# SCHEME & SYLLABUS OF UNDERGRADUATE DEGREE COURSE

# Ceramic Engineering and Technology

**Effective for the students admitted in year 2021-22 and onwards.**

# B.Tech.: Ceramic Engineering and Technology
## 2nd Year - III Semester

| SN | Category | Course Code | Course Title | Hours | | | Marks | | | | Cr |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Exm Hrs | IA | ETE | Total | |
| **THEORY** | | | | | | | | | | | |
| 1 | UCB | 3CR1 – 01 | Advanced Engineering Mathematics-I | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 2 | DC | 3CR4 – 02 | Introduction to Ceramics | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 3 | | 3CR4 – 03 | Ceramic Raw Materials and analysis | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 4 | | 3CR4 – 04 | Particle and Fluid Mechanics | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 5 | | 3CR4 – 05 | Material Science and Engineering | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 6 | | 3CR4 – 06 | Thermodynamics and Phase Equilibria | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| | | | **Sub Total** | 18 | 0 | 0 | - | 180 | 420 | **600** | **18** |
| **PRACTICAL & SESSIONAL** | | | | | | | | | | | |
| 7 | DC | 3CR4 – 20 | Ceramic Raw Materials and analysis Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 8 | | 3CR4 – 21 | Mineralogy and Microscopy Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 9 | | 3CR4 – 22 | Mechanical Operation of Ceramic Raw Material Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 10 | | 3CR4 – 23 | Particle and Fluid Mechanics Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 11 | | 3CR4 – 24 | Computer Programming Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 12 | UI | 3CR7 – 30 | Industrial Training | 0 | 0 | 1 | - | 60 | 40 | **100** | **1** |
| 13 | UGE/CA | 3CR8 – 00 | | | | | | | | | **1** |
| | | | **Sub- Total** | 0 | 0 | 11 | - | 360 | 240 | **600** | **7** |
| | | **TOTAL OF III SEMESTER** | | 18 | 0 | 11 | - | 540 | 660 | **1200** | **25** |

***L: Lecture, T: Tutorial, P: Practical, Cr: Credits, ETE: End Term Exam, IA: Internal Assessment***

# B.Tech.: Ceramic Engineering and Technology
## 2nd Year - IV Semester

| SN | Category | Course Code | Course Title | Hours | | | Marks | | | | Cr |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Exm Hrs | IA | ETE | Total | |
| **THEORY** | | | | | | | | | | | |
| 1 | UCB | 4CR1 – 01 | Advance Engineering Mathematics-II | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 2 | DC | 4CR4 – 02 | Physical Ceramics-I (Structure of Ceramic materials) | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 3 | | 4CR4 – 03 | Ceramic Processing | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 4 | | 4CR4 – 04 | Ceramic Characterization and Instrumentation | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 5 | | 4CR4 – 05 | Cement Technology | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 6 | | 4CR4 – 06 | Heat and Mass Transfer | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| | | | **Sub Total** | 18 | 0 | 0 | - | 180 | 420 | **600** | **18** |
| **PRACTICAL & SESSIONAL** | | | | | | | | | | | |
| 7 | DC | 4CR4 – 20 | Ceramic Processing Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 8 | | 4CR4 – 21 | Ceramic Characterization and Instrumentation Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 9 | | 4CR4 – 22 | Cement Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 10 | | 4CR4 – 23 | Heat and Mass Transfer Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 11 | | 4CR4 – 24 | Electric Properties of Materials Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 12 | | 4CR4– 25 | MATLAB & Simulink Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 13 | UGE/CA | 4CR8 – 00 | | | | | | | | | **1** |
| | | | **Sub- Total** | 0 | 0 | 10 | - | 360 | 240 | **600** | **7** |
| | | **TOTAL OF IV SEMESTER** | | 18 | 0 | 10 | - | 540 | 660 | **1200** | **25** |

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# B.Tech.: Ceramic Engineering and Technology
## 3rd Year - V Semester

