3	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO2	State the chemistry of precursor solution	3	2	2	1	2	–	–	–	–	–	–	–	–	–	3	3
CO3	Interpret the gel formation, its types and properties	3	3	1	1	2	–	–	–	–	–	–	–	–	–	3	3
CO4	Prepare different materials through sol gel process	3	2	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO5	Identify suitable application areas for sol gel process	3	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
SOL-GEL SCIENCE		3	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5011 NUCLEAR AND SPACE CERAMICS L T P C
3 0 0 3

OBJECTIVES:
The course is aimed to introduce the students to the basic concepts of ceramic materials used for nuclear and space applications.

UNIT I FUNDAMENTALS OF NUCLEAR CERAMICS 9
Atomic structure- atomic number- mass number- isotopes- nuclear energy and nuclear forces, binding energy- nuclear stability- radio activity- nuclear reactions- nuclear fission, nuclear fusion.

UNIT II NUCLEAR REACTORS 9
Types of reactors- ordinary water moderated reactors- heavy water cooled and moderated reactors- design, construction and control of nuclear reactors- moderators- coolants, reflectors and structural materials - Manufacturers.

UNIT III FUELS 9
Methods of production and properties, uranium oxide, thorium oxide, beryllium oxides encapsulation, nuclear fuel cycle, spent fuel characteristics, reprocessing techniques.

UNIT IV RADIATION PROTECTION 9
Types of waste- disposal- ICRP recommendations- radiation hazards and prevention, radiation dose units.

UNIT V SPACE CERAMICS 9
Materials aspects of missile and satellite re entry- aerospace nuclear propulsion technology, auxiliary space powder devices- rocket nozzle technology- the space environment and its effects- Manufacturers.

TOTAL: 45 PERIODS

OUTCOMES:
On completion of the course the students are expected to

CO1. Have studied the basic concepts of nuclear physics.
CO2. Have learnt about the nuclear reactors.
CO3. Have studied in detail about the production and properties of various fuels.
CO4. Have studied about the radiation protection.
CO5. Have studied the basics about space ceramics.

TEXT BOOKS:
1. Merrite L.C, Basic Principles of Nuclear Science and Reactors, Wiley Eastern, 1977.
2. Benedict M and Pigter T.A, Nuclear Chemical Engineering, McGraw Hill, 1981.

REFERENCES:
1. Terpstra, Ceramic Processing, Chapman and Hall, 1995.
2. Gan-Moog, chow and Kenneth E Gonslaves, Nanotechnology, American ChemicalSociety, 1996.
3. Norton, F.H, Fine Ceramics, Technology and Applications, McGraw Hill, London, NY,1970.
4.YutaiKatoh and Alex Cozzi, Ceramics in Nuclear Applications, John Wiley and Sons, New Jersey, 2010.
5.Sharon Marra, Ceramics in Nuclear and Alternative Energy Applications, John Wiley and Sons, New Jersey, 2007.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Have studied the basic concepts of nuclear physics.	3	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO2	Have learnt about the nuclear reactors.	3	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO3	Have studied in detail about the production and properties of various fuels.	3	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO4	Have studied about the radiation protection.	3	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO5	Have studied the basics about space ceramics.	3	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
NUCLEAR AND SPACE CERAMICS		3	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

CT5012 THIN FILM COATINGTECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

The course is aimed to

- Discuss the fundamentals of coatings.
- Elaborate on various thin film forming techniques
- Describe the interfacial adhesion of thin films.
- List the different properties and applications of Thin film coatings.

UNIT I COATINGS – FUNDAMENTALS 8

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 and LIQUID PHASE TECHNIQUES 10

PVD, Vacuum evaporation techniques – molecular beam epitaxy, electron beam evaporation, reactive evaporation, CVD process-CVD reactor- CVD kinetics- product and process route. Liquid phase techniques – electrophoretic deposition, liquid phase epitaxy.

UNIT III GLOW DISCHARGE TECHNIQUES 9

Sputtering – diode sputtering, reactive sputtering, bias sputtering (ion plating), magnetron sputtering, ion beam sputter deposition, reactive ion plating. Plasma process – plasma enhanced CVD.

UNIT IV INTERFACIAL ADHESION AND STRENGTH 9

Interfacial adhesion of films – adhesion, interfacial delamination, adhesion measurement techniques, nanoindentation for assessing interfacial toughness of film/substrate system. Mechanics of interface fracture. Coating adhesion evaluation methods - sandwich specimen based methods, bimaterial specimen based methods, supplementary techniques.

UNIT V APPLICATIONS 9

Thin Film Sensors: Temperature Sensors, Magnetic Field Sensors, Force and Pressure Sensors, Current Sensors, Humidity Sensors, Tunable Thin Film Sensors, Gas Sensors, Chemical Sensors, Biological Sensors, Smart Sensors and Multi Functional Sensors - Thin Film Optical Coatings - Thin Film for Harvesting Solar Energy – Thin Film for Automobiles: Thermal Barrier Coatings, Hydrophobic and Self-Cleaning Coatings and Transparent Conducting Coatings.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. Know the fundamentals of coatings, substrate selection and film growth.
CO2. Have knowledge on thin film forming techniques**.**
CO3. Assess interfacial adhesion of films through adhesion measurement techniques.
CO4. Explain the properties and applications thin films.

TEXT BOOKS:

1. Sam Zhang, Thin Films and Coatings, CRC Press, 2016
2. AmitabhaBasuThe World of Thin Film Coatings, Publications Division, Ministry of Information and Broadcasting, Government of India, 2014.

REFERENCES:

1. Hocking M.G.Vasantasree V Sidky PS, Metallic and Ceramic coatings, Longman, 1989.
2. Krishna Seshan, Thin Film deposition, processes and technologies, second edition, Noyes publications, William Andrew Publishing, Norwich, New York, U.S.A.
3. Lisa C Klien(Ed),Sol Gel Technique for Thin Films, Fibres, Performs, Electronis and Specialty Shapes, Noyes publications, New Jersy, 1988.
4. Boriosenko Al, HighTemperature Protective Coatings,American Publishing Co., New Delhi, 1986.
5. Orlando Auciello and Rainer Waser, Science and Technology of Electro ceramic Thin film, NATO ASI series- Kluwer Academic publishers, 1995.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	**Know the fundamentals of coatings, substrate selection and film growth.**	3	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO2	**Have knowledge on thin film forming techniques.**	3	3	1	1	2	–	–	–	–	–	–	–	–	–	3	3
CO3	Assess interfacial adhesion of films through adhesion measurement techniques.	3	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO4	**Explain the properties and applications thin films.**	3	2	2	2	2	–	–	–	–	–	–	–	–	–	3	3
THIN FILM TECHNOLOGY		3	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5013 **BIOCERAMICS** **L T P C**
3 0 0 3

OBJECTIVES:

The course is aimed to

- Introduce various materials used as implants and the importance of ceramics
- Describe various compositions of ceramics used as implants
- Discuss about MaterialShaping.

UNIT I INTRODUCTION 9

Hard tissue- Structure, Properties, healing, repairing methods, Implant materials – Autograft, allograft, xenograft, 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 - Industries.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. State various implant materials
CO2. Know the fabrication, application and biological response of inert bioceramics.
CO3. Appraise the importance of calcium phosphate based bioceramic materials
CO4. Examine the usage of silica based ceramics in clinical applications
CO5. Recognize the usage of ceramics in implant as coatings, cements and scaffolds

TEXT BOOKS:

1. JoonPark :Bioceramics Properties, Characterization and Application, Springer,1995.
2. Maria valet regi: Bioceramic with Clinical Applications, Wiley,2010.

REFERENCES:

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. HeimoO.Ylanen: Bioactive Glasses Materials, Properties and Applications, Woodhead Publishing in materials2011.
4. W.Bonfield, G.W.Harting, K.E.Tanner: BioceramicsVol-IV, Butterworth Heinmann,2010.
5. Antonio Ravaglioli and A. Krajewski, Bioceramics: Materials · Properties · Applications, Chapman and Hall, London, 1992.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3	PSO 4
CO1	State various implant materials	–	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO2	Know the fabrication, application and biological response of inert bioceramics.	–	3	2	2	1	–	–	–	–	–	–	–	–	–	3	3
CO3	Appraise the importance of calcium phosphate based bioceramic materials	–	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO4	Examine the usage of silica based ceramics in clinical applications	–	3	2	1	1	–	–	–	–	–	–	–	–	–	3	3
CO5	Recognize the usage of ceramics in implant as coatings, cements and scaffolds	–	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
BIO CERAMICS		–	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3

1, 2 and 3 are correlation levels with weightingsas Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5014 **NANOCERAMICS** **L T P C**
3 0 0 3

OBJECTIVES:

The course is aimed to

- teach the fundamentals of nanomaterial science and technology.
- explain the basis of nanomaterial preparation methods.
- familiarize the applications of nanomaterials.

UNIT I INTRODUCTION **8**

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering-Classifications of nanostructured materials- Energy consideration- Density of states - nano particles- quantum dots, nanowires- ultra – thin films - multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, ptical, Magnetic and Thermal properties.

UNIT II GENERAL METHODS OF PREPARATION **9**

Bottom-up approach -Top-down Approach, Sol-Gel Method, Co-Precipitation, Hydrothermal route, Ultrasonication, Mechanical Milling, Colloidal routes, Thin film growth - physicslvapour deposition(PVD), Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE. Chemical vapourdeposition(CVD), MOCVD,

UNIT III NANOMATERIALS **12**

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, 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, TiO2,MgO, ZrO2, NiO, nanoalumina, CaO, AgTiO2, Ferrites, Nanoclays-functionalization and applications-Quantum wires, Quantum dotspreparation, properties and applications.

UNIT IV CHARACTERIZATION TECHNIQUES **9**

X-ray diffraction technique, Scanning Electron Microscopy , Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- Atomic force microscopy (AFM), SPM, STM, SIMS-Nanoindentation.

