POOJYA DODDAPPA APPA COLLEGE OF ENGINEERING, KALABURAGI

B.E. in CERAMICS AND CEMENT TECHNOLOGY

Choice Based Credit System (CBCS)

Scheme of Teaching and Examination 2023-2024

Effective for students admitted in 2020-2021

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.

Course Title: Electrical and Magnetic Ceramics
[As per Choice Based Credit System (CBCS) Scheme]

Course Code	19CC71	CIE Marks	50
Credits	Three	SEE Marks	50
Course Type Theory	Theory		
Lecture Hours/Week	4	Total Marks	100
Total Hours	52 Hours	SEE Hours	03

Course Objectives:

MODULES	Hours
Module-1 Introduction; Definition and fundamentals of electricalconductivity in different category of materials. Dielectric Properties of Ceramics: Dielectric constant and loss, polarization mechanisms in dielectrics, dielectric strength, factors affecting dielectric strength, basic ceramic dielectric materials such as Glass, Porcelain and steatite, Rutile and barium titanate. Basic definition of linear and non-linear dielectrics.	10 Hours
Module-2 Non-Linear Dielectrics: Phenomena of piezoelectricity, pyroelectricity and ferroelectricity. Structural origin of ferroelectric state. Hysteresis, Ferroelectric domains, compositional and grain size factors on ferroelectric state of materials ($BaTiO_3$), Antiferroelectric-Ferroelectric transition. Electro-Optic Ceramics; Basic phenomena, Optical phase retardation with electro-optic materials, PLZT compositionalsystem, processing and fabrication	10 Hours
Module-3 Ceramic Capacitors: Classification of capacitors – class-Iand class-II capacitors. Varieties of ceramic capacitors: Thick and Thin film capacitors, single layer discrete capacitors and multilayercapacitors. Synthesis and fabrication of various types of capacitors, likedisc, multilayer ceramic capacitors by tape casting method.	10 Hours
Module-4 Magnetic Ceramics:Basic theory on magnetic behavior/properties, phenomena of diamagnetism, paramagnetism, Ferro-magnetism, anti- ferromagnetism, Ferri-magnetism, ferromagnetic domains and domain motion. Classes of Magnetic Ceramics; Spinel ferrites, Effect of composition in spinel ferrites. Manganese and Nickel Zinc Ferrites, Hexagonal ferrites ($BaO.\ 6Fe_2O_3$) and Garnet ferrites (YIG). General method of synthesis and fabricationof magnetic ceramics.	10Hrs
Module-5 Ionic conductivity in ceramic materials: Mechanism of Ionic Conductivity, ceramic materials exhibiting ionic conductivity, applications of ionically conductive materials. Ceramic sensors and Superconductors: Elementary idea ofvaristors and thermistors. Applications of zirconia and alumina based ceramics for solid oxide fuel cells and solid state batteries for sustainable energy production. Superconductivity phenomena, mechanism of superconductivity, types of superconductors and applicationsof superconductors	12Hrs

Text books:

L. L. Hench and J. K. West "Principles of Electronic Ceramics" John Wiley &Sons- A Wiley-Interscience Publications New York 1990

Reference Books:

1. Relva C. Buchanan "Ceramic Materials for Electronics-Processing, Propertiesand Applications" Marcel Dekker Inc. New York 1986

2.David W. Richerson "Modern Ceramic Engineering- Properties, Processing andUse in Design"

Marcel Dekker Inc., New York 1992

E books and online course materials:

1.L Solymar D. Walsh and R. R. A. Syms, Electrical Properties of Materials 9th Edition, Oxford University Press UK 2014

2. https://nptel.ac.in/course.php

Course outcomes:

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

Course Code	CO #	Course Outcome (CO)	Blooms Level
15CC72	CO1	Differentiate electrical behavior of conductors, insulators and dielectricmaterials	L2
	CO2	Illustration of structure-property correlation for ferroelectric property behavior of ceramics and electro-optic ceramics	L4
	CO3	Analysis of structure-properties correlations For compositions to prepare ceramiccapacitors and insulators	L4
	CO4	Illustration of structure-property correlationfor magnetic property behavior of ceramics and its compositions	L5
	CO5	Applications of ion conducting ceramics ceramic sensor and ceramic superconductors	L3

COURSE TITLE: Materials Technology	
Course Code: 19CC742	CIE: 50
Number of Lectures Hours/Week:03	SEE: 50
Total Number of Lecture Hours: 42 (3credits)	SEE Hours: 03

