POOJYA DODDAPPA APPA COLLEGE OF ENGINEERING, KALABURAGI

B.E. in CERAMICS AND CEMENT TECHNOLOGY

Choice Based Credit System (CBCS)

Scheme of Teaching and Examination 2022-2023

Effective for students admitted in 2019-2020

VII Semester

Sl. No.	Course and Course Code		Course Title	Teaching Department	Teaching Hours/Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/Drawing	Self Study	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	PC	19CC71	Electrical & Magnetic ceramics	CCT	4	-	--	--	--	50	50	100	4
2	PC	19CC72	Composite materials	CCT	3		--	0.5	--	50	50	100	3.5+0.5
3	PE	19CC731	Non Destructive Testing	CCT	3	-	--	--	--	50	50	100	3
		19CC732	Bio materials										
4	PE	19CC741	Structure & properties of materials	CCT	3	--	--	--	--	50	50	100	3
		19CC742	Materials Technology										
		19CC743	Process Calculations										
5	OE	19CC75OE	Ceramic Technology	CCT	3	-	--		--	50	50	100	3
6	PC	19CCS76	Seminar/Case study/Group work	CCT	-	-			--	50	50	100	1
7	PROJ	19CCP77	Project Work Phase - 1	CCT	-	--	--		--	50	50	100	3
Total					**16**	**--**	**2**	**1**	**--**	**400**	**400**	**800**	**21**

Note: PC: Professional core, PE: Professional Elective, OE: Open Elective, MP: Mini-project, INT: Internship.

Internship: All the students admitted to III year of BE/B.Tech has to undergo mandatory internship of 4 weeks during the vacations of VI and VII semesters and /or VII and VIII semesters.

THEORY COURSE TITLE: Electrical and Magnetic ceramics	
Course Code: 19CC71	CIE: 50
Number of Lectures Hours/Week: 04	SEE: 50
Total Number of Lecture Hours: 52	SEE Hours: 03

Modules	Teaching Hours
Module-I: Dielectric Properties and magnetic properties: Dielectric constant and loss, polarization, dielectrics, dielectric strength, Linear dielectrics and non linear dielectrics, alumina, steatite and mica. Piezoelectric, pyroelectric and ferroelectric behavior of ceramics, Basic concepts and phenomena, compositional systems of electro optic ceramics Magnetic properties of ceramics Basic theory, magnetic behavior, properties, diamagnetism, paramagnetism, ferro magnetism, anti-ferromagnetism, ferrimagnetism, exchange and indirect exchange interactions spin order, lattice interactions, ferri magnetic and ferromagnetic domains.[1][2][3][4][5][6]	11
Module-II: Classification of capacitors – class-I and class-II capacitors. Structure and electrical behaviour of of barium titanate, PZT and PLZT related materials.	10
Module-III Classes of magnetic ceramics, spinel ferrites, structure of spinel ferrites, effect of composition in ferrites, manganese and nickel zinc ferrite. Hexagonal ferrites, structure, properties and applications. Rare earth garnets, YIG . Structure, properties and applications. Comparison of Ceramic magnets over metallic magnetic materials [3][1]	10
Module-IV: General idea of detailed manufacturing method of porcelain insulators with flow chart. Synthesis and fabrication of various types of capacitors, like disc, multilayer ceramic capacitors by tape casting method. Synthesis and fabrication of electro-optic ceramics by CP and HP process. Thin films by CVD process. General method of synthesis and fabrication of magnetic ceramics, with flow chart. [2][1][6] [4] [3]	11
Module V Different types of conduction Basic mechanism of conduction in solid electrolytes, crystalline and glass ionic conductors, Applications of Zirconia and alumina based Ceramics for solid oxide fuel cells and solid state batteries for sustainable energy production.	10

Ceramics superconductors and their applications.	

Text books:

[1] R. C. Buchanan, *Ceramic materials for electronics: processing, properties, and applications*. M. Dekker, 1986.

[2] D. Richerson, *Modern Ceramic Engineering: Properties, Processing, and Use in Design, Third Edition*. Taylor & Francis, 1992.

[3] W. D. Kingery, H. K. Bowen, and D. R. Uhlmann, *Introduction to ceramics*, Second edi. John-Wiley and Sons, Inc, 1976.

[4] W. D. Callister, "Materials Science and Engineering." p. All Pages, 1997.

[5] A. J. Moulson and J. M. Herbert, *Electroceramics: Materials, Properties, Applications*. Wiley, 2003.

[6] R. K. Pande, *Fundamentals of Electroceramics*. 2019.