UNIT V APPLICATIONS **7**

NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechology: 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:
On completion of the course, the students are expected to

CO1. be familiar with the science of nanomaterials
CO2. demonstrate the preparation of nanomaterials
CO3. have gained knowledge in characteristic nanomaterial

TEXT BOOKS:

1. M. S. RamachandndraRao, Shubra Singh, Nanoscience and Nanotechnology: Fundamentals to Frontiers, Wiley India, 2013.
2. A.S. Edelstein and R.C. Cammearata, eds., “Nanomaterials: Synthesis, Properties and Applications”, Institute of Physics Publishing, Bristol and Philadelphia, 1996.

REFERENCES:

1. G Timp (Editor), “Nanotechnology”, AIP press/Springer, 1999.
2. AkhleshLakhtakia (Editor),“The Hand Book of Nano Technology,Nanometer Structure, Theory, Modeling and Simulations”. Prentice-Hall of India (P) Ltd, New Delhi, 2007.
3. N John Dinardo, “Nanoscale characterization of surfaces and Interfaces”, 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000
4. Ajay Kumar Mishra, Sol-Gel Based Nano Ceramic Materials, Springer, 2017.
5.DebasishSarkar, Nanostructured Ceramics: Characterization and Analysis, CRC Press, 2018.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	be familiar with the science of nanomaterials	3	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO2	demonstrate the preparation of nanomaterials	3	3	1	1	2	–	–	–	–	–	–	–	–	–	3	3
CO3	have gained knowledge in characteristic nanomaterial	3	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
NANO CERAMICS		3	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5015 FUNCTIONAL CERAMICS L T P C
3 0 0 3

OBJECTIVES:

The course is aimed to

- Explain various functional applications of ceramics
- Discuss the significance of ceramics in the functional applications

UNIT I FUNCTIONAL CERAMIC 9

Introduction to functional ceramics- Functional characteristics –Materials selections- Engineering with ceramic- Ceramic in metal processing- Gas production- Industrial processes- Heat engines – uses of Porous ceramic.

UNIT II CERAMICS IN LOCOMOTIVE 9

Automotive- Wear and corrosion resistance application-Seals –Valves-Pumps-thread guide. Ceramic in auto mobile parts-Bearing-Disk break –Clutches-Windows-Engine-Wear pads- Turbines-turbines blade-electrical vehicles-sonar applications

UNIT III MEDICAL APPLICATIONS OF CERAMIC 9

Bio ceramics- ceramics for medical applications- Replacement and repair- -ceramic in knee replacement, hip replacement-dental ceramics-heart valves- other parts of human body - Industries.

UNITI IV CERAMIC IN NUCLEAR, SPACE AND DEFENCE APPLICATION 9

Types of reactor-structure-preparation and properties of oxides, carbides, nitride and composites used in fission and fusion nuclear reactor. Ceramic used in space shuttle-rocket engine. Military application- Armor applications - Manufacturers.

UNIT V FUNCTIONAL GLASSES 9

Borosilicate glasses – pyrex glass and jena type, composition – fabrication of laboratory ware – vycor glass. Safety glasses – Manufacture of crown and flint glass. Ophthalmic glass filters – photo chromic glass – laser glass – electro chromic glass – GRIN lenses and components - Manufacturers.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. Know the functional characteristics of ceramics
CO2. Select a ceramic material for specific application
CO3. Appraise the significance of using ceramics in a specific application
CO4. Describe different functional glasses

TEXT BOOKS:

1.DavidW.Richerson, Morden Ceramic Engineering Properties processing and use in design, Third edition,CRC Press, 2016.
2.Park JB, Bio materials: introduction, PlenumPress, New York,1979

REFERENCES:

1.Barycartor C and Grant Norton “Ceramic Materials and Engineering” Springer 2013

2. NarottamP.Bansasl and Jacques lamon Ceramic matrix composite material modeling and technology ,Johan Wily sons 2014

3. Noborou Ichinose, Introduction to Fine Ceramics: Applications in Engineering, John Wiley and Sons Ltd., 1987.

4. DebasishSarkar, Nanostructured Ceramics:Characterization and Analysis, CRC Press, 2018.

5.Qingrui Yin, Binghe Zhu and HuarongZeng, Microstructure, Property and Processing of Functional Ceramics, Springer Science and Business Media, 2010.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Know the functional characteristics of ceramics	–	3	1	1	2	–	–	–	–	–	–	–	–	–	3	3
CO2	Select a ceramic material for specific application	–	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO3	Appraise the significance of using ceramics in a specific application	–	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO4	Describe different functional glasses	–	3	2	1	2	–	–	–	–	–	–	–	–	–	3	3
FUNCTIONAL CERAMICS		–	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5016 **FIBRES AND COMPOSITES** **L T P C**
3 0 0 3

OBJECTIVES:
The course is aimed to
- Introduce about types of composites, reinforcement and matrix .
- Describe the different types of reinforcement , its manufacturing techniques and properties.
- Give knowledge on PMC, MMC, CMC , C/C composites, manufacturing process, properties and applications.

UNIT I INTRODUCTION **7**
Definition, Classification, Advantages – disadvantages of composites, Fiber reinforced composites, Particulate composites, Hybrid composites, properties of composites – Elastic behaviour under longitudinal loading and transverse loading, Dispersed phase-particulate, fibre, whisker, Matrix phase-polymer, ceramic, Metal, Applications.

UNIT II REINFORCEMENT **10**
Fibre definition, fibre flexibility; Glass fibres – types, manufacturing process, properties, glass wool forming process; Alumina fibres, mullitefibres, zirconia fibres, boron fibres, carbon fibres and graphite fibres – manufacturing techniques, properties and applications, Background of whisker growth, composite processing, fiber/powder/whisker with matrix powder mixing, SiC and Si_3N_4 whiskers, VLC synthesis, properties.

UNIT III POLYMER MATRIX COMPOSITES(PMC) **10**
Polymer matrix materials – Thermoset, thermoplastic, elastomer, mechanical behaviour of polymers, melting and glass transition temperature, polymerization, processing methods of polymeric matrix composites: hand lay-up, autoclaving, filament winding, pultrusion, compression molding, pre-pegging, sheet molding compounds, process capability and application of PMC.

UNIT IV METAL MATRIX COMPOSITES (MMC) **9**
Metallic matrix materials – Aluminum alloys, Titanium alloys, Magnesium alloys, selection of reinforcements, processing of MMC- liquid state process- solid state process, secondary processing, properties of MMC-Modulus, strength, toughness, thermal characteristics, applications of MMC.

UNIT V CERAMIC MATRIX COMPOSITES (CMC) **9**
Crystalline oxides – Alumina, Zirconia, Silicon Nitrate, Glasses ceramics – Magnesium Alumino-silicates, processing of CMC – ceramic particle based process, In Situ ceramic composite processing, chemical vapor infiltration, mechanical properties of CMC-strength and modulus, fracture toughness, applications of CMC, processing of Carbon-Carbon (C/C) composites, applications of C/C composites

TOTAL: 45 PERIODS

OUTCOMES:
On completion of the course, the students are expected to
CO1. Be familiar with the composite materials and its applications.
CO2. Recall different matrix and reinforecements
CO3. Prepare of PMC, MMC and CMC by various methods
CO4. Adjudge applications of PMC, MMC and CMC materials.

TEXT BOOKS:
1. Balasubramanian M, Composites materials and processing, CRC Press, 2014.
2. Chawla K.K, Composites materials Science and engineering, Springer, 2012.

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.
4.CallisterW. D, Jr., D. G. Rethwisch, Materials science and engineering, Wiley India Pvt ltd, 2014.
5. https://nptel.ac.in/courses/112104221/21

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Be familiar with the composite materials and its applications.	–	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO2	Recall different matrix and reinforecements	–	3	2	1	2	–	–	–	–	–	–	–	–	–	3	3
CO3	Prepare of PMC, MMC and CMC by various methods	–	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
CO4	Adjudge applications of PMC, MMC and CMC materials.	–	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3
FIBRES AND COMPOSITES		–	3	2	2	2	–	–	–	–	–	–	–	–	–	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5017	MACHINING AND JOINING OF CERAMIC S	L T P C
		3 0 0 3

OBJECTIVES:

The course is aimed to impart knowledge about

- various machining processes
- Advanced machining processes
- Surface finishing methods
- conventional and advanced joining techniques of ceramics with other materials

UNIT I BASIC MACHINING METHODS 9

Basic machining requirement of ceramics- Ductile grinding –material removal mechanisms. Ultrasonic machining, Abrasive water jet machining, Diamond wheel – Principles ,mechanisms, applications, chemical– Electrochemical –Electrical discharge Machining of ceramic materials - Electrolytic in-process dressing.

UNIT II ADVANCED MACHINING 9

Micro machining- Micro EDM,ECM – Tooling principle, material removal rate and mechanisms - LASER assisted Grinding, Ion Beam machining–Sputtering–Laser, Electron Beam machining

UNIT III SURFACE FINISHING 9

Super polishing, chemical compound polishing, Ultrasonic Lapping, Abrasive flow finishing, Magneto rheological abrasive finishing, Polycrystalline Diamond lapping of ceramics, Flame polishing–Annealing–Healing of surface cracks– Electrolytic In-Process Dressing Grinding of Ceramic materials –UV bonded grinding wheel

UNIT IV JOINING METHODS 9

Mechanical Joints - Adhesive joints –testing of joint strength, wettability, reactivity, thermodynamic stability- Filler materials - High temperature Brazing – Brazing of diamonds, CBN, Oxides, carbides, composites – metal and ceramic joints -Active brazing of advanced ceramic composites to metallic systems - applications

UNIT V ADVANCED JOINING METHODS 9

Liquid Silicon infiltration, Arc joint-Transient Liquid phase bonding-nano powder infiltration and Transient Eutectic phase. Spark plasma sintering-Microwave Assisted joining-Laser Assisted joining-Glass and Glass ceramic Joining materials –Solid state Ti–Si–C reaction joints– Pre ceramic –polymer joints - applications

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. Have a basic understanding about various basic machining and advanced methods
CO2. Have understanding about the surface finishing methods.
CO3. Have basic knowledge about Joining of ceramics with other materials
CO4. have knowledge about surface preparation and testing of joint

TEXT BOOKS:

1. IoanD.Marinesar, Handbook of Advanced Ceramics Machining, CRC press. 2006
2. IoanD.Marinesar, Hans Kurt Tonshoff, Ichiro Inasaki, Handbook of Ceramic Grinding and polishing, Noyes Publication , 2000

REFERENCES:

1.Dusan P. Sekulic, Advances in Brazing – Science , Technology and applications Woodhead Publishing,2013

2. NarottamP.Bansal and Jacques Lamon, Ceramic Matrix Composites-Materials, Modeling and Technology, John Wiley and sons, Inc., Hoboken, New Jersey, 2015.

