**POOJYA DODDAPPA APPA COLLEGE OF ENGINEERING, KALABURAGI**

B.E. in CERAMICS AND CEMENT TECHNOLOGY

**Choice Based Credit System (CBCS)**

Scheme of Teaching and Examination 2021-2022

Effective for students admitted in 2018-2019

**VIII Semester**

| Sl. No. | Course and Course Code | | Course Title | Teaching Department | Teaching Hours/Week | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory Lecture | Tutorial | Practical/ Drawing | Duration in hours | SEE Marks | CIE Marks | Total Marks | |
| 1 | PC | 18CC81 | Design with Ceramics | CCT | 03 | - | -- | -- | 50 | 50 | 100 | 3 |
| 2 | PE | 18CC821 | Special Glasses & Glass Ceramics | CCT | 03 | - | -- | -- | 50 | 50 | 100 | 3 |
| | | 18CC822 | Process control | | | | | | | | | |
| | | 18CC823 | Structural ceramics | | | | | | | | | |
| 3 | PC | 18CC83 | Nano Materials | CCT | 03 | - | -- | -- | 50 | 50 | 100 | 3 |
| 4 | PE | 18CCCM84 | Certification Course (NPTEL/ MOOC) | -- | -- | -- | -- | -- | -- | -- | -- | 1 |
| 5 | PROJ | 18CCP85 | Project Work Phase - II | CCT | -- | | | -- | 50 | 50 | 100 | 11 |
| 6 | INT | 18CCIN86 | Internship | (Completed during the intervening vacations of VI and VII semesters and /or VII and VIII semesters.) | | | | -- | -- | -- | -- | 1 |
| **Total** | | | | | **09** | **-** | **--** | **--** | **200** | **200** | **400** | **22** |

**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: Design With Ceramics | |
|---|---|
| Course Code: 19CC81 | CIE: 50 |
| Number of Lectures Hours/Week: 04 | SEE: 50 |
| Total Number of Lecture Hours: 52 | SEE Hours: 03 |

| Modules | Teaching Hours |
|---|---|
| Module 1<br>Introduction to deformation of solids: Elementary idea of Hertz model and JKR model for deformation of spherical solids in contact and their comparison and estimation of parameters.[1]<br><br>Young's modulus and strength of perfect solids and theoretical strength.[2] | 11 |
| Module 2<br>Introduction to plastic, elastic and visco-elastic deformation of solids, **plastic deformation of rock salt structure crystals**, plastic deformation of alumina crystal, creep of single crystal and polycrystalline ceramic.<br>Elastic modulii, an-elasticity, Brittle Fracture and crack propagation, static fatigue, fracture, effects of micro-structure. [2][3] [4] | 11 |
| Module 3<br>Design Consideration:-Requirements of application, property limitations, fabrication limitations, reliability requirements and cost.<br>Design approaches: - Empirical design, Deterministic design, Statistical design approach, Comparison of all three design approaches<br>Elements of Weibull statistics and its use in design and advantages and limitations of Weibull statistical design approach.[3][5][4] | 10 |
| Module 4<br>Failure analysis:- Location of fracture origin, techniques of fractography, elementary idea about determining failure cause using modern tools for fracture analysis[3] | 10 |
| Module 5<br>Material Selection: - General parameters considered for selection of materials, parameters for selection of material for insulating and refractory furnace lining, ceramics seals and high temperature heat exchangers, Thermal barrier coatings. [3][6] | 10 |

**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] H. J. Butt, K. Graf, and M. Kappl, *Physics and Chemistry of Interfaces*. Wiley, 2006.
[2] W. D. Kingery, H. K. Bowen, and D. R. Uhlmann, *Introduction to ceramics*, Second edi. John-Wiley and Sons, Inc, 1976.
[3] D. Richerson, *Modern Ceramic Engineering: Properties, Processing, and Use in Design, Third Edition*. Taylor & Francis, 1992.
[4] A. O. Surendranathan, *An Introduction to Ceramics and Refractories*. 2014.
[5] M. Barsoum and W. Barsoum, *Fundamentals of Ceramics*. Taylor & Francis, 2002.


**Reference Books:**




[6] V. Sankar, "Thermal Barrier Coatings Material Selection , Method of Preparation and Applications - Review," *Int. J. Mech. Eng. Robot. Res.*, vol. 3, no. 2, pp. 510–517, 2014.