Reference Books:

A. J. Moulson and J. M. Herbert, *Electroceramics: Materials, Properties, Applications*. Wiley, 2003.

E-books and online course materials:

R. K. Pande, *Fundamentals of Electroceramics*. 2019.

Course outcomes:

On completion of the course, the student will have the ability to:

CO #	Course Outcome (CO)
CO1	Explain principles of dielectric and magnetic ceramics
CO2	Explain principles and applications of capacitors and electro-optic ceramics
CO3	Explain classifications, comparisons and applications of various magnetic ferrites
CO4	Explain and outline the manufacturing methods of electro and magnetic ceramics.
CO5	Explain principles and applications of conducting ceramics and ceramic superconductors

Course Title: Composite Materials		
Subject Code	19CC72	CIE: 50
Number of Lecture Hours/Week	3(Theory)	SEE: 50
Total Number of Lecture Hours	35+7=42 hrs(7hrs self study component)	SEE Hours: 03
Modules		Teaching Hours
Module-1 Introduction: Definition of composite, natural composite materials, comparison between monolithic materials and composite materials. Reinforcements; types, characteristics governing utilization of fibers as high performance engineering materials, flexibility of fiber–derivation, functions of fibers and matrix, advantages and limitation of composite materials. Applications of composite materials; Aerospace industry, automotive industry, sporting goods industry, marine applications, consumer goods, construction and civil structure, industrial applications. Glass fiber : types of glass fibers : compositions of E glass fiber , Cglass Fiber , S glass fiber , preparation methods ; drawing method , sol gel method, structure , properties and applications		8
Module-2 Ceramic fibers; Preparation, properties and applications of, boron fiber, alumina fiber, carbon fiber, silicon carbide fiber, silicon nitride fiber , boron nitride fiber. Organic fibers; Preparation, properties and applications. Metallic fibers: Fabrication , properties and applications of metallic fibers , comparison of different fibers		8
Module-3 Polymer matrix materials :Thermoplastic resins- nylons , polypropylene , PEEK, PPPS, fabrics , prepegs , thermoset ,thermoplastic prepegs , molding compounds , -sheet molding compounds , thick ,bulk , injection ,honey comb and other core materials. Advantages and dis advantages of thermoset and thermoplastic composite processing. Manufacturing processes of thermoset composites: prepeg process, layup, spray up process, filament winding process, pultrusion, injection molding process. Manufacture of thermoplastic composites: thermoplastic tape winding, compression molding, hot pressing, auto clave processing, and diaphragm forming. Machining and cutting of composite materials; introduction, objective and purpose of machining, challenges during machining of composites, cutting tools, Cutting operations : water jet cutting , laser cutting , drilling operation		10
Module-4 Metal matrix composites; metal matrix materials Fabrication techniques of metal matrix composites – diffusion bonding, squeeze casting, and insitu fabrication techniques. Properties and applications of metal matrix composites Ceramic matrix materials :Ceramic matrix composites: Fabrication methods: slurry		8

infiltration process, hot pressing, melts infiltration process, chemical vapor infiltration process. Properties and applications of ceramic matrix composites.	
Module-5 Carbon fiber composites: manufacture, properties and applications. Multifilamentary super conducting composites: principle, manufacture, properties and applications. Physical properties of composites: density, strength, fracture, fatigue. Interface of composites :wet ability and bonding interface in composites, interactions at interface , types of bonding at interface , measurement of interfacial strength, interface at polymer ,metal ,ceramic matrix composites., Recycling of composites: Introduction, categories of dealing with wastes: land filling or burying, incineration or burning, Recycling methods: regrinding ,pyrolysis	8
Question paper pattern: Student has to answer any five full questions, selecting one from each module.	
Reference Books: Reference books 1.Composite materials (Science & Engineering)-K.K. Chawla (Springer Verlag) 2. Introduction to material science for Engineers –James F. Shackelford, Macmillan, New York. 3.Material Science and Engineering –L.H. Van Vlack, Addison –Wesley 4.Modern ceramic engineering –D.W. Richardson 5.Handbook of Composite materials –American Chemical Society 6.Handbook of structural ceramics –Mel M. Schwartz, McGraw 7Composites manufacturing ,materials ,products and process engineering.Sanjay K Maunder	
E books and online course materials:	