3.JainV.K,Introduction to micromachining, Alpha Science International Ltd, 2010.

4.SchneiderS.J, R.W.Rice, The science of Ceramic Machining and surface finishing, National Bureau of Standards Special Publication,1970.

5.Charles A. Lewinsohn, Mrityunjay Singh and Ronald Loehman, Advances in Joining of Ceramics, John Wiley and Sons, 2012.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Have a basic understanding about various basic machining and advanced methods	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO2	Have understanding about the surface finishing methods.	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO3	Have basic knowledge about Joining of ceramics with other materials	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO4	have knowledge about surface preparation and testing of joint	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
MACHINING AND JOINING OF CERAMIC		3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5018 MICROWAVE PROCESSING OF CERAMICS LT P C
3 0 0 3

OBJECTIVES:

The course is aimed to

- introduce the basics of microwave
- describe the usage of microwave for industrial heating and the necessary set ups
- discuss the hazards and safety measures to be taken for microwave usage

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- applicationto laboratory models and pilot systemcomparison 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

OUTCOMES:

On completion of the course the students are expected to

CO1. Have learnt the introduction about microwave processing.
CO2. Have learnt the concepts of microwave heating circuit.
CO3. Have learnt the applicator types of microwave.
CO4. Have studied the industrial applications of microwave processing.
CO5. Have studied the hazard and safety of microwave processing.

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 andII, 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.

3.DavidE.Clark, David A.Lewis, Jon P.Binner, Microwaves: Theory and Application in Materials Processing V, Ceramic Transactions, 2001.

4. National Materials Advisory Board, Microwave Processing of Materials, National Academies Press, 1994.

5.Narottam P. Bansal and J. P. Singh, Innovative Processing and Synthesis of Ceramics, Glasses, and Composites VII, John Wiley and Sons, 2012.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Have learnt the introduction about microwave processing.	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO2	Have learnt the concepts of microwave heating circuit.	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO3	Have learnt the applicator types of microwave.	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO4	Have studied the industrial applications of microwave processing.	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO5	Have studied the hazard and safety of microwave processing.	3	3	2	2	1	–	–	–	–	–	–	–	3	–	–	3
MICROWAVE PROCESSING OF CERAMICS		3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3

1, 2 and 3 are correlation levels with weightingsas Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5019	NON DESTRUCTIVE MATERIAL TESTING	L T P C 3 0 0 3

OBJECTIVES:

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

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

OUTCOMES:

On completion of the course the students are expected to

CO1. Have studied the basic concepts of non-destructive testing and surface NDT methods

CO2. Have learnt about small business and preparation of feasibility chart.

CO3. Have a basic knowledge about establishment of a business.

CO4. Have learnt about how to manage a business unit.

CO5. Have some basic concepts about promotion of entrepreneurship and practical knowledge about some case studies.

TEXT BOOKS:

1.HullB and V.John, Non Destructive Testing, McMillan Education Ltd, 1968.
2. McGonnagle, W.J, Non-destructing testing methods, McGraw Hill Co., NY, 1961.

REFERENCES:

1. Metals Handbook, Volume 2, 8th Edn, ASTM, Metals Park, Ohio.
2. Dainty, Laser Speckle and Related Phenomena, Springer – Verlag, New York, 1984.
3. PrasadJ and C G K Nair, Non Destructive Test and Evaluation of Materials, TATA McGraw Hill, New Delhi, 2008.
4.Dos Reis H, Non-Destructive Testing And Evaluation For Manufacturing And Construction, Hemisphere Publishing Corporation, US, 1990.
5. Baldev Raj, T. Jayakumar and M. Thavasimuthu, Practical Non-destructive Testing, Narosa Publishing House, New Delhi, 2002.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3	PSO 4
CO1	Have studied the basic concepts of non-destructive testing and surface NDT methods	3	2	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO2	Have learnt about small business and preparation of feasibility chart.	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO3	Have a basic knowledge about establishment of a business.	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO4	Have learnt about how to manage a business unit.	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO5	Have some basic concepts about promotion of entrepreneurship and practical knowledge about some case studies.	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
NON DESTRUCTIVE MATERIALS TESTING		3	3	2	2	2		–	–	–	–	–	–	3	–	–	3

1, 2 and 3 are correlation levels with weightingsas Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5020 MATERIALS AND METALLURGY L T P C
3 0 0 3

OBJECTIVES:

The course is aimed to

- cover the concepts of metallic and non metallic materials,
- discuss physical metallurgy, high temperature reactions and processing methods

UNIT I FERROUS AND NON-FERROUS MATERIALS 9

Introduction - Iron and Steel, Classification of Steels - Wrought Iron, Cast Iron, Grey Cast Iron, White Cast Iron, malleable cast iron, Nodular Cast Iron, Chilled Cast Iron - Stainless Steels-Tool Steels - High speed Steel, Molybdenum High Speed Steel- Non-Ferrous Metals - Copper, Aluminum, Lead, Tin, Zinc, Nickel, Magnesium, Vanadium, Cadmium - Alloys- Copper alloys, Aluminum alloys, Nickel alloys.

UNIT II NON-METALLIC MATERIALS 9

Polymers - types of polymer, commodity and engineering polymers - Properties and applications of PE, PP, PS, PVC, PMMA, PET,PC, PA, ABS, PAI, PPS, PEEK, PTFE, Thermo set polymers- Urea and Phenol, formaldehydes

UNIT III BASICS OF METALLURGY 9

Introduction – classification – metals, metallic ores, sampling, identification, extraction – copper, aluminum, lead, iron and 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 IV HIGH TEMPERATURE METALLURGICAL PROCESS 9

Introduction – reactions involving solids and 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. Primary and Secondary Steel Making - Ladle Metallurgical Operation - Deoxidization, Desulphurization, Sulphide shape control, Inert gas rinsing, Vacuum Reactors, Secondary refining process - AOD, VAD, VOD, VAR and ESR, Ingate and Continuous Casting.

UNIT V MANUFACTURING PROCESS 9

Metal Casting - Pattern and Moulds, Sand Casting, Permanent Mould Casting, Investment Casting, Shell Molding, Hot warm and cold working of metals, Metal forming, rolling, forging, extrusion, wire drawing, sheet metal forming, metal joining - soldering, brazing, welding, Powder metallurgy - production of powders, compaction and sintering.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. Classify and Distinguish different types of cast irons, steels and non ferrous alloys

CO2. Classify and distinguish the different types of non metallic materials

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CO3. Describe the concept of heat treatment of steels and strengthening mechanisms
CO4. Analyze the various high temperature metallurgical reactions.
CO5. Be able to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

TEXT BOOKS:

1. George E Dieter, Mechanical Metallurgy, McGraw Hill Book, 1998
2. SeshadriSeetharaman, Fundamentals of Metallurgy, 1st Edn, Wood head Publishing Limited, 2005.

REFERENCES:

1. PrabhdevK.H, Handbook of Heat Treatment of Steels, Tata McGraw Hill Publishing Company Ltd, 1998.
2. Higgins R.A, Engineering Metallurgy, Part 2, Metallurgical Process Technology, 2nd Edn, ELBS,1974.
3. Avner S.H, Introduction to Physical Metallurgy, 15th Edn, McGraw Hill Book Company,1997.
4. AngeloP.C, R.Subramanian, " Powder Metallurgy Science, Technology and Applications", PHI Learning private Ltd., 2009
5. Rajput R.K, "A Text Book of Manufacturing Technology (Manufacturing Processes)", Laxmi Publications Ltd., 2007.
6. A.K., "Steel Making", PHI Learning Private Ltd., 2012
7. AhindraGhosh, " Iron and steel making Theory and Practice" PHI Learning private Ltd., 2008.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3	PSO 4
CO1	Classify and Distinguish different types of cast irons, steels and non ferrous alloys	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO2	Classify and distinguish the different types of non metallic materials	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO3	Describe the concept of heat treatment of steels & strengthening mechanisms	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO4	Analyze the various high temperature metallurgical reactions.	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO5	Be able to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
MATERIALS AND METALLURGY		3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5021 PHASE EQUILIBRIA OF CERAMICS L T P C
3 0 0 3

OBJECTIVES:

The course is aimed to

- provide the necessary tools to apply the principles and concepts of phase equilibria and evaluate in various systems.

UNIT I INTRODUCTION 9

Introduction, phase, component, variable, Gibb's phase rule, single component system – H_2O, SiO_2, iron, ZrO_2, Carbon, Hume Rothery's rule; binary phase diagrams – solid solutions, eutectic, peritectic, liquid immiscibility, decomposition, polymorphism, ex-solution, lever rule, ternary diagrams - single phase equilibrium, two phase equilibrium, three phase equilibrium .

UNIT II THERMODYNAMICS OFPHASEEQUILIBRIA 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 PHASEDIAGRAMS 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 phasediagrams.