**E-books and online course materials:**

1. https://uomustansiriyah.edu.iq/media/lectures/5/5_2016_05_01!08_27_09_PM.pdf
2. https://www.youtube.com/watch?v=7Be7hGvqoAg

**Course outcomes:**

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

| CO # | Course Outcome (CO) | Blooms level |
|---|---|---|
| **CO1** | Apply Hertz model, JKR theory for powder compaction of spherical particles and summarize Young's modulus and theoretical strength. | 3 |
| **CO2** | Explain plastic, elastic and visco-elastic and permanent deformation of Single crystals, polycrystalline ceramics, and effect of micro-structure on strength of ceramics. | 3 |
| **CO3** | Appraise design considerations and explain three methods of design approaches based on empirical design, deterministic design and Weibull statistical approach. Numerical problems based on Weibull statistical method | 4 |
| **CO4** | Compare methods of failure analysis and fractography and their comparison and ability to summarize fractography. | 4 |
| **CO5** | Summarize selection of materials for various applications | 3 |

| Course Title: **STRUCTURAL CERAMICS** | | |
|---|---|---|
| Course Code | 19CC823 | CIE: 50 |
| Number of Lecture Hours/Week | 3 | SEE: 50 |
| Total Number of Lecture Hours | 42 | SEE Hours: 03 |

Prerequisite

Course Objectives: To impart knowledge and enable students to understand
1. Enable students to define and classify structural ceramics and explore theirapplication.
2. Enable to apply theoretical aspects to explain the toughness and toughningmechanism.
3. Enable to understand the properties and applications of composites, oxide andnon- oxide materials
4. Describe methods of synthesis and explain fabrication of oxide and non-oxideceramics for structural ceramics

| **Modules** | **Teaching Hours** |
|---|---|
| Module I<br><br>Introduction & Classification of structural ceramics. Applications of structural ceramic materials in space technology, power generation, automobile and biological Application. | 10 hours |
| Module II<br><br>Ceramic films and coating (CVD/PVD) for structural applications, thermal barrier coatings, bio-compatible Coating. | 06 hours |
| Module III<br><br>Fracture mechanics of Ceramics, Griffith criteria, definition of fracture toughness, methods of measurement of fracture toughness, toughening mechanisms: modulus Transfer, Crack deflection, crack bridging, pull out transformation toughening. | 10 hours |
| Module IV<br><br>Properties and applications of structural ceramics and composites: Alumina, zirconia, forsterite, And cordierite. Polymorphism of $ZrO_2$, martinsitic transformation and transformation, toughening of $ZrO_2$, $ZrO_2$ based composites. Calcium Phosphate based composites | 08 hours |
| Module V<br><br>Processing and fabrication of composites: Processing techniques of Composite, preparation of fiber from oxide, non-oxide ceramics and glasses, Metal matrix composites, ceramic–ceramic composites, Glass ceramics, polymer matrix composites. Study of fibers, particulars & whisker, reinforced composites | 08 hours |

**Question paper pattern:** Question paper shall contain FIVE modules, each module
Containing TWO questions. Students shall answer any ONE full question from eachmodule.

**Text books:**

1. Barsoum, M., & Barsoum, W. (2002). Fundamentals of Ceramics. Taylor &Francis.
2. Basu, B., & Balani, K. (2011). Advanced Structural Ceramics. Americanceramic society: Wiley.
3. Kingery, W. D., Bowen, H. K., & Uhlmann, D. R. (1976). Introduction toceramics. (Second edition). John-Wiley and Sons,
4. Richerson, D. (1992). Modern Ceramic Engineering: Properties, Processing, andUse in Design (Third Edition.). Marcel Dekker Inc.
5. Singer, F., & Singer, S. S. (1963). Industrial ceramics. The University ofMichigan: Chemical Publishing Co.