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	**CO #**	Course Outcome (CO)	Blooms Level
	CO1	Define , classify the composites understand applications of composites composites, understand manufacture ,properties and applications of glass fiber	C1
	CO2	Know the fabrication process followed for ceramic fibers, organic fibers and metallic fibers .understand their properties, and applications. Will be in a position to compare the properties of different fibers.	C2
	CO3	Explain fabrication ,advantages ,disadvantages of thermosetting and thermoplastic polymers and machining and cutting of polymers	C3
	CO4	Explain manufacture , properties and applications of ceramic and metal matrix composites	C4
	CO5	Explain carbon fiber composites, multifilamentary composites , properties of composites , interface of composites and recycling of composites .	C5

Subject	NON DESTRUCTIVE TESTING	
Subject Code	**19CC731**	
Credits	**3**	
Hrs / week	**42**	
CIE: 50 Marks	**SEE: 50 Marks**	**SEE: 3 Hrs duration**

Course Objectives: To impart knowledge and enable students to understand

1. Basic differences between destructive and non destructive testing. how to handle visual, leak and liquid penetration NDT methods
2. Magnetic particle and Eddy current inspection methods , their advantages and limitations
3. Ultrasonic NDT working methodology, their advantages and limitations
4. Radiographic, Neutron and Thermal NDT methods, their applications and limitations
5. Optical, Acoustic and Microwave NDT working methodology their applications and limitations

Etc.

SYLLABUS

Module	Contents	No. of hrs.
Module 1	Introduction to NDT**:** Selection of NDT methods. Visual inspection, leak testing, Liquid penetration inspection- advantages and limitations.	O6
Module 2	Magnetic particle inspection**:** Methods of generating magnetic field, types of magnetic particles and suspension liquids, steps in inspection, applications and limitations of the test. Eddy current inspection**:** principle of operation, process variables , inspection coils- applications and limitations the test	08
Module 3	Ultrasonic inspection**:** Basic equipment, characteristics of ultrasonic waves, variables during ultrasonic inspections. Inspection methods, normal incident pulse echo, angle beam pulse echo and transmission type. Method of display- A,B and C scan mode. Transducer elements, couplets, search units, contact type and immersion types inspection methods, inspection of products like casting, extrusions, rolled product, weld set- applications and limitations of the test	10
Module 4	Radiography inspection**:** Principles, radiation sources. X-Rays and their generation, gamma rays and their generation. Radio graphic films. X-ray filters, image intensifiers. Industrial radiography. Image quality indicators, radiography sensitivity- applications and limitations of the test. Neutron radiography: working methodology its application and limitations. Thermal NDT**:** principle, inspection methods,applications and limitations of the test	10
Module 5	Optical Holography**:** Basics of Holography, recording and reconstruction-info metric techniques of inspection, procedures of inspection, typical applications. Acoustical Holography: working principle, applications and limitations. Microwave NDT: Working principle, applications and limitations. Indian	08

	Standard for NDT.	

Course Outcomes: At the end of the course, students will be able to:

CO No.	Course Outcome	
CO1	Indentify the importance of non destructive testing in comparison with destructive testing.	
CO2	Operate different types of non destructive tools.	
CO3	Analyze/Identify surface and volumetric flaws existing in any engineering materials components.	

Text books:

1. Non Destructive Test and Evaluation of Materials- J Prasad and C. G. Krishnadas Nair, Tata McGraw Hill Education

2. Non Destructive Testing- Nagesh S.N and Jyothilakshmi R., Subhas Stores

Reference books:

1. Non Destructive Testing - Mc Gonnagle JJ – Garden and reach New York.

2. Non Destructive Evolution and Quality Control - volume 17 of metals hand book 9 edition Asia internal 1989.

3.The Testing instruction of Engineering materials - Davis H.E Troxel G.E wiskovil C.T - McGraw hill

Question paper pattern:

Question paper shall contain FIVE modules, each module containing TWO questions. Students shall answer any ONE full question from each module.

COURSE TITLE**: PROCESS CALCULATIONS**		
Course Code: 19CC743		CIE: 50
Number of Lecture Hours/Week: 3		SEE: 50
Total Number of Lecture Hours: 42		SEE Hours: 03