| SN | Category | Course Code | Course Title | Hours | | | Marks | | | | Cr |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Exm Hrs | IA | ETE | Total | |
| **THEORY** | | | | | | | | | | | |
| 1 | DC | 5CR4 – 01 | Physical Ceramics-II (Properties of Ceramic materials) | 3 | 0 | 0 | 3 | 30 | **70** | **100** | **3** |
| 2 | | 5CR4 – 02 | Refractory | 3 | 0 | 0 | 3 | 30 | **70** | **100** | **3** |
| 3 | | 5CR4 – 03 | Glass and Glass Ceramics | 3 | 0 | 0 | 3 | 30 | **70** | **100** | **3** |
| 4 | | 5CR4 – 04 | Electroceramics | 3 | 0 | 0 | 3 | 30 | **70** | **100** | **3** |
| 5 | | 5CR4 – 05 | Fuels, Furnaces and Pyrometers | 3 | 0 | 0 | 3 | 30 | **70** | **100** | **3** |
| 6 | DE | 5CR5 – 11 | Introduction to Metallurgical Processes | 2 | 0 | 0 | 2 | 30 | **70** | **100** | **2** |
| | | 5CR5 – 12 | Refractory for Steel Making | | | | | | | | |
| | | 5CR5 – 13 | Plant, Equipment And Furnace Design | | | | | | | | |
| 7 | | 5CR5 – 14 | Theory Of Solid Mechanics | 2 | 0 | 0 | 2 | 30 | 70 | **100** | **2** |
| | | 5CR5 – 15 | Electronic Measurement & Instrumentation | | | | | | | | |
| | | 5CR5 – 16 | Nanoceramics | | | | | | | | |
| | | | **Sub Total** | 19 | 0 | 0 | - | 210 | 490 | **700** | **19** |
| **PRACTICAL & SESSIONAL** | | | | | | | | | | | |
| 8 | DC | 5CR4 – 20 | Refractory Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 9 | | 5CR4 – 21 | Glass and Glass Ceramics Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 10 | | 5CR4 – 22 | Electro-Ceramic Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 11 | UI | 5CR7 – 30 | Industrial Training | 0 | 0 | 1 | - | 60 | 40 | **100** | **3** |
| 12 | UGE/CA | 5CR8 – 00 | | | | | | | | | **1** |
| | | | Sub- Total | 0 | 0 | 7 | - | 240 | 160 | **400** | **7** |
| | | **TOTAL OF V SEMESTER** | | 19 | 0 | 7 | - | 450 | 650 | **1100** | **26** |

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# B.Tech. Ceramic Engineering and Technology
## 3rd Year - VI Semester

| SN | Category | Course Code | Course Title | Hours | | | Marks | | | | Cr |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Exm Hrs | IA | ETE | Total | |
| **THEORY** | | | | | | | | | | | |
| 1 | DC | 6CR4 – 01 | Monolithic Refractory | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 2 | | 6CR4 – 02 | Pottery and Heavy Clayware Ceramics | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 3 | | 6CR4 – 03 | Ceramic Coating-Enamel and Glazes | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 4 | | 6CR4 – 04 | Bioceramics | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 5 | | 6CR4 – 05 | Polymer Science and Engineering | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 6 | DE | 6CR5 – 11 | Electric Properties of Materials | 2 | 0 | 0 | 2 | 30 | 70 | **100** | **2** |
| 7 | | 6CR5 – 12 | Oxide and Non-Oxide Ceramics | | | | | | | | |
| 8 | | 6CR5 – 13 | Waste Management of Ceramic Industries | | | | | | | | |
| | | | **Sub Total** | 17 | 0 | 0 | - | 180 | 420 | **600** | **17** |
| **PRACTICAL & SESSIONAL** | | | | | | | | | | | |
| 9 | DC | 6CR4 – 20 | Monolithic Refractory Lab | 0 | 0 | 2 | - | **60** | **40** | **100** | **1** |
| 10 | | 6CR4 – 21 | Pottery and Heavy Clayware Lab | 0 | 0 | 2 | - | **60** | **40** | **100** | **1** |
| 11 | | 6CR4 – 22 | Ceramic Coating Lab | 0 | 0 | 2 | - | **60** | **40** | **100** | **1** |
| 12 | UI | 6CR7 – 50 | Mini Project | 0 | 0 | 3 | - | **60** | **40** | **100** | **2** |
| 13 | UGE | 6CR8 – 00 | | | | | | | | | **2** |
| | | | **Sub- Total** | 0 | 0 | 9 | - | 240 | 160 | **400** | **7** |
| | | **TOTAL OF VI SEMESTER** | | 19 | 0 | 9 | - | 420 | 580 | **1000** | **24** |

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# B.Tech. Ceramic Engineering and Technology
## 4th Year - VII Semester

| THEORY | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SN | Category | Course Code | Course Title | Hours | | | Marks | | | | Cr |
| | | | | L | T | P | Exm Hrs | IA | ETE | Total | |
| 1 | DC | 7CR4 – 01 | Colloidal and Sol-Gel Processing | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 2 | DE | 7CR5 – 11 | Ceramic Equipment Design | 2 | 0 | 0 | 3 | 30 | 70 | **100** | **2** |
| | | 7CR5 – 12 | Industrial Furnace Design | | | | | | | | |
| | | 7CR5 – 13 | Composite Materials | | | | | | | | |
| 3 | UE | | University Open Elective-1 | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| | | | **Sub Total** | 8 | 0 | 0 | | 90 | 210 | **300** | **8** |
| **PRACTICAL & SESSIONAL** | | | | | | | | | | | |
| 4 | DC | 7CR4 - 20 | Colloidal and sol-gel Processing Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 5 | UI | 7CR7 - 40 | Seminar | 0 | 0 | 1 | - | 60 | 40 | **100** | **3** |
| 6 | | 7CR7 - 50 | Project | 0 | 0 | 3 | - | 60 | 40 | **100** | **2** |
| 7 | UGE | 7CR8 – 00 | | | | | | | | | **1** |
| | | | **Sub- Total** | 0 | 0 | 6 | - | 180 | 120 | **300** | **7** |
| | | **TOTAL OF VII SEMESTER** | | 8 | 0 | 6 | - | 270 | 330 | **600** | **15** |