**Reference Books:**

**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) |
|---|---|---|
| | **CO1** | Apply theoretical aspects to explain the applications of ceramics for structural applications applications(load bearing Application). |
| | **CO2** | Explain various coating methods used for coating ceramics |
| | **CO3** | Apply knowledge of toughening mechanisms to calculate parameters fracture toughness, modulus of rupture modulus of elasticity, stress and strength of ceramics |
| | **CO4** | Explain the properties of oxide andnon-oxide ceramics and composites to recognize there appropriate applications |
| | **CO5** | Illustrate methods of synthesis,processing and fabrication of various oxide and non-oxide ceramics forstructural ceramics |

| THEORY COURSE TITLE: NANO MATRIARIALS | |
|---|---|
| **Course Code: 19CC83** | **CIE: 50** |
| **Number of Lectures Hours/Week: 03** | **SEE: 50** |
| **Total Number of Lecture Hours: 42** | **SEE Hours: 03** |

| Modules | Teaching Hours |
|---|---|
| **MODULE I**<br>History and emergence of nano-technology and nano materials, necessity of nano-materials, classification of nano-materials, challenges in nano-technology, bottom-up &top-down approaches, physical chemistry of solid surfaces:-surface energy, chemical potential, and electro static stabilization, steric stabilization (solvent and polymer, mixed steric and electric interactions. | 9 |
| **MODULE II**<br>Zero dimensional nano structures and nano materials, nano particles through homogegenous nucleation, synthesis of metallic nano particles i.e. gold, silver (influence of reduction reagents, polymer stabilizers), synthesis of oxide nano particles:-sol-gel process, controlled release of ions, solid state phase aggregation, paper phase reactions, hydro-thermal combustion, solution combustion synthesis, synthesis inside micells or using micro emulsions , aerosol synthesis, template based synthesis. | 8 |
| **MODULE III**.<br>One-dimensional nano structures:-nano wires and nano rods:-evaporation and condensation growth, vapour liquid solid growth (VLS), template based synthesis, electro spinning, lithography ,two dimensional nano structures, fundamentals of film growth, vaccum signs, physical vapor deposition (evaporation and sputtering), chemical vapor deposition, atomic layour deposition, sol-gel films. | 8 |
| **MODULE IV**<br>Special nano materials:-carbon fullerene and carbon nano tubes, micro and mesoporous materials, core cell structure, nano composites, characterization and properties of nano materials: X-ray diffraction, SEM, TEM, gas adsorption, optical spectroscopy, surface Plasma resonance, super para- magnetism, electrical conductivity, melting point, mechanical properties. | 8 |
| **MODULE V**<br>Nano structures fabricated by physical techniques, lithography, photo lithography, micro contact printing, applicatons of nano materials: electronics, biological applications, catalysis, band gap engineered quantum devices, nano mechanics, photonic crystals and others | 9 |

**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. Guozhong Cao Nanostructures and Nanmaterials Synthesis, Properties and Applications. Imperial College Press 57 Shelton streets Covent Gardon Londen. WC2H9HE, published: 8 April 2004
2. K.W. Kolasinski, “Surface Science: Foundations of Catalysis and Nanoscience”, Wiley, 2002.
3. G.A. Ozin and A.C. Arsenault, “Nanochemistry : A chemical approach to nanomaterials”, Royal Society of Chemistry, 2005.
4. Edward L. Wolf, "Nanophysics and Nanotechnology - An Introduction to Modern Concepts in Nanoscience" Second Edition, John Wiley & Sons, 2006.

**Reference Books:**


1. Vladimir P. Torchilin (2006) Nanoparticulates as Drug Carriers, Imperial College Press.
2. M. Reza Mozafari (2007) Nanomaterials and Nanosystems for Biomedical Applications, Springer.
3. Nanotechnology – Basic Science & Emerging Technologies, Chapman & Hall/CRC 2002
4. Nanomaterials Nanotechnologies and Design: An introduction for engineers and architects, Micheal F. Ashby, P.J. Ferreria, D.L.Schodek.


**E-books and online course materials:**

1. https://www.google.co.in/books/edition/Nanostructures_Nanomaterials/Ez1dYxO_ma8C?hl=en&gbpv=1&printsec=frontcover

**Course outcomes:**

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

| CO # | |
|---|---|
| **CO1** | Describe the necessity, applications, stabilization nanomaterials and their classification |
| **CO2** | Explain the synthesis of Zero dimensional nanomaterials by various methods. |
| **CO3** | Explain the synthesis of one and two dimensional nanomaterials (nano wires and nanosheets) by various methods. |
| **CO4** | Investigate and interprete characterization data of nanomaterials |
| **CO5** | Analyze to application of nanomaterials and its products |