Modules	**Teaching Hours**
Module-I: Fundamentals of process engineering, manufacturing processes of various ceramics materials. General ideas about various operations of a typical process, temperature scales, kgatom, kmol, mole fraction, valency, normality, molarity, molality, ppm, ppb, problems, calculation of average molecular weight, density and specific gravity of gaseous mixtures, problems, methods of expressing compositions of solids, liquids and gases.	9
Module-II: Material balance without reaction: General material balance equation. Typical steady state material balances in distillation, absorption, crystallization, drying, mixing and evaporation. Material balances involving bypass, recycle and purging operations.	9
Module-III: Steady state material balance with reaction: Principles of stoichiometry, concept of limiting and excess reactants and inerts, fractional and percentage conversion, fractional yield and percentage yield, selectivity, related problems.	8
Module-IV: Fuels, proximate and ultimate analyses of fuels, ORSAT analysis, Calculations involving combustion of solid, liquid and gaseous fuels, excess air.	8
Module-V: Energy balance: General steady state energy balance equation, Heat capacity. Enthalpy, Heat of formation, Heat of reaction, Heat of combustion, Heat of solution, Heat of mixing, Heat of crystallization. Hess's law, Determination of enthalpy of reaction at standard and elevated temperatures, flame temperature.	8
Question paper pattern: Question paper shall contain five units, each unit containing two questions. Students shall answer any one question from each unit.	
Text books: 1. D.C. Sikdar, Chemical Process Calculations, PHI Learning Pvt. Ltd, Eastern Economy Edition, 2013	
Reference Books: 1. Bhatt, B.I., and Vora, S. M., "Stoichiometry (SI units)", Third edition, 1996, Tata McGraw	

Hill Publishing Ltd., New Delhi.
2. Hougen O.A., Watson K.M. and Ragatz R.A., "Chemical Process Principles (Part I)
4. Himmelblau D.M., "Basic Principles and Calculations in Chemical Engineering", 6th ed., Prentice Hall of India, New Delhi, 13 1997.

E-books and online course materials:

1. D.C. Sikdar, Chemical Process Calculations, PHI Learning Pvt. Ltd, Eastern Economy Edition, 2013

Course outcomes:
On completion of the course, the student will have the ability to:

CO #	Course Outcome (CO)
CO1	Perform, composition calculations and gas calculations
CO2	Perform material balance calculations without chemical reactions
CO3	Perform material balance calculations with chemical reactions
CO4	Perform combustion calculations
CO5	Perform energy balance calculations

Course Title: Ceramic Technology		
Subject Code	19CC75OE (Open Elective)	CIE: 50
Number of Lecture Hours/Week	3(Theory)	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03
Modules		**Teaching Hours**
Module-1 Introduction to Materials- Classification, properties and importance of engineering materials. Study on bonds in materials and their properties. Ceramics- Definition, classifications and properties of ceramic materials. Comparison of properties of ceramics with metals and polymers.		8
Module-2 Classification and properties of Clays and feldspars. Properties and polymorphism of quartz. Shaping of ceramic articles: dry and semi dry, uniaxial pressing, extrusion, jiggering and jollying, slip casting, isostatic pressing, tape casting.		8
Module-3 Conventional Ceramics: Manufacture, properties and applications of Refractories, Glass, White wares and Portland cement		8
Module-4 Advanced ceramics: manufacture, properties and applications of Cermets, Abrasives - Alumina, silicon carbide, zirconia. Piezoelectric		10

Ceramics- Lead zirconate, Titanate and Barium titanate. Ceramic insulators, Bio-ceramics - Calcium phosphate, Hydroxyapatite. Automotive ceramics – Ceramic sparkplug, ceramic insulators and ceramic catalysts.	
Module-5 Testing of ceramics: Water of plasticity, Adsorbed moisture, Bulk density, Apparent porosity, Loss on ignition, Drying shrinkage and Firing shrinkage.	8

Course outcomes:

Question paper pattern:
Student has to answer any five full questions, selecting one from each module.

Reference Books:

1. Industrials ceramics-F Singer and Singer S.S.
2. Elements of ceramics –F.H. Norton
3. Ceramic White wares. - Ryan.
4. Ceramic White wares – New comb.
5. Principal of Ceramic Processing –James Reid

E books and online course materials:

1. Ceramic Engg and Science Proceedings Am.Cer.Socisty https://ceramicsonlinelibrary.Wiley.com
2. Ceramics engg Books-Alibris https://m.alibris.com

Course outcomes:
On completion of the course, the student will have the ability to understand:

Course Code	CO #	Course Outcome (CO)	Blooms Level
	CO1	Classification made on engineering materials, nature of bonds existing in materials and comparison of engineering materials	L2
	CO2	Clays and their types, Feldspar and their types, polymerization of Quartz. The fabrication methods used in ceramic shaping	L1, L2
	CO3	Manufacture process, properties and applications of Refractories, Glass, White wares and Portland cement	L5
	CO4	The applications of ceramic components in engineering as well as biomedical field	L3, L5
	CO5	Importance and significance of testing ceramic raw materials and ceramic components	L3