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# B.Tech.: Ceramic Engineering and Technology
## 4th Year - VIII Semester

| SN | Category | Course Code | Course Title | Hours | | | Marks | | | | Cr |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Exm Hrs | IA | ETE | Total | |
| **THEORY** | | | | | | | | | | | |
| 1 | UE | | University Open Elective-2 | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| | | | Sub Total | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| | | | | | | | | | | | |
| **PRACTICAL & SESSIONAL** | | | | | | | | | | | |
| 2 | UI | 8CR4 – 50 | Project | 0 | 0 | 3 | - | 60 | 40 | **100** | **4** |
| 3 | | 8CR7 – 40 | Seminar | 0 | 0 | 2 | - | 60 | 40 | **100** | **2** |
| 4 | UGE | 8CR8 – 00 | | 0 | 0 | 0 | - | - | - | **-** | **2** |
| | | | Sub- Total | 0 | 0 | 5 | | 120 | 80 | **200** | **8** |
| | | **TOTAL OF VIII SEMESTER** | | 3 | 0 | 5 | | 150 | 150 | **300** | **11** |

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| List of Open Electives Offered by Ceramic Engineering and Technology | | | | |
|---|---|---|---|---|
| **Subject Code** | **Title** | | **Subject Code** | **Title** |
| **Open Elective - I** | | | **Open Elective - II** | |
| **7CR6–60.1** | Introduction to Metallurgical Processes | | **8CR6–60.1** | Introduction to Ceramics |
| **7CR6–60.2** | Refractory for Steel Making | | **8CR6–60.2** | Industrial Furnace Design |
| **7CR6–60.3** | Plant, Equipment And Furnace Design | | **8CR6–60.3** | Composite Materials |

# SYLLABUS OF
# UNDERGRADUATE DEGREE COURSE

## Ceramic Engineering and Technology

**Effective for the students admitted in year 2021-22 and onwards.**

# B.Tech.: Ceramic Engineering and Technology
## 2nd Year - III Semester

| SN | Category | Course Code | Course Title | Hours | | | Marks | | | | Cr |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Exm Hrs | IA | ETE | Total | |
| **THEORY** | | | | | | | | | | | |
| 1 | UCB | 3CR1 – 01 | Advanced Engineering Mathematics-I | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 2 | DC | 3CR4 – 02 | Introduction to Ceramics | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 3 | | 3CR4 – 03 | Ceramic Raw Materials and analysis | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 4 | | 3CR4 – 04 | Particle and Fluid Mechanics | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 5 | | 3CR4 – 05 | Material Science and Engineering | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 6 | | 3CR4 – 06 | Thermodynamics and Phase Equilibria | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| | | | **Sub Total** | 18 | 0 | 0 | - | 180 | 420 | **600** | **18** |
| **PRACTICAL & SESSIONAL** | | | | | | | | | | | |
| 7 | DC | 3CR4 – 20 | Ceramic Raw Materials and analysis Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 8 | | 3CR4 – 21 | Mineralogy and Microscopy Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 9 | | 3CR4 – 22 | Mechanical Operation of Ceramic Raw Material Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 10 | | 3CR4 – 23 | Particle and Fluid Mechanics Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 11 | | 3CR4 – 24 | Computer Programming Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 12 | UI | 3CR7 – 30 | Industrial Training | 0 | 0 | 1 | - | 60 | 40 | **100** | **1** |
| 13 | UGE/CA | 3CR8 – 00 | | | | | - | | | | **1** |
| | | | **Sub- Total** | 0 | 0 | 11 | - | 360 | 240 | **600** | **7** |
| | | **TOTAL OF III SEMESTER** | | 18 | 0 | 11 | - | 540 | 660 | **1200** | **25** |

***L:*** *Lecture,* ***T:*** *Tutorial,* ***P:*** *Practical,* ***Cr:*** *Credits* ***ETE:*** *End Term Exam,* ***IA:*** *Internal Assessment*

# 3CR4-01: Advanced Engineering Mathematics-I

**Credit: 3Max.**
**3L+0T+0P**

**Marks: 100(IA: 30, ETE: 70)**
**End Term Exam: 3 Hours**

**Course Objectives**

This course aims to impart the knowledge of fundamental concepts of numerical analysis, probability & statistics and introduction to the partial differential equations.

**Course Outcome:-**Upon successful completion of the course the students will be able to

**CO-1** To study the numerical interpolations for equal and unequal intervals, numerical differentiation, integration and solving ordinary differential equations by numerical methods.