UNIT IV PHASETRANSFORMATIONS 9

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

UNIT V CONSTRUCTION AND DETERMINATION OF PHASE DIAGRAMS 9

Construction of phase diagrams - cooling curves, thermal analysis, techniques - introduction, ex-situ methods - sample preparation and non equilibration, phase and compositional analysis, identification of new phases, in-situ methods - thermal analysis, coulometric titration, high temperature XRD, thermo-microscopy, optical methods, oscillation method of phase analysis - in-situ electric, dielectric and magnetic measurements

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. interpret phase diagrams, and calculate phase stability diagrams in unary, binary and ternary phase diagrams.
CO2. understand the relation between thermodynamics and phase equilibria

CO3. Interpret and know applications of binary and ternary phase diagrams (unary systems, binary systems, ternary effects on microstructures, phase calculations, drawing isothermal and vertical sections of real ternary systems).

CO4. analyze the phase transformation and microstructural development

CO5. construct and evaluate phase diagrams

TEXT BOOKS:

1. Flake C Campbell, Phase Diagrams - Understanding the Basics, ASM International, 2012
2. ZhaoJ C, Methods for Phase Diagram Determination, Elsevier, 2007

REFERENCES:

1. Kingery W.D, Bowen H.K and Uhlmann D.R, Introduction to Ceramics, 2nd Edn., John Wiley and 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.
4. Kingery W.D, Yet Ming Chiang and Dunbar P.Birnie III, Physical Ceramics – Principles for Ceramic Science and Engineering, John Wiley and Sons,1995.
5. WestD R F, N Saunders, Ternary Phase Diagrams in Material Science, Woodhead Publishing, 2006

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	interpret phase diagrams, and calculate phase stability diagrams in unary, binary and ternary phase diagrams.	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO2	understand the relation between thermodynamics and phase equilibria	3	3	2	2	1	–	–	–	–	–	–	–	3	–	–	3
CO3	Interpret and know applications of binary and ternary phase diagrams	3	2	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO4	analyze the phase transformation and microstructural development	2	3	2	2	1	–	–	–	–	–	–	–	3	–	–	3
CO5	construct and evaluate phase diagrams	3	2	2	2	2	–	–	–	–	–	–	–	3	–	–	3
PHASE EQUILIBRIA OF CERAMICS		3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5022 SINTERING OF CERAMICS L T P C
3 0 0 3

OBJECTIVES:

The course is aimed to

- Introduce basics of sintering like the driving force for sintering
- Discuss the mechanisms of solid phase and viscous sintering
- Describe the changes on liquid phase sintering and its types.
- Cover topics on advanced and novel sintering techniques.

UNIT I INTRODUCTION 9

Introduction to Sintering Techniques, Measurement– heating schedule, multistage– Physical properties, Microstructure, Thermal, Electrical and Magnetic Properties– Sintering atmosphere, Driving force – Mechanisms of sintering- Grain growth, Oswald Ripening – Topological and Interfacial tension requirements – Controlling the boundary Mobility – Controlled Microstructure

UNIT II SOLID PHASE AND VISCOUS SINTERING 9

Scaling Laws, Analytical Models – Stages of sintering – kinetic Equations and limitations – Diffusion Mechanisms – Viscous flow – Hot Pressing Models and Mechanisms – Stress intensification factor – Sintering of mixed powders – Glass– Cordierite, ZnO-SiC, Al_2O_3-SiC, Cr_2O_3-Al_2O_3 – Applications

UNIT III LIQUID PHASE SINTERING 9

Driving force for densification – stages in Liquid phase sintering – Thermodynamic and Kinetic factors –Phase diagram concepts, interfacial energy, wetting angle, Dihedral Angle, Solubility, Capillary forces, effect of gravity.Grain boundary films – Mechanisms of Liquid phase sintering – Rearrangementand Liquid redistribution, Solution Precipitation, Pore filling, Coarsening – Hot Pressing with a Liquid phase – Phase diagrams – Activated Sintering – Vitrification – Applications

UNIT IV SPECIAL TOPICS IN SINTERING 9

Sintering of ceramic Composites – Constrained sintering – thin films, Multilayers – Effect of Additives – Role of MgO in Al_2O_3 – Reaction sintering – Process Variables, Applications – Viscous sintering with crystallization – Process Variables.

UNIT V NOVEL SINTERING TECHNIQUES 9

Pressure Assisted Sintering – Extrusion, Shockwave Consolidation, Densification maps – Induction Sintering – LASER Sintering – Microwave sintering – spark Plasma Sintering – Hot pressing – Sinter forging – Hot isostatic pressing (HIP) – flash sintering – Applications and Case studies.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to,

CO1. Know the driving force for sintering.

CO2. Explain the mechanisms of solid, liquid and viscous phase sintering.

CO3. Have knowledge on the applications of different sintering techniques.
CO4. Appreciate the advanced and novel sintering techniques.

TEXT BOOKS:

1. .RahamanM.N, "Ceramic Processing and Sintering", Taylor and Francis, Second Edition, 2016.
2. Randall M.German, “Sintering Theory and Practice”, John Wiley and Sons, Inc., 1996.

REFERENCES:

1. Randall M.German et al, “Sintering Technology”, Marcel Dekker, Inc., 1996
2. David W. Richerson, “Modern Ceramic Engineering”, CRC Press, 4thEdn., 2018
3. Narottam. P. Bansaland Jacques Lamon, “ Ceramic Matrix Composites, Materials Modeling and Technology”, Wiley, The American Ceramic Society, 2015
4. Hayne Palmour, “Sintering’85”, Plenum Press, 1987
5. Suk-Joong L. Kang, “Sintering: Densification, Grain Growth and Microstructure”, Elsevier Publications, 2005

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Know the driving force for sintering.	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO2	Explain the mechanisms of solid, liquid & viscous phase sintering.	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO3	Have knowledge on the applications of different sintering techniques.	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
CO4	Appreciate the advanced & novel sintering techniques.	3	3	2	2	2	–	–	–	–	–	–	–	3	–	–	3
SINTERING OF CERAMICS		3	3	2	2	2		–	–		–	–	–	3	–	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5023 CERAMIC WASTE RECOVERY AND MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

The course is aimed to

- Introduce factors for elimination and reduction of wastage
- Describe the ways to reuse the wastage.
- Discuss ways to calculate the loss in wastage
- Familiarize the various wastages that is available from other industries and the ways of using them in ceramic Industry

UNITI SOLID WASTE FROM CERAMIC PLANTS 9

Body scrap, Scrap from cast ware during finishing, Scrap from handling. Property variation due to scrap addition, Method of scrap storage , Handling of scrap ,Testing of scrap. Calculation of scrap addition

Scrap from broken wares, Addition of broken wares in the ball mill

UNITII LIQUID WASTE FROM CERAMIC PLANT 9

Design of settling tanks, Adjustment of water pH , Filter pressing of slurry.

Testing and adjustment of recovery materials, Reclaimed glaze usage, Methods to eliminate contamination in reclaimed glazes. Testing of outlet water

UNIT III HEAT RECOVERY FROM CERAMIC PLANT 9

Waste heat generation from kilns, Duct design for hot gas transport, Heat recovery - Regeneration, Recuperator , Energy transfer efficiency

UNITIV SOLID WASTE FROM OTHER PLANTS 9

Clay scrap from mineral Industries, Blast furnace slag powder, Silica fumes, Flyash,Scrap refractory bricks,Reuse of glass tank refractory bricks, Reuse of scrap Iron oxide powder for Ferrite component making, Red mud from bauxite purification

UNITV CASE STUDY 9

Use of sanitary scrap for road building, Use of sanitary ware for concrete structure, Use of glass waste for making fusion glass tiles, glass powder for cement replacement, Conversion of waste to useful product.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students are expected to

CO1. Classify the types of solid waste generated in ceramic plant
CO2. Recognize the types of liquid waste generated in ceramic plant
CO3. Know the means of waste heat recovery from ceramic plant
CO4. Discuss the types of solid waste generated from other plants
CO5. Develop ways to convert waste to useful product

TEXT BOOKS:

1. SubhashAnand, Solid waste Management, Mittal Publications, 2010
2. Bernd Bilitewski, Georg Hardtle and Klaus Marek, Waste Management, Springer, 1996

REFERENCES:

1. Thomas Christensen , Solid waste Technology and Management, 2 volume set, Wiley, 2011
2. RamachandraRaoS R,Resource Recovery and Recycling from metallurgical waste, Elsevier, 2006
3. Mukesh C. Limbachiya and John Roberts, Sustainable Waste Management and Recycling: Glass waste, Thomas Telford, 2004.
4. Lawrence A. Smith, Jeffrey L. Meansand Edwin F. Barth, Recycling and reuse of industrial wastes, Battelle Press, 1995.
5. Frechette V, Ceramic Engineering and Science: Emerging Priorities, Plenum Press, NY, Springer,1974.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Classify the types of solid waste generated in ceramic plant	3	3	2	1	2	-	-	-	-	-	-	-	3	-	-	3
CO2	Recognize the types of liquid waste generated in ceramic plant	3	3	2	2	2	-	-	-	-	-	-	-	3	-	-	3
CO3	Know the means of waste heat recovery from ceramic plant	3	2	2	2	1	-	-	-	-	-	-	-	3	-	-	3
CO4	Discuss the types of solid waste generated from other plants	3	3	1	1	2	-	-	-	-	-	-	-	3	-	-	3
CO5	Develop ways to convert waste to useful product	3	3	2	2	1	-	-	-	-	-	-	-	3	-	-	3
CERAMIC WASTE RECOVERY AND MANAGEMENT		3	3	2	2	2	-	-	-	-	-	-	-	3	-	-	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5024 **MECHANICAL BEHAVIOR OF CERAMICS** **L T P C**
2 1 0 3

OBJECTIVES:

The course is aimed to impart basic knowledge about

- Elastic behaviour of Ceramic Materials
- Fracture behaviour , strength and creep behaviour of ceramic materials
- Toughening techniques and thermal shock behaviour of ceramic materials.