	Teaching Hours
Modules I: Introduction to materials, classification maid on engineering materials. Selection of materials-factors affecting selection of materials for engineering purposes. Study on classification maid on metals and detailed study on ferrous materials.	08
Module-II: study on non-ferrous materials- copper and its alloys, aluminum and its alloys, magnesium and its alloys, nickel and its alloys, lead and its alloys, zinc and its alloys, titanium and its alloys Shaping of metals- Die casting of metals and alloys, shell mould casting, Die-casting, Centrifugal casting, Shell Casting, Investment casing, Extrusion and Forging of metals	10
Module-III: Powder metallurgy- definition, applications, advantages and	08

limitations. Powder metallurgy process, characteristics of metal powders, production of metal powders, blending and mixing of powders, compaction of powders, pressing and sintering of compacted component. Hot pressing of powders, Secondary operations on powder compacted component.	
Module-IV: Ceramic materials, types of ceramic materials, general methods used in the manufacture of ceramic materials, properties, applications of ceramic materials. Polymers- introduction to polymers, classification of polymers, general polymer processing, properties and applications of polymers	08
Module-V: loss on ignition, water of plasticity, Tensile strength, Compression testing, Hardness testing, Impact resistance, Torsion testing, Fatigue testing, Creep testing and radio graphic testing .	08

Question paper pattern:
Question paper shall contain five modules, each module containing two questions. Students shall answer any one question from each module.

Text books:

1. Material science and Metallurgy- by O.P.Khanna
2. Engineering Materials and Metallurgy- Dr. Rakesh Dogra
3. Metallurgy Fundamentals- Daniel A. Brandt, J. C. Warner

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

CO #	Course Outcome (COs)
CO1	Identify the materials for different applications and factors to be considered for selecting a material (L1, L2)
CO2	Understand the properties , applications and fabrication of ferrous materials (L2)
CO3	Assess the importance of powder metallurgy route in comparison with conventional fabrication of materials (L3)
CO4	Understand the properties, applications and manufacture of ceramic and polymeric materials (L3, L4)
CO5	Analyze and explain the properties of materials by various testing methods (L4, l5)

Course Title: Non Destructive Testing
[As per Choice Based Credit System (CBCS) Scheme]

Course Code	19CC731	CIE Marks	50
Credits	Three	SEE Marks	50
Course Type Theory	Theory		
Lecture Hours/Week	42	Total Marks	100
Total Hours	42 Hours	SEE Hours	03

Course Objectives:

MODULES	Hours
Module-1 Introduction to NDT**:** Selection of NDT methods. Visual inspection, Liquid penetration inspection- advantages and limitations.	8
Module-2 Magnetic particle inspection**:** Methods of generating magnetic field, types of magnetic	8

particles and suspension liquids, steps in inspection – applications and limitations of the test. Leak testing	
Module-3 Ultrasonic inspection**:** Basic equipment, characteristicsof 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, contacttype 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 theirgeneration. Radio graphic films. X-ray filters image intensifiers. Industrial radiography. Image quality indicators, radiography sensitivity- applications and limitations of the test.	8
Module-5 Neutron radiography working methodology its application and limitations. Thermal NDT inspection principles, inspection methods Optical Holography**:** Basics of Holography, recording and reconstruction-info metric techniques of inspection, procedures of inspection, typical applications.	8

Text books: 1. Non-Destructive Testing Techniques- by Ravi Prakash, firstrevised edition, new age international publications.

2. Basics of Non-Destructive testing- by Lari and Kumar, S.K. Kataria & Sonspublication.

Non-Destructive Test and Evaluation of Materials- by J. Prasad andC.G.K.Nair,2nd edition, McGraw Higher Ed publication.

Course outcomes:

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

Course Code	**CO #**	Course Outcome (CO)	Blooms level
19CC731	Find the basic differences between NDT and destructive testing and and liquid penetrant NDT methods	CO1	L1
	Illustrate magnetic particle and leak testing and handle the both tests.	CO2	L3
	Utilize Ultrasonic testing tools and outline their advantages and limitations	CO3	L3, L5
	Examine the components for defects using radiographic Non destructive testing tools and outline their advantages and limitations	CO4	L4
	Explain Optical Holography and neutron testing methods and assess their applications and limitations	CO5	L5

COURSE TITLE: Materials Technology		
Course Code: 19CC742	CIE: 50	
Number of Lectures Hours/Week:03	SEE: 50	
Total Number of Lecture Hours: 42 (3credits)	SEE Hours: 03	
		Teaching Hours
Modules I: Introduction to materials, classification maid on engineering materials.		08