**CO-2** To study the solution of polynomials, algebraic and transcendental by numerical methods including linear equations.

**CO-3** Compute the discrete and continuous random variables, probability distributions, expectations, moments, MGF, mean and variances.

**CO-4** Define and explain the different statistical distributions like Binomial, Poisson, Normal, Uniform, Exponential distributions and to compute the method of least squares, correlation and regression.

**CO-5** To study the theory of partial differential equations by using separation of variables.

| SN | Contents | Hours |
|---|---|---|
| 1 | **Numerical Methods–**1: Finite differences and operators, Interpolation using Newton's forward and backward difference formulae. Gauss's forward and backward interpolation formulae. Stirling's formulae. Lagrange's interpolation for unequal intervals. Numerical Differentiation. Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules. Numerical solution of ordinary differential equations: Euler and modified Euler's methods. Runge- Kutta method of fourth order, Milne's PC methods. | **10** |
| 2 | **Numerical Methods–2**: Solution of polynomial, algebraic and transcendental equations-Bisection method, Newton-Raphson method and Regula-Falsi method. Solution of systems of linear equations using LU decomposition, Gauss elimination method. | **7** |
| 3 | **Probability and Statistics-1:** Discrete and Continuous random variables, Probability distribution function, conditional distribution. Mathematical Expectations: Moments, Moment Generating Functions, Mean and variance. | **8** |
| 4 | **Probability and Statistics-2:** Binomial distribution, Poisson Distribution, Normal Distribution. Curve fitting, Correlation, Karl Pearson's correlation coefficient, Rank correlation coefficient. Lines of Regression, Regression coefficients, Angle between lines of regression | **10** |
| 5 | **Partial Differential Equations:** Classification of Second order partial differential equations, Separation of variables: One dimensional Heat and One dimensional Wave equations. Two dimensional Laplace equations. | **5** |
| | **Total** | **40** |

**REFERENCE BOOKS**

1. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Fifth Edition, Narosa Publishing House, (2016).
2. H.K. Dass, Advanced Engineering Mathematics, 22nd Edition, S. Chand, (2018).
3. Erwin O. Kreyszig, Advanced Engineering Mathematics,, Tenth Edition, Wiley India Pvt. Ltd, (2015)
4. Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Academic Press, (2009).
5. K. E. Atkinson, An Introduction to Numerical Analysis (2nd edition), Wiley-India, (1989).

# 3CR4-02: Introduction to Ceramics

**Credit: 3**
**3L+0T+0P**

**Max. Marks: 100(IA: 30, ETE: 70)**
**End Term Exam: 3 Hours**

**Course Objectives**

- To aware and provide knowledge of different types and parts of ceramics
- To provide essential knowledge in forming/manufacturing process, binders, drying, calcinations and sintering of Ceramics

**Course Outcomes**

- To know the different types of ceramics and its application and properties in details.
- Concept on forming of ceramics and powder consolidation method and Binders & Additives.
- Analyze the different pressing method of ceramics

| SN | Contents | Hours |
|---|---|---|
| 1 | **Introduction to Ceramics:** Definition, classification and scope of ceramics, ceramics versus metals and organics, historical perspective on the development of ceramics and ceramic industries. Advanced ceramics versus traditional ceramics. Refractories, whitewares, cement, etc. Elementary ideas of their manufacture and applications. Basic glass processing, container glass, fibre glass, speciality glass products, glass ceramics, glass microspheres, laminated glass, photochrome and photo sensitive glass modern / high tech ceramics, high tech functions and functional ceramics, structural ceramics, electrical and electronic ceramics, chemical and nuclear ceramics, bio-ceramics, ceramic membranes, artificial gems and ceramics, aerospace and other strategic application. | 9 |
| 2 | **Forming of ceramics and powder consolidation method**: Introduction, characteristics of solid particles, particle shapes, size, equivalent particle diameter, surface area, average particle size & size distribution. | 8 |
| 3 | **Binders & Additives:** Packing of particles, additives in forming processes, selection of additives; solvent, binder, plasticizers, deflocculants and lubricant. | 8 |
| 4 | **Dry and Semidry pressing methods:** Dry and semidry pressing methods die compaction and isostatic compaction, Casting methods: slip casting, pressure casting and tape casting. Plastic forming method :extrusion and injection molding. | 8 |
| 5 | **Drying & Calcination:** Drying of cast or extruded articles, binder removal, calcinations & affecting factors. Sintering: Introduction to sintering of ceramics, hot and iso-static processing of ceramics. | 7 |
| | **Total** | **40** |

**TEXT BOOKS**

1. S. Kumar/ Hand Book of Ceramics/Kumar and Associates 1995
2. J. H. Chesters/ Refractories- Production and Properties/ The Iron and Steel Institute, London
3. M. N. Rahaman/ Ceramic Processing and Sintering/ 2nd Ed/ CRC Press, 2003.
4. J.S. Reed/ Introduction to the Principles of Ceramic Processing/ 2nd Ed./ John Wiley & Sons. 1995.