UNIT I ELASTIC BEHAVIOUR **9**

Elastic constants – elastic deformation of isotropic and crystalline materials - effect of lattice constant, Grain size and Temperature- Theoretical strength – Yield criteria - stress – strain relationship - Stiffness measurement – static and dynamic methods,– Critical resolved shear stress

UNIT II FRACTURE **9**

Types of fracture - ductile and brittle fracture - Linear elastic fracture mechanics, Stress concentration, Griffith theory , stress at crack tip – Irwin theory - Critical stress intensity factor measurement – single edge notched, Chevron notched beam, indentation method, notch test – Statistical treatment.

UNIT III STRENGTH **9**

Strength reducing mechanisms – subcritical crack propagation , failure under constant stress. Stable crack propagation – R curve, measurement. Fatigue of Ceramics – Testing method, paristheory , Life time prediction.

UNIT IV THERMAL BEHAVIOUR **9**

Thermal stress, Eshellbymethod .Thermal shock resistance parameters, measurement, micro cracking of ceramics, thermal tempering. Thermal conductivity - measurement, Creep of Ceramics – mechanisms, measurement types – Diffusion, dislocation, Construction of Deformation Map- safe life design.

UNIT V TOUGHENING AND MECHANICAL PROPERTIES OF CERMICS **9**

Toughening mechanisms – crack deflection, crack bowing, crack branching, crack tip shielding by process zone and bridging effect, transformation toughening

Mechanical properties of Alumina, Silicon Nitride, Silicon Carbide and Porous ceramics

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students are expected to

CO1. Have a basic understanding about elasticity, deformation point of isotropic and crystalline materials.

CO2. Have learnt about various fractures, fracture testing techniques, strength behaviour , thermal shock resistance and creep behaviour

CO3. Design ceramic components for safe life and identify suitable ceramic material for intended application

TEXT BOOKS:

1. John B.Watchman, Mechanical Properties of Ceramics, John Wiley and Sons Inc., NY, 1996.
2. Davidge, R.W., Mechanical Behaviour of Ceramics, Ceramic Book Literature Service, London, UK, 1979.

REFERENCES:

1. Barsoum. M.W, Fundamentals of Ceramis, 1 st edition, Taylor & Francis, 2003.
2. Hasselman, D.P.H and HellerR.A. (Ed), Thermal Stresses in Service Environments, Plenum Press,1989.
3. Cocks A.C.F and PonterA.R.C, Mechanics of creep brittle material -1 and 2, Elsevier Applied Science, 1989.
4. JahanmirSaid, Friction and Wear of Ceramics, Marcel Dekker Inc, 1993.
5. Roy.W.Rice, Mechanical Properties of Ceramics and Composites, Marcel Dekker Inc. , 1993.
6. Parton V.Z.andBorishkovskyV.G., Dynamic Fracture Mechanics (VOl-2), Hemisphere Publishing, 1990.
7. Kussmaul. K., Fracture Mechanics Verification by Large-Scale Testing, Mechanical Engg.Publication, 1991.
8. BratR.C, HasselmanD.P.H., MunzD., Sakai M.andV.Ya.Shevchenko, Fracture Mechanics of Ceramics, Plenom Press Publication, 1991.
9. SastriV.S and Edward Ghalai, Corrosion-preventionand protection, John Willey and Sons, 2007.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome														
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PSO 4
CO1	Have a basic understanding about elasticity, deformation point of isotropic and crystalline materials.	−	3	2	2	3	−	−	−	−	−	−	3	3	−	−	3
CO2	Have learnt about various fractures, fracture testing techniques, strength behaviour , thermal shock resistance and creep behaviour	−	3	2	2	3	−	−	−	−	−	−	3	3	−	−	3
CO3	Design ceramic components for safe life and identify suitable ceramic material for intended application	−	3	2	2	3	−	−	−	−	−	−	3	3	−	−	3
MECHANICAL BEHAVIOR OF CERAMICS		−	3	2	2	3	−	−	−	−	−	−	3	3	−	−	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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CT5025 **GLAZING AND ENAMELING** **L T P C**
3 0 0 3

OBJECTIVES:

The course is aimed to

- introduce the students to importance of glazing and glaze raw materials
- describe various glazing techniques and defects formed in glaze
- analyze various glaze properties and their testing methods
- familiarize the students with decoration techniques in glaze and enamels

UNIT I INTRODUCTION TO GLAZE **9**

Definitions - glaze raw materials- frit preparation - frit rules - engobe - classification of glazes - compounding of lead and leadless glaze Role of individual raw materials - colouring agents - stains - mixed colours - metallic lustures– unitoperations and processes - glaze Additives - special glazes - matt glazes, snake skin glazes,crackled glazes, salt glazes and other glazes - Manufacturing Sectors - Market Scenario.

UNIT II GLAZING TECHNIQUES AND DEFECTS **9**

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

UNIT III 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 - protective care - restoration.

UNIT IV ENAMEL **9**

Raw material for Enamels, Preparation of Enamel glaze slip , Metal preparation for Enameling Ground coating cover coating Application of enamel on metal surface , Heat treatment of enamel plate, Application and usage of Enamel board and plate - Manufacturing Sectors - Market Scenario.

UNIT V 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 leadfrits, glaze fit, thermal expansion, chemical durability , colour measurement, thermal shock measurement.

TOTAL: 45 PERIOD

OUTCOMES:

On completion of the course the students are expected to

CO1. Have learnt the definition of glazes and classification of glazes and Enamel.
CO2. Have a thorough knowledge about the raw materials and properties of the glaze raw materials.
CO3. Have a thorough knowledge about the various glazing techniques.
CO4. Have learnt the properties and defects produced by glazing.
CO5. Have complete understanding about the various methods of decorating the glazed and Enamel articles.

TEXT BOOKS:

1. Kenneth Shaw, Ceramic Glazes, Elsevier Publishing Co., NY, 1971.
2. Emmanuel Cooper, The Potter Book of Glaze Recipes, B.T.Batsford Ltd., London, 1986.

REFERENCES:

1. The Art of Enameling Techniques Projects and Inspiration Barnes andNobles, 28 Aug 2006
2. HiraokiYanagida, The Chemistry of Ceramics, John Wiley and Sons, 1996.
3. Richard A.Eppler, Douglas R.Eppler, Glazes and Glass Coatings, American Ceramic Society, 2000.
4. Maureen Mills, Surface Design for Ceramics, Lark Books, 2008.
5. Susan Buys and Victoria Oakley, Conservation and Restoration Ceramics, Routlege, 2014.
6. Hazel H.Gorham, Japanese and Oriental Ceramic, Charles E.Tuttle Company Ltd., 2012.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3	PS O4
CO1	Have learnt the definition of glazes and classification of glazes and Enamel.	–	2	3	2	2	–	–	–	–	–	–	–	–	3	–	3
CO2	Have a thorough knowledge about the raw materials and properties of the glaze raw materials.	–	2	3	2	2	–	–	–	–	–	–	–	–	3	–	3
CO3	Have a thorough knowledge about the various glazing techniques.	–	2	2	1	2	–	–	–	–	–	–	–	–	3	–	3
CO4	Have learnt the properties and defects produced by glazing.	–	2	3	2	1	–	–	–	–	–	–	–	–	3	–	3
CO5	Have complete understanding about the various methods of decorating the glazed and Enamel articles.	–	2	3	2	2	–	–	–	–	–	–	–	–	3	–	3
GLAZING AND ENAMELING		–	2	3	2	2	–	–	–	–	–	–	–	–	3	–	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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AUDIT COURSES (AC)

AD5091 **CONSTITUTION OF INDIA**

L	T	P	C
3	0	0	0

OBJECTIVES:

- Teach history and philosophy of Indian Constitution.
- Describe the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- Summarize powers and functions of Indian government.
- Explain emergency rule.
- Explain structure and functions of local administration.

UNIT I INTRODUCTION 9

History of Making of the Indian Constitution-Drafting Committee- (Composition & Working) - Philosophy of the Indian Constitution-Preamble-Salient Features

UNIT II CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES 9

Fundamental Rights-Right to Equality-Right to Freedom-Right against Exploitation Right to Freedom of Religion-Cultural and Educational Rights-Right to Constitutional Remedies Directive Principles of State Policy-Fundamental Duties

UNIT III ORGANS OF GOVERNANCE 9

Parliament-Composition-Qualifications and Disqualifications-Powers and Functions-Executive President-Governor-Council of Ministers-Judiciary, Appointment and Transfer of Judges, Qualifications Powers and Functions

UNIT IV EMERGENCY PROVISIONS 9

Emergency Provisions - National Emergency, President Rule, Financial Emergency

UNIT V LOCAL ADMINISTRATION 9

District's Administration head- Role and Importance-Municipalities- Introduction- Mayor and role of Elected Representative-CEO of Municipal Corporation-Pachayati raj- Introduction- PRI- Zila Pachayat-Elected officials and their roles- CEO ZilaPachayat- Position and role-Block level-Organizational Hierarchy (Different departments)-Village level- Role of Elected and Appointed officials-Importance of grass root democracy

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Able to understand history and philosophy of Indian Constitution.
CO2: Able to understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
CO3: Able to understand powers and functions of Indian government.
CO4: Able to understand emergency rule.
CO5: Able to understand structure and functions of local administration.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									✓			✓
CO2									✓			✓
CO3									✓			✓
CO4									✓			✓
CO5									✓			✓

Attested

TEXTBOOKS:

1. Basu D D, Introduction to the Constitution of India, Lexis Nexis, 2015.
2. Busi S N, Ambedkar B R framing of Indian Constitution, 1st Edition, 2015.
3. Jain M P, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. The Constitution of India (Bare Act), Government Publication,1950

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AD5092 **VALUE EDUCATION** **L T P C**
3 0 0 0

OBJECTIVES:

- Develop knowledge of self-development
- Explain the importance of Human values
- Develop the overall personality through value education
- Overcome the self destructive habits with value education
- Interpret social empowerment with value education

UNIT I INTRODUCTION TO VALUE EDUCATION 9

Values and self-development –Social values and individual attitudes, Work ethics, Indian vision of humanism, Moral and non- moral valuation, Standards and principles, Value judgements

UNIT II IMPORTANCE OF VALUES 9

Importance of cultivation of values, Sense of duty, Devotion, Self-reliance, Confidence, Concentration, Truthfulness, Cleanliness. Honesty, Humanity, Power of faith, National Unity, Patriotism, Love for nature, Discipline

UNIT III INFLUENCE OF VALUE EDUCATION 9

Personality and Behaviour development - Soul and Scientific attitude. Positive Thinking, Integrity and discipline, Punctuality, Love and Kindness, Avoid fault Thinking, Free from anger, Dignity of labour, Universal brotherhood and religious tolerance, True friendshipHappiness Vs suffering, love for truth.