Selection of materials-factors affecting selection of materials for engineering purposes. Study on classification maid on metals and detailed study on ferrous materials.	
Module-II: study on non-ferrous materials- copper and its alloys, aluminum and its alloys, magnesium and its alloys, nickel and its alloys, lead and its alloys, zinc and its alloys, titanium and its alloys Shaping of metals- Die casting of metals and alloys, shell mould casting, Die-casting, Centrifugal casting, Shell Casting, Investment casing, Extrusion and Forging of metals	10
Module-III: Powder metallurgy- definition, applications, advantages and limitations. Powder metallurgy process, characteristics of metal powders, production of metal powders, blending and mixing of powders, compaction of powders, pressing and sintering of compacted component. Hot pressing of powders, Secondary operations on powder compacted component.	08
Module-IV: Ceramic materials, types of ceramic materials, general methods used in the manufacture of ceramic materials, properties, applications of ceramic materials. Polymers- introduction to polymers, classification of polymers, general polymer processing, properties and applications of polymers	08
Module-V: loss on ignition, water of plasticity, Tensile strength, Compression testing, Hardness testing, Impact resistance, Torsion testing, Fatigue testing, Creep testing and radio graphic testing .	08

Question paper pattern:
Question paper shall contain five modules, each module containing two questions. Students shall answer any one question from each module.

Text books:

1. Material science and Metallurgy- by O.P.Khanna
2. Engineering Materials and Metallurgy- Dr. Rakesh Dogra
3. Metallurgy Fundamentals- Daniel A. Brandt, J. C. Warner

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

CO #	Course Outcome (COs)
CO1	Identify the materials for different applications and factors to be considered for selecting a material (L1, L2)
CO2	Understand the properties , applications and fabrication of ferrous materials (L2)
CO3	Assess the importance of powder metallurgy route in comparison with conventional fabrication of materials (L3)
CO4	Understand the properties, applications and manufacture of ceramic and polymeric materials (L3, L4)
CO5	Analyze and explain the properties of materials by various testing methods (L4, l5)

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 Ceramics- Lead zirconate, Titanate and Barium titanate. Ceramic insulators, Bio-ceramics - Calcium phosphate, Hydroxyapatite. Automotive ceramics – Ceramic sparkplug, ceramic insulators and ceramic catalysts.	10
Module-5 Testing of ceramics: Water of plasticity, Adsorbed moisture, Bulk density, Apparent porosity, Loss on ignition, Drying shrinkage and Firing shrinkage.	8
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
19CC75OE	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

Course Title: Seminar [As per Choice Based Credit System (CBCS) Scheme]			
Course Code	19CCS76	CIE Marks	50
Credits	Three	SEE Marks	50
Course Type Theory	Theory		
Lecture Hours/Week	1	Total Marks	100
Total Hours	12 Hours	SEE Hours	03
Course Objectives: To enable the students to obtain the knowledge about latest development in ceramic engg. field			
Course outcomes: On completion of the course, the student will have the ability to			
COs			
CO1	Identify a technical seminar topic using the criteria of recent trends in civil engineering, industrial development and societal issues		
CO2	Collect exhaustive literature relevant to the selected topic		
CO3	Summarize effectively the literature review and provide the critical analysis of the selected topic		
CO4	Present the seminar topic using good oral and writing skill		
CO5	Prepare a well-organized and compiled seminar report.		

Course Title: Project Phase-1
[As per Choice Based Credit System (CBCS) Scheme]

Course Code	19CCP77	CIE Marks	50
Credits	3	SEE Marks	50
Course Type Theory	Practical/Lab		
Lecture Hours/Week	2	Total Marks	100
Total Hours	18	SEE Hours	03

Course Objectives: To allow the students to carry out literature survey in the field of their interest and prepare a report containing literature review, objective and methodology.

In project phase-1, a student shall select the topic of the project work and Guide in the beginning of the VII Sem only and shall complete the literature survey and finalize the objectives of the project work as part of Project phase-I by the end of the VII Sem. The project work will be carried out in batches containing maximum four students.

Question paper pattern: Evaluation of CIE marks: 50% marks will be evaluated by the respective guide on the basis of the performance of the student during project work remaining 50% marks will be evaluated by expert committee constituted by HOD containing minimum two experts of the department in the relevant field. Students have to deliver seminar before expert committee. Evaluation of SEE marks: Viva-voce examination will be conducted in the presence of internal and external examiners appointed by HOD.

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

Cos	**Course outcome**	**Blooms Level**
CO1	Intend technically/ engineering based project in a clear and brief manner	L1
CO2	Identify the investigators gaps in the literature review and relate them to current project.	L2
CO3	Prepare a work plan and its related procedures consisting of fore casting of project costs, time lines, quality & ethical issues	L3. L5
CO4	Present the project outlining in the literature review, methodology and expected results.	L4
CO5	Prepare a well-organized and compiled project report involving literature review, methodology and final results.	L4. L5