**REFERENCE BOOKS**

1. D. W. Richerson/ Modern Ceramic Engineering: Properties, Processing, and Use in Design/ 3rd ed/ CRC Press 2005.
2. D. A. Brosan and G. C. Robinson/ Introduction to Drying of Ceramics: with laboratory exercises/Net Library/ Incorporated, 2003.
3. H. Mehrer/ Diffusion in Solids: Fundamentals, Methods, Materials, Diffusion-Controlled Processes/ Springer, 2007
4. David Segal/ Chemical Synthesis of Advanced Ceramic Materials/ Cambridge University Press 1989.
5. A. J. Moulson and J. M. Herbert./Electroceramics: Materials, Properties and Applications/ John Wiley & Sons 2003

# 3CR4-03: Ceramic Raw Materials and analysis

**Credit: 3** **Max. Marks: 100(IA: 30, ETE: 70)**
**3L+0T+0P** **End Term Exam: 3 Hours**

**Course Objectives**

- To provide the students with basic knowledge of ceramic raw materials and it's processing
- Bridging the qualification gap between the academia and industry.
- Provide effective and efficient work strategies towards development in the field of ceramic.

**Course Outcomes**

- Know the various types and structures of rocks and its utility in ceramic industry.
- Analyze the classification of various minerals and brief idea on processing of synthetic raw material.
- Concept on different types of ceramic raw materials and its properties and application.
- Understand the Optical Behavior like optical activity, Isotropic and anisotropic minerals, Bi-referingence and optical microscope.
- Demonstrate the basic knowledge of Chromatography and effect of heat in different raw materials.

| SN | Contents | Hours |
|---|---|---|
| 1 | **Introduction of Basic Rocks and Minerals:-**Rocks Types: Various types of rocks; igneous, sedimentary and metamorphic. Structures rocks: Textures, Structures and classification of above rocks. Origin of igneous, sedimentary and metamorphic rocks. Geology and its utility in ceramic industry. Ceramic Minerals: Description and classification of various minerals based on their chemical compositions, Physical properties and occurrence. | 8 |
| 2 | **Brief idea on processing of synthetic raw materials:**-Bayer process, Calcined Alumina, Tabular Alumina, Fused Alumina, Sea-water Magnesia, Zircon and Zirconia, Titania, Magnesio-Aluminate Spinel, Fumed Silica etc.<br>Application& limitations: The application areas and limitations of synthetic raw materials. | 6 |
| 3 | **Basic Ceramic Raw materials:**-Importance, use and limitations of natural raw materials in refractories, whitewares, cement, potteries, and glass ceramic Industries; Bauxite, Limestone, Chromite, Magnesite, Dolomite, Fluorite, Graphite, Gypsum, Haematite, Kaolinite, Fireclay, Ball clay, Montmorillonite, Magnetite, Nepheline Syenite, Microcline, Feldspars (soda, potash, lime), Pyrophyllite, Quartz, Quartzite, Sillimanite, Kyanite, Andalusite, Talc, Wollastonite, Zircon, Beryl, Mica, Vermicullite, Silica sand etc ; | 8 |
| 4 | **Optical Properties:**Optical activity, Polarizing microscope, Isotropic and anisotropic minerals, Bi-referingence,Pleo-chroism, Propagation of light through uni-axial and bi-axial minerals, Extinction, Cleavage and interference figures, Beck's effect.<br>Optical microscope: Systematic description of minerals under polarizing microscope | 7 |
| 5 | **Chromatography:** Introduction, Paper and thin layer chromatography, Liquid chromatography, Types of liquid chromatography, Column and detection systems. | 5 |

| | | |
|---|---|---|
| **6** | **Effect of heat on different raw materials:** Differential thermal analysis (DTA), thermo gravimetric analysis (TGA), thermal analysis, Differential Scanning Calorimetry (DSC), Factors affecting the phase transformations with suitable examples, Dilatometry–basic principles, instrumentations and case study in ceramic applications. | **6** |
| **Total** | | **40** |

**TEXT BOOKS**

1. Dr. Praveen Singh/Engineering Geology 2012
2. W. E. Worrall /Ceramic Raw Material /Pergamon Press 1982
3. S. Kumar/Hand Book of Ceramic/Kumar and Associates 1995

**REFERENCE BOOKS**

1. Chatwal Anand/Instrumental Methods of Chemical Analysis / Himalaya Pub. 2009
2. R. F. Speyer/Thermal Analysis of Materials/CRC Press 1994
3. Berry/ Mineralogy/ W H Freeman & Co (Sd); 2 Sub edition 1983
4. Braithwaete/Chromatographic Methods /Chapman and Hall 1996
5. Sinton/Raw Materials for Glass and Ceramics /Wiley 2006
6. Paul Bormans/ Ceramics are More Than Clay Alone/Cambridge International Science Publishing 2004

# 3CR4-04: Particle and Fluid Mechanics

**Credit: 3**
**3L+0T+0P**

**Max. Marks: 150(IA: 30, ETE: 70)**
**End Term Exam: 3 Hours**

## Course Objectives

- To identify and obtain the particle Mechanics with the help of screening and separation.
- To understand the principles of separators and filters and different types of equipments
- To apply and recognize the principles of Kinematics and Conservation of Mass in the form of mathematical equations. To acquire the basic concept of fluid mechanics & fluid flow.
- To understand the fundamental descriptions of Boundary Layer thickness boundary layer separation and control with layer equations.