UNIT IV REINCARNATION THROUGH VALUE EDUCATION 9

Aware of self-destructive habits, Association and Cooperation, Doing best for saving nature Character and Competence –Holy books vs Blind faith, Self-management and Good health, Science of reincarnation

UNIT V VALUE EDUCATION IN SOCIAL EMPOWERMENT 9

Equality, Non violence, Humility, Role of Women, All religions and same message,Mind your Mind, Self-control, Honesty, Studying effectively

TOTAL: 45 PERIODS

OUTCOMES:

CO1 – Gain knowledge of self-development
CO2 – Learn the importance of Human values
CO3 – Develop the overall personality through value education
CO4 – Overcome the self destructive habits with value education
CO5 – Interpret social empowerment with value education

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							✓	✓				✓
CO2							✓	✓	✓			✓
CO3							✓	✓	✓			✓
CO4							✓	✓				✓
CO5							✓	✓				✓

REFERENCES:

1. Chakroborty , S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press ,New Delhi

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AD5093 **PEDAGOGY STUDIES** **L T P C**
3 0 0 0

OBJECTIVES:

- Understand the methodology of pedagogy.
- Compare pedagogical practices used by teachers in formal and informal classrooms in developing countries.
- Infer how can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy.
- Illustrate the factors necessary for professional development.
- Identify the Research gaps in pedagogy.

UNIT I INTRODUCTION AND METHODOLOGY: 9

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW 9

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES 9

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT 9

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS 9

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 45 PERIODS

OUTCOMES:

- Understand the methodology of pedagogy.
- Understand Pedagogical practices used by teachers in formal and informal classrooms in developing countries.
- Find how can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy.
- Know the factors necessary for professional development.
- Identify the Research gaps in pedagogy.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												✓
CO2												✓
CO3												✓
CO4												✓
CO5												✓

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REFERENCES:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.

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AD5094 **STRESS MANAGEMENT BY YOGA**

L T P C
3 0 0 0

OBJECTIVES:

- Develop healthy mind in a healthy body thus improving social health also improve efficiency
- Invent Do's and Don't's in life through Yam
- Categorize Do's and Don't's in life through Niyam
- Develop a healthy mind and body through Yog Asans
- Invent breathing techniques through Pranayam

UNIT I INTRODUCTION TO YOGA **9**

Definitions of Eight parts of yog.(Ashtanga)

UNIT II YAM **9**

Do`s and Don't's in life.
Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

UNIT III NIYAM **9**

Do`s and Don't's in life.
Ahinsa, satya, astheya, bramhacharya and aparigraha

UNIT IV ASAN **9**

Various yog poses and their benefits for mind & body

UNIT V PRANAYAM **9**

Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 45 PERIODS

OUTCOMES:

CO1 – Develop healthy mind in a healthy body thus improving social health also improve efficiency
CO2 – Learn Do's and Don't's in life through Yam
CO3 – Learn Do's and Don't's in life through Niyam
CO4 – Develop a healthy mind and body through Yog Asans
CO5 – Learn breathing techniques through Pranayam

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							✓	✓				✓
CO2							✓	✓				✓
CO3							✓	✓				✓
CO4							✓	✓				✓
CO5							✓	✓				✓

REFERENCES:

1. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata
2. 'Yogic Asanas for Group Tarining-Part-I" : Janardan Swami Yogabhyasi Mandal, Nagpur

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AD5095 PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS L T P C
3 0 0 0

OBJECTIVES:

- Develop basic personality skills holistically
- Develop deep personality skills holistically to achieve happy goals
- Rewrite the responsibilities
- Reframe a person with stable mind, pleasing personality and determination
- Discover wisdom in students

UNIT I NEETISATAKAM-HOLISTIC DEVELOPMENT OF PERSONALITY - I 9

Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue)

UNIT II NEETISATAKAM-HOLISTIC DEVELOPMENT OF PERSONALITY - II 9

Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)

UNIT III APPROACH TO DAY TO DAY WORK AND DUTIES 9

Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48

UNIT IV STATEMENTS OF BASIC KNOWLEDGE – I 9

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18

UNIT V PERSONALITY OF ROLE MODEL - SHRIMAD BHAGWADGEETA 9

Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 45PERIODS

OUTCOMES:

CO1: To develop basic personality skills holistically
CO2: To develop deep personality skills holistically to achieve happy goals
CO3: To rewrite the responsibilities
CO4: To reframe a person with stable mind, pleasing personality and determination
CO5: To awaken wisdom in students

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									✓			✓
CO2									✓			✓
CO3									✓			✓
CO4									✓			✓
CO5									✓			✓

REFERENCES:

1. Gopinath,Rashtriya Sanskrit Sansthanam P, Bhartrihari's ThreeSatakam , Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram,Publication Department, Kolkata,2016

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AD5097 **ESSENCE OF INDIAN KNOWLEDGE TRADITION** **L T P C**
3 0 0 0

COURSE OBJECTIVES

The course will introduce the students to

- get a knowledge about Indian Culture
- Know Indian Languages and Literature religion and philosophy and the fine arts in India
- Explore the Science and Scientists of Ancient, Medieval and Modern India
- Understand education systems in India

UNIT I INTRODUCTION TO CULTURE 9

Culture, civilization, culture and heritage, general characteristics of culture, importance of culture in human literature, Indian Culture, Ancient India, Medieval India, Modern India.

UNIT II INDIAN LANGUAGES AND LITERATURE 9

Indian Languages and Literature – I: Languages and Literature of South India, – Indian Languages and Literature – II: Northern Indian Languages & Literature

UNIT III RELIGION AND PHILOSOPHY 9

Major religions practiced in India and Understanding their Philosophy – religious movements in Modern India (Selected movements only)

UNIT IV FINE ARTS IN INDIA (ART, TECHNOLOGY& ENGINEERING) 9

Indian Painting, Indian handicrafts, Music, divisions of Indian classic music, modern Indian music, Dance and Drama, Indian Architecture (ancient, medieval and modern), Science and Technology in India, development of science in ancient, medieval and modern India

UNIT V EDUCATION SYSTEM IN INDIA 9

Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Science and Scientists of Medieval India, Scientists of Modern India

TOTAL: 45PERIODS

COURSE OUTCOMES

After successful completion of the course the students will be able to

- Understand philosophy of Indian culture.
- Distinguish the Indian languages and literature.
- Learn the philosophy of ancient, medieval and modern India.
- Acquire the information about the fine arts in India.
- Know the contribution of scientists of different eras.
- Understand education systems in India

REFERENCES:

1. Kapil Kapoor, “Text and Interpretation: The India Tradition”,ISBN: 81246033375, 2005
2. “Science in Samskrit”, Samskrita Bharti Publisher, ISBN 13: 978-8187276333, 2007
3. NCERT, “Position paper on Arts, Music, Dance and Theatre”, ISBN 81-7450 494-X, 200
4. Narain, “Examinations in ancient India”, Arya Book Depot, 1993
5. Satya Prakash, “Founders of Sciences in Ancient India”, Vijay Kumar Publisher, 1989
6. M. Hiriyanna, “Essentials of Indian Philosophy”, Motilal Banarsidass Publishers, ISBN 13: 978- 8120810990, 2014

AD5098 SANGA TAMIL LITERATURE APPRECIATION L T P C

3 0 0 0

Course Objectives: The main learning objective of this course is to make the students an appreciation for:

1. Introduction to Sanga Tamil Literature.
2. ‘Agathinai’ and‘Purathinai’ in SangaTamil Literature.
3. ‘Attruppadai’in SangaTamil Literature.
4. ‘Puranaanuru’in SangaTamil Literature.
5. ‘Pathitrupaththu’in SangaTamil Literature.

UNIT I SANGA TAMIL LITERATURE AN INTRODUCTION 9

Introduction to Tamil Sangam–History of Tamil Three Sangams–Introduction to Tamil Sangam Literature–Special Branches in Tamil Sangam Literature- Tamil Sangam Literature’s Grammar- Tamil Sangam Literature’s parables.

UNIT II ‘AGATHINAI’AND‘PURATHINAI’ 9

Tholkappiyar’s Meaningful Verses–Three literature materials–Agathinai’s message- History of Culturefrom Agathinai– Purathinai–Classification–Mesaage to Society from Purathinai.

UNIT III ‘ATTRUPPADAI’. 9

AttruppadaiLiterature–Attruppadaiin‘Puranaanuru’-Attruppadaiin‘Pathitrupaththu’-Attruppadai in ‘Paththupaattu’.

UNIT IV ‘PURANAANURU’ 9

Puranaanuru onGood Administration,Rulerand Subjects–Emotion&itsEffectin Puranaanuru.

UNIT V ‘PATHITRUPATHTHU’ 9

Pathitrupaththuin‘Ettuthogai’–Pathitrupaththu’sParables–Tamildynasty:Valor,Administration, Charity in Pathitrupaththu- Mesaage to Society from Pathitrupaththu.