## Course Outcomes

- To identify the relationship between crushing and grinding of particles with different Industrial screening equipments, Separation based on size, shape, density and surface properties.
- To apply the concept Law of motion of single particle sedimentation, different equipment for mixing of fluids and solids and different storage systems for particles
- To express and represent the fluid flow in diverse real-life engineering application.
- To apply the basic principle of continuity and momentum to model fluid flow problems in engineering.

| SN | Contents | Hours |
|---|---|---|
| 1 | **Particle Mechanics:** Theory of crushing and grinding crushers grinders and ultra fine grinders. Close and open circuit grinding, selection of equipment and power requirement. **Screening & Separation:** Sieve analysis, cumulative and differential plots. Industrial screening equipments, Separation based on size, shape, density and surface properties. | 6 |
| 2 | **Separators and Filters:** Law of motion of single particle sedimentation, free and hindred settling. Thickener and settling chambers. Flotation, rotary fluids, centrifuge, cyclone, electrostatic and magnetic separators. Pneumatic and hydraulic transportation of solids, Jansen's equation. Conveyors, bins, silos and hoppers. Different equipment for mixing of fluids and solids, mixing index.<br>Filtration: Flow through filter cake and medium, plate and frame filters, centrifugal filters, filter media, filter aids, washing of filter cakes, selection of filtration equipments. | 9 |
| 3 | **Basic Definitions and Fluid Properties-I:** Definition of Fluid, Incompressible and compressible fluids, Fluid as a continuum, Mass, Density, specific weight, relative density, specific volume, Bulk modulus, velocity of sound ideal fluid viscosity, Newtonian and Non-Newtonian fluid, Kinematic viscosity,<br>**Basic Definitions and Fluid Properties-II:** Effect of temperature and pressure on viscosity, surface tension capillarity, vapour pressure and cavitations. Fluid States: General differential equation, Hydrostatics manometry, Fluid forces on submerged surfaces. Curved surfaces, Aerostatics, Isothermal atmosphere, polytropic atmosphere. | 10 |
| 4 | **Kinematics and Conservation of Mass-I:** Flow classifications, Fluid velocity and acceleration, streamlines and the stream function, Path lines and Rotational flow, Flownet, Laplace equation,<br>**Kinematics and Conservation of Mass-II:** Conservation of mass and the continuity equation for three dimensions, Equation of motion, Euler's equation of motion, Bernoulli's equation, Applications of Bernoulli's Pitot tube. | 8 |

| | | |
|---|---|---|
| **5** | **The Boundary Layer:** Description of the boundary layer. Boundary Layer thickness boundary layer separation and control, The Prandtl boundary layer equation, Flow round a body, Drag skin friction drag, pressure drag, combined skin friction & pressure drag (Profile drag) wave drag, lift induced drag, Variation of drug co- efficient with Reynolds's number. | **7** |
| **Total** | | **40** |

**TEXT BOOKS:**

1. Modi & Seth /Hydraulic and Fluid mechanics/Standard Book House New Delhi 2004
2. Balachandran /Engineering Fluid Mechanics / Prentice-Hall of India Pvt.Ltd 2011
3. Munson/ Fundamentals of Fluid Mechanics /Wiley 2009

**REFERENCE BOOKS**

1. W. L. McCabe, J. C. Smith and P. Harriot/ Unit Operations of Chemical Engineering/ McGraw Hill professional 2005
2. R. H. Perry, D. W. Green and J. O. Maloney/ Chemical Engineers' Handbook/ McGraw-Hill 1999

# 3CR4-05: Material Science and Engineering

**Credit: 3**
**3L+0T+0P**

**Max. Marks: 100(IA: 30, ETE: 70)**
**End Term Exam: 3 Hours**

## Course Objectives

- This course enables students to understand the different types of properties, Crystal structure and behaviour of materials.
- To develop an understanding on the stress and strain relationships for elastic behaviour.
- To make understand the deformation mechanisms in metals/alloys and correlation with the deformation behavior.
- Identifying the role of defects and their interactions on the strength and fracture of metals.