Total (L:45) = 45 PERIODS

COURSE OUTCOMES: Upon completionofthiscourse, the studentswillbeable to:

1. Appreciate and apply the messages in Sanga Tamil Literature in their life.
2. Differentiate‘Agathinai’ and‘Purathinai’in their personal andsocietallife.
3. Appreciate and apply the messages in‘ Attruppadai’in their personal and societalife.
4. Appreciate and apply the messages in‘ Puranaanuru’in their personal and societallife.
5. Appreciate and apply the messages in‘ Pathitrupaththu’in their personal and societallife.

REFERENCES:

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2. HankHeifetz andGeorgeL. Hart, The Puranануru,Penguin Books,2002.
3. Kamil Zvelebil,TheSmile of Murugan: OnTamil Literature of South India, Brill Academic Pub,1997.
4. GeorgeL. Hart, Poetsof theTamil Anthologies: AncientPoemsofLove andWar, Princeton University Press,2015.
5. XavierS.Thani Nayagam, Landscape and poetry:astudy of nature in classical Tamil poetry,Asia Pub.House, 1967.

	P												PS		
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1									0.9						0.6
2									0.9						0.6
3									0.9						0.6
4									0.9						0.6
5									0.9						0.6

HSMC– ELECTIVES – HUMANITIES I (ODD SEMESTER)

HU5171	LANGUAGE AND COMMUNICATION	LT P C 3 0 0 3

COURSE DESCRIPTION

This course offers an introduction to language and communication. The primary goal of this course is to familiarize students with key ideas related to communication using language as well as non verbal means. Ideas related to the use of language and the underlying power structures are also examined. The course also examines the role of media in communication and in the dissemination of ideas as well as opinions.

Objectives

- ✓ To familiarize students with the concept of communication using linguistic and non linguistic resources.
- ✓ To help students ask critical questions regarding facts and opinions.
- ✓ To provide students with the material to discuss issues such as language and power structures.
- ✓ To help students think critically about false propaganda and fake news.

Learning Outcomes

- ➢ Students will be able to use linguistic and non linguistic resources of language in an integrated manner for communication.
- ➢ Students will be able to analyse communication in terms of facts and opinions.
- ➢ Students will be able to discuss, analyse and argue about issues related to language and power.

UNIT I LINGUISTIC AND NON-LINGUISTIC RESOURCE OF COMMUNICATION: 9

a) Writing and Speech
b) Distinction between language structure and language use, form and function, acceptability and grammaticality
c) Gestures and Body language, pictures and symbols, cultural appropriacy
d) Communicative Competency, context and situation, combination of linguistic and non-linguistic elements of communication

UNIT II STRUCTURE OF WRITING/CONVERSATION: 9

a) Language skills and the communication cycle; speaking and listening, writing and reading
b) Initiating and closing conversations, intervention, turn taking
c) Writing for target reader, rhetorical devices and strategies
d) Coherence and Cohesion in speech and writing

UNIT III POWER STRUCTURE AND LANGUAGE USE: 9

a) Gender and language use
b) Politeness expressions and their use
c) Ethical dimensions of language use
d) Language rights as part of human rights

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UNIT IV MEDIA COMMUNICATION: 9

a) Print media, electronic media, social media
b) Power of media
c) Manufacturing of opinion, fake news and hidden agendas

UNIT V PERSUASIVE COMMUNICATION AND MISCOMMUNICATION: 9

a) Fundamentals of persuasive communication
b) Persuasive strategies
c) Communication barriers

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Austin, 1962, J.L. How to do things with words. Oxford: Clarendon Press. Grice, P.1989. Studies in the way of words. Cambridge, M.A: Harvard University Press.
2. Chomsky, N.1966. Aspects of the theory of syntax, The MIT press, Cambridge. Chomsky, N.2006. Language and Mind, Cambridge University Press.
3. Hymes. D.N. 1972, On communication competence in J.B. Pride and J.Holmes (ed), Sociolinguistics, pp 269-293, London Penguin.
4. Gilbert, H.Harman, 1976. Psychological aspect of the theory of syntax in Journal of Philosophy, page 75-87.
5. Stephen. C. Levenson, 1983, Pragmatics, Cambridge University press.
6. Stangley, J. 2007. Language in Context. Clarendon press, Oxford. 7. Shannon, 1942. A Mathematical Theory of Communication. 8. Searle, J.R. 1969. Speech acts: An essay in the philosophy of language. Cambridge: Cambridge University Press.

HU5172 VALUES AND ETHICS L T P C
3 0 0 3

OBJECTIVES:

- Teach definition and classification of values.
- Explain Purusartha.
- Describe Sarvodaya idea.
- Summarize sustenance of life.
- Conclude views of hierarchy of values.

UNIT I DEFINITION AND CLASSIFICATION OF VALUES 9

Extrinsic values- Universal and Situational values- Physical- Environmental-Sensuous- Economic-Social-Aesthetic-Moral and Religious values

UNIT II CONCEPTS RELATED TO VALUES 9

Purusartha-Virtue- Right- duty- justice- Equality- Love and Good

UNIT III IDEOLOGY OF SARVODAYA 9

Egoism- Altruism and universalism- The Ideal of Sarvodaya and Vasudhaiva Kutumbakam

UNIT IV SUSTENANCE OF LIFE 9

The Problem of Sustenance of value in the process of Social, Political and Technological Changes

UNIT V VIEWS ON HIERARCHY OF VALUES 9

The Problem of hierarchy of values and their choice, The views of Pt. Madan Mohan Malviya and Mahatma Gandhi

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Able to understand definition and classification of values.
CO2: Able to understand purusartha.
CO3: Able to understand sarvodaya idea.
CO4: Able to understand sustenance of life.
CO5: Able to understand views of hierarchy of values.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								✓	✓			✓
CO2								✓	✓			✓
CO3								✓	✓			✓
CO4								✓	✓			✓
CO5								✓	✓			✓

TEXTBOOKS:

1. AwadeshPradhan :MahamanakeVichara. (B.H.U., Vanarasi-2007)
2. Little, William, : An Introduction of Ethics (Allied Publisher, Indian Reprint 1955)
3. William, K Frankena : Ethics (Prentice Hall of India, 1988)

HU5173 HUMAN RELATIONS AT WORK L T P C
3 0 0 3

OBJECTIVES:

- Illustrate human relations at work its relationship with self.
- Explain the importance of interacting with people at work to develop teamwork.
- Infer the importance of physical health in maintaining human relations at work.
- Describe the importance of staying psychologically healthy.
- Identify the essential qualities for progressing in career.

UNIT I UNDERSTANDING AND MANAGING YOURSELF 9

Human Relations and You: Self-Esteem and Self-Confidence: Self-Motivation and Goal Setting; Emotional Intelligence, Attitudes, and Happiness; Values and Ethics and Problem Solving and Creativity.

UNIT II DEALING EFFECTIVELY WITH PEOPLE 9

Communication in the Workplace; Specialized Tactics for Getting Along with Others in the Workplace; Managing Conflict; Becoming an Effective Leader; Motivating Others and Developing Teamwork; Diversity and Cross-Cultural Competence.

UNIT III STAYING PHYSICALLY HEALTHY 9

Yoga, Pranayam and Exercise: Aerobic and anaerobic.

UNIT IV STAYING PSYCHOLOGICALLY HEALTHY 9

Managing Stress and Personal Problems, Meditation.

UNIT V DEVELOPING CAREER THRUST 9

Getting Ahead in Your Career, Learning Strategies, Perception, Life Span Changes, and Developing Good Work Habits.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

CO1: Understand the importance of self-management.

CO2: Know how to deal with people to develop teamwork.

CO3: Know the importance of staying healthy.

CO4: Know how to manage stress and personal problems.

CO5: Develop the personal qualities essential for career growth.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						✓		✓	✓			✓
CO2									✓	✓		✓
CO3						✓		✓	✓			✓
CO4								✓				✓
CO5								✓	✓	✓		✓

TEXT BOOK:

1. Dubrien, A. J. (2017). Human Relations for Career and Personal Success: Concepts, Applications, and Skills, 11th Ed. Upper Saddle River, NJ: Pearson.

REFERENCES:

1. Greenberg, J. S. (2017). Comprehensive stress management (14th edition), New York: McGraw Hill.
2. Udai, Y. (2015). Yogasanaurpranayam. New Delhi: N.S. Publications.

HU5174 PSYCHOLOGICAL PROCESSES L T P C
3 0 0 3

COURSE DESCRIPTION

Psychological Processes course is designed for students to be aware of the basic principles of psychology for the better understanding of people's psyche and behaviour around them. This course enables learners to use the optimal use of different forms of thinking skills and thereby results in effective communication in diverse situations. Every unit of the syllabus highlights the psychological process of people, the most powerful and constructive use of perceptions.

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OBJECTIVES

The major objectives of this course is

- To develop students' awareness – on psychology, learning behavior and usage of perception effectively.
- To learn to use the various kinds of thinking in a formal context.
- To critically evaluate content and comprehend the message on the bases of perception, personality and intelligence.

UNIT 1: INTRODUCTION

What is psychology? - Why study psychology? - Psychology as science – Behavior and its role in human communication – socio-cultural bases of behaviour – Biological bases of behavior - Brain and its functions – Principles of Heredity – Cognition and its functions Fields of psychology – Cognitve and Perceptual – Industrial and Organizational.

UNIT 2: SENSORY & PERCEPTUAL PROCESSES

Some general properties of Senses: Visual system – the eye, colour vision – Auditory system – Hearing, listening, Sounds - Other senses - Selective attention; physiological correlates of attention; Internal influences on perception learning – set - motivation & emotion - cognitive styles; External influences on perception figure and ground separation – movement – organization – illusion; Internal- external interactions: Constancy - Depth Perception- Binocular & Monocular Perception; Perceptual defense & Perceptual vigilance; Sensory deprivation -Sensory bombardment; ESP - Social Perception.