## Course Outcomes

- Students can take Knowledge on the elastic deformation, elastic constants and their relationships.
- To solve problems related to elasticity and understand the plastic behavior and theories of yielding.
- To identify ductile/brittle metallic systems based on the knowledge of slip systems.
- To improve the strength/ductility of the metals/alloys from the knowledge of deformation mechanisms and strengthening mechanisms.
- Students can take knowledge on Interaction of electromagnetic waves with matter, Photoconductors and Luminescence.

| SN | Contents | Hours |
|---|---|---|
| 1 | Crystallography: Introduction, Space lattice, Bravais lattice, Basis, Unit Cell, Lattice parameters, Crystal structure, Factor affecting ceramic crystal structures, Miller indices, crystal symmetry, Different crystal structures: BCC, FCC and HCP. Study of AX, $A_mX_p$, and $A_mB_nX_p$ type ceramic crystal structures. | 8 |
| 2 | Type of standard crystal structures: Introduction, Structure of silicates (Orthosilicates, Pyrosilicates, Single chain, Double chain, Sheet and Network silicates), Structure of kaolinite clay $Al_2(OH)_4(Si_2O_5)$, Talc $Mg_3(OH)_2(Si_2O_5)_2$, and Mica $KAl_2(OH)2(AlSi_3O_{10})$ , Zeolite. 5 Polymers and Liquid crystals. Polymer and liquid crystals. | 8 |
| 3 | Crystal imperfection: Classification of defects in natural crystals: Point, Line, Plane, Electronic imperfections, Transient imperfection. Points defects: thermodynamics of point defects, Lattice vacancies, Schottky defects, Frenkel defects, Extrinsic vacancies and colour centers.<br>Dislocations: Introduction, edge and screw dislocations, Burger vector, Slip systems, Energy of dislocations, Theory of dislocation, Interaction between dislocations. | 8 |
| 4 | Mechanical Properties: Mechanism of plastic deformation, Strengthening mechanism, Recovery recrystallization and grain growth, Dislocations in crystal growth.<br>Imperfection Techniques, Effect: Effects of crystal imperfection on electronics, optical and mechanical properties and technique for imperfect determination and controlling the crystal imperfection in crystal growth.<br>Diffusion: Diffusion, Diffusion mechanisms, Steady-State Diffusion, Nonsteady-State Diffusion, Factors that influence Diffusion. | 8 |

| | | |
|---|---|---|
| **5** | Optical properties: Interaction of electromagnetic waves with matter. Absorption, reflection, transmittance and colour of materials.<br>Photoconductivity: Introduction. Photo conducting materials. Electronic transition in photoconductors. Absorption and Excitation. Trapping and capture. Simple model of a photoconductor.<br>Luminescence: Introduction. Model for luminescence in sulphide phosphors. Thallium activated alkali halides. Electroluminescence. | **9** |
| | **Total** | **40** |

**TEXT BOOKS:**

1. W. F. Smith/ Foundations of Materials Science and Engineering/ McGraw-Hill Professional. 2003.
2. V. Raghavan/ Materials Science and Engineering 4th Ed/ PrenticeHall of India Pvt. Ltd, New Delhi. 2004
3. J. F. Shackelford and M. Meier/ Introduction to Materials Science for Engineers/ Prentice Hall PTR. 2005
4. W. D. Calister/ Material Science and Engineering By/Willy India 2006
5. Shackeford /Introduction to Materials Science for Engineers/ Prentice Hall 2008
6. Chung/ Introduction to Materials Science and Engineering /CRC Press 2006

**REFERENCE BOOKS**

1. W. D. Kingery, H. K. Bowen and D. R. Uhlmann/ Introduction to Ceramics, 2nd Ed./ John Wiley & Sons, Singapore. 1991
2. L.V. Azaroff/ Introduction to Solids/ Tata McGraw Hill Publishing Co. Ltd. 1977
3. L. H. V. Vlack/ Elements of Materials Science and Engineering, 6th Edition/ Prentice Hall,

# 3CR4-06: Thermodynamics and Phase Equilibria

**Credit: 3**
**3L+0T+0P**

**Max. Marks: 100(IA: 30, ETE: 70)**
**End Term Exam: 3 Hours**

**Course Objectives**

- To provide the students with basic knowledge of processing and design of advanced Thermodynamics.
- Bridging the qualification gap between the academia and industry.
- To improve the leadership and communication skill including moral values.