UNIT 3: COGNITION & AFFECT

Learning and memory – philosophy of mind – concepts - words – images – semantic features – Association of words – Repetition – Retrieval – Chunking - Schemata - Emotion and motivation – nature and types of motivation – Biological & Psychosocial motivation – nature and types of emotions – physiological & cognitive bases of emotions – expressions of emotions – managing negative emotions - enhancing positive emotions.

UNIT 4: THINKING, PROBLEM-SOLVING & DECISION MAKING

Thinking skills – Types of thinking skills – Concrete & Abstract thinking – Convergent & Divergent - Analytical & Creative thinking – Problem & Possibility thinking – Vertical & Lateral thinking – Problem solving skills – stages of problem solving skills – Decision making - intuition and reasoning skills - Thinking and language - The thinking process- concepts, problem solving, decision-making, creative thinking; language communication.

UNIT 5: PERSONALITY & INTELLIGENCE

Psychological phenomena & Attributes of humans - cognition, motivation, and behavior - thoughts, feelings, perceptions, and actions – personality dimensions, traits, patterns - Specialized knowledge, performance accomplishments, automaticity or ease of functioning, skilled performance under challenge - generative flexibility, and speed of learning or behavior change.

References

1. Morgan, C.T.and King, R.A (1994) Introduction to Psychology, Tata McGraw Hill Co Ltd, New Delhi.
2. Robert A. Baron (2002), Psychology, 5th Edition, Prentice Hall, India.
3. Michael W.Passer, Ronald E.smith (2007), Psychology: The science of mind and Behavior,3rd Edition Tata McGraw-Hill Edition.
4. Robert S.Feldman (2004) Understanding Psychology 6th Edition Tata McGraw – Hill.

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5. Endler, N. S., & Summerfeldt, L. J. (1995). Intelligence.personality. psychopathology. and adjustment. In D. H. Saklofske & M. Zeidner (Eds.). International handbook of personality and intelligence (pp. 249-284). New York: Plenum Press.
6. Ford, M. E. (1994). A living systems approach to the integration of personality and intelligence.In R. J. Sternberg.& P. Ruzgis (Eds.). Personality and intelligence (pp. 188-21 7). New York: Cambridge University Press.
- De Bono, E (1990) Lateral Thinking, Harper Perennial, New York.

HU5175 EDUCATION, TECHNOLOGY AND SOCIETY L T P C
3 0 0 3

COURSE DESCRIPTION

This course introduces students to multidisciplinary studies in Education, Technology and Society. Students will get an understanding of the relationship between education, technology and society. They will also learn about the long lasting impact of good education in a technologically advanced society.

COURSE OBJECTIVES:

The course aims

- To help learners understand the basics of different types of technology utilised in the field of education
- To make them realize the impact of education in society
- To make them evolve as responsible citizen in a technologically advanced society

LEARNING OUTCOMES

By the end of the course, learners will be able to

- Understand the various apps of technology apps and use them to access, generate and present information effectively.
- Apply technology based resources and other media formats equitably, ethically and legally.
- Integrate their technical education for betterment of society as well as their personal life.

UNIT I INDIAN EDUCATION SYSTEM

Gurukul to ICT education – Teacher as facilitator – Macaulay's Minutes – English medium vs Regional medium – Importance of Education in Modern India - Challenges in Education

UNIT II LEARNING THEORIES

Learning Theories – Behaviorism – Cognitivism – Social Constuctivism – Humanism Learning Styles – Multiple Intelligences – Emotional Intelligence – Blooms Taxonomy

UNIT III TECHNOLOGICAL ADVANCEMENTS

Web tools – Social media in education – elearning – MOOCs – Mobile assisted learning – Learning Apps – Blended learning - Self-directed learning

UNIT IV EDUCATIONAL TECHNOLOGY

Technological implications on Education – Teaching, Learning & Testing with Technology - Advantages and drawbacks – Critical analysis on the use of technology

Attested

UNIT V ETHICAL IMPLICATIONS

Plagiarism – Online Copyright issues – Ethical and value implications of education and technology on individual and society.

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TOTAL:45 PERIODS

TEACHING METHODS

Teaching modes include guest lectures, discussion groups, presentations, visual media, and a practicum style of learning.

EVALUATION

As this is course is not a content based course, it focuses more on the ethical use of technology in education and society, and so, evaluation can be based on assignments and discussions. So there is no need for an end semester examination. Internals marks can be taken for the total marks.

INTERNAL (100 % WEIGHTAGE)

(a) Written Test (40 marks)
(b) Assignment: Write a real time report of the technology use in any school / college (15 marks)
(c) Presentation: Students choose any one of the technological tools and present its relevance to education and society (15 marks)
(d) Group discussion: Students discuss in groups on case studies relating to various challenges in education and technology use in society (20 marks)
(e) Blog entry: Making weekly blog posts in Class Blog on the topics related to the course posted by the instructor and commenting on others' posts. (10 marks)

REFERENCES

1) Education and Social order by Bertrand Russel
2) Theories of learning by Bower and Hilgard
3) Technology and Society by Jan L Harrington

HU5176 PHILOSOPHY L T P C
3 0 0 3

OBJECTIVES

- To create a new understanding by teaching philosophy through a comparison of Indian and Western traditions.
- To Fosters critical thinking and imagination by dealing with inter-related concepts in literature and science.
- To bridge the gap between the sciences and humanities through introspective analyses.
- To nurture an understanding of the self and elucidates ways to progress towards a higher understanding of one's self and others.

UNIT I KNOWLEDGE 9

Knowledge (Vidya) Versus Ignorance (Avidya)- Brihadaranyaka Upanishad. Unity and Multiplicity – Isha Upanishad. What is True Knowledge? Ways to True Knowledge. Introduction to Philosophy of Yoga, Socratic Debate, Plato's Views.Asking and Answering Questions to Stimulate Critical Thinking and to Draw Ideas.Argumentative Dialogues.Dialectical Methods to Arrive at Conclusions.

UNIT II ORIGIN 9

Origin of Universe And Creation – 'Nasidiya Sukta' in Relation With Big Bang Theory. Greek Concept of Chaos.The Concept of Space – Space as the Final Goal – Udgitha. Relationship Between Teacher And Student – The Knowledge Of Combinations, Body And Speech – Siksha Valli – Taittriya Upanishad.

UNIT III WORD **9**

Aum- Speech and Breath as Pair – Chandogya Upanishad and Brihadaryanaka Upanishad.Significance of Chants, Structure of Language and Cosmic Correspondences.The Non-Dual Word – Bhartrihari's Vakyapadiyam. Sphota-Ultimate Reality Expressed Through Language. Intention.Thought 'Sabdanaor' and Speaking.

UNIT IV KNOWLEDGE AS POWER/OPPRESSION **9**

Power- as Self-Realization in Gita.Krishna's Advice to Arjuna on How to Conquer Mind. Francis Bacon – Four Idols – What Prevents One From Gaining Knowledge? Michel Foucault- Knowledge as Oppression.Panopticon.Rtam (Truth) and Satyam (Eternal Truth).

UNIT V SELF KNOWLEDGE/BRAHMAN **9**

Knowledge about Self, Transcendental Self.The Different Chakras and the Stages of Sublimation.Philosophy of Yoga and Siva for Union of Mind and Body.Concept of Yin/Yang.Aspects of the Feminine / Masculine.

TOTAL : 45 PERIODS

OUTCOMES:

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

1. Think sceptically, ask questions and to arrive at deductions.
2. Connect and relate different branches of thought.
3. Comprehends the relation between language, thought and action.
4. Arrive at a better understanding of self and others and forms a new outlook.

REFERENCES:

1. Swami Nikhilananda: The Upanishads, Swami Nikhilananda, Advaita Ashrama, Kolkata.
2. Swamy Tapasyananda: Srimad Bhagavad Gita, The Scripture of Mankind, Sri Ramakrishna Math, Chennai.
3. Subrahmanyam, Korada: Vakyapadiyam of Bhartrhari Brahmakanda, Sri Garib Dass series.
4. Swami Lokeswarananda: Chandogya Upanishad, Swami Lokeswarananda, Ramakrishna Mission Institute of Culture, Kolkata.
5. Brahma, Apuruseya: The Four Vedas: Translated in English.
6. Haich, Elizabeth: Sexual Energy and Yoga.
7. Bacon, Francis: Power as Knowledge
8. Vlastos, Gregory: Socrates Ironist and Moral Philosopher.
9. Plato: The Republic, Penguin.
10. Gutting, Garry: Foucault A Very Short Introduction, Oxford.

HU5177 APPLICATIONS OF PSYCHOLOGY IN EVERYDAY LIFE L T P C
3 0 0 3

UNITI INTRODUCTION 7

Nature and fields.

UNITII PSYCHOLOGY ININDUSTRIES AND ORGANIZATIONS 9

Job analysis; fatigue and accidents;consumerbehavior.

UNITIII PSYCHOLOGY AND MENTALHEALTH 11

Abnormality, symptoms and causes psychological disorders

UNITIV PSYCHOLOGY AND COUNSELING 7

Need of Counseling, Counselor and the Counselee,Counseling Process, Areas of Counseling.

UNITV PSYCHOLOGY AND SOCIALBEHAVIOUR 11

Group, group dynamics, team building, Prejudice and stereotypes; Effective Communication, conflict and negotiation.

TOTAL:45PERIODS

TEXTBOOKS

1. Schultz,D.&Schultz,S.E.(2009). PsychologyandWorkToday(10thed.). New Jersey: Pearson/PrenticeHall
2. Butcher,J.N., Mineka,S.,&Hooley,J. M.(2010). Abnormal psychology(14th ed.).NewYork: Pearson
3. Gladding,S.T. (2014).Counselling:Acomprehensiveprofession. NewDelhi: PearsonEducation
4. Aronson, E.,Wilson, T. D.,&Akert, R. M.(2010).Social Psychology(7th Ed.). UpperSaddleRiver,NJ: PrenticeHall