**Course Outcomes**

- Basic Terminology and concepts and Knowledge of Laws of Thermodynamics.
- Perceive the different phase equilibrium of Ceramic Ingredients.
- Concept on Thermodynamic stability of Materials having Intermediate phases & Compound.
- Analyze the Behavior of gases equation through terminology of Laws of Thermodynamics.
- Know the basic Chemical Equilibrium Reaction.

| SN | Contents | Hours |
|---|---|---|
| 1 | **Introduction:** Basic Terminology and concepts, Brief introduction to laws of thermodynamics, concept of states of matter, intensive and extensive properties of systems, thermal and statistical entropy.Auxiliary Functions: Thermodynamic functions, Maxwell's equations and their applications in solution of problems, thermodynamics cycles. | 8 |
| 2 | **Phase Equilibria:** Component, Solubility limit, phases, microstructure, phase equilibria, binary isomorphous systems, interpretation of phase diagrams, lever rule, development of microstructure on isomorphous alloys, mechanical properties of isomorphous alloys, binary eutectic systems | 7 |
| 3 | Thermodynamic stability of Materials. Equilibrium diagrams having Intermediate phases &compound, eutectoid and peritectic reactions, congruent phase transformation, ternary phase diagrams. Ellingham diagram and its importance, application of electrochemical series in ceramics. | 8 |
| 4 | **Behavior of gases:** Equation of state of gas, internal energy of real gas, Ideal gases, experimental determination of heat capacities, quasi adiabatic process, Ruchhardts method of measuring gama, velocity of longitudinal waves, kinetic theory of ideal gas. | 8 |
| 5 | **Chemical equilibrium:** Daltons law, semi permeable membrane, Gibbs theorem, Gibbs Helmoltz equation entropy of a mixture of inert ideal gases, Gibbs function of a mixture of inert ideal gases, chemical equilibrium, condition for mechanical stability. Thermodynamics equations for a phase: Thermodynamics equations for a phase, chemical potentials, degree of reactions, equation of reaction equilibrium. | 9 |
| | **Total** | **40** |

**TEXT BOOK**

1. W. D. Calister/Material Science and Engineering/ Wiley India 2007
2. F. A. Hummel/ Introduction to Phase Equilibrium in Ceramic Systems/ First Edition/CRC Press . 1984
3. G. Smith, R. S. Roth, T. Negas and L. P. Cook/ Phase Diagrams for Ceramists/ American Ceramic Society 1983
4. Richard H. Dittman/ Heat and Thermodynamics/TMGH 2007

**REFERENCE BOOKS**

1. D. R. F. West/ Ternary Phase Diagrams in Materials Science/ Maney Publishing; 3rd edition, 2002
2. D. R. Gaskell/ Introduction to the Thermodynamics of Materials/ Taylor & Francis, 2003
3. J. M. Smith, H. C. V. Ness, and M. M. Abbott/ Introduction to Chemical Engineering Thermodynamics/ 7th Ed, McGraw-Hill Professional, 2005
4. Ghosh/Textbook of Materials and Metallurgical Thermodynamics/PHI Learning Pvt. Ltd 2004
5. Y. M. Chiang, D. Birnie III and W. D. Kingery/ Physical Ceramics: Principles for Ceramic Science and Engineering/ Wiley, 1996
6. M. Alper (Editor), G. Kostorz (Series Editor), H. Herman (Series Editor)/ Phase Diagrams in Advanced Ceramics/ Treatise on Materials Science and Technology Academic Press, 1995
7. E. M. Levin, R. S. Roth, G. Smith, C. R. Robbins, H. F. McMurdie, L. P. Cook and M. K. Reser/ Phase Diagram for Ceramists: salts/ The American Ceramic Society, 1975

# 3CR4-20 Ceramic Raw Materials and analysis Lab

**Credit: 1** **Max. Marks: 100 (IA: 60, ETE: 40)**

**0L+0T+2P**

**Course Objectives**

- Student able to know how chemical analysis has been done by titration method
- Knowledge about various types of chemical, indicator and lubricants
- Students know about operating the instruments like TGA, DTA and Infrared Moisture Balance and performing the experiments with the help of this.

**Course Outcomes**

- To understanding by chemical analysis of various constituents present in different types of ceramic raw material.
- To aware and perform the operating system of TGA and DTA instrument
- To understanding and know the moisture contents of ceramic Raw materials.

**Contents of the Subject**

1. Determination of sulphate and chlorides in a given sample.
2. Determination of bicarbonates in a given sample.
3. Estimation of Na2O, K2O and B2O3 present in a sample.
4. Chemical analysis of limestone for insoluble content R2O3 (R = Fe, Al etc.), CaO, MgO.
5. Chemical analysis of gypsum and dolomite for insoluble content.
6. Chemical analysis of a given sample of sand.
7. Thermo gravimetric analysis of a given sample.
8. Differential thermal analysis of given sample.
9. Determination of moisture content in a given sample using Infrared Moisture Balance.
10. Determination of thermal behavior of ceramic specimen by dilatometric method

# 3CR4-21 Mineralogy and Microscopy Lab

**Credit: 1** **Max. Marks: 100 (IA: 60, ETE: 40)**
**0L+0T+2P**

**Course Objectives**

- Understand the basics of mineralogy and learn identification of various types of minerals and rocks.

**Course Outcomes**

- To introduce fundamental concepts, ideas and materials in geology.
- To Aware of polarizing microscope and its different parts
- To identify the following minerals in thin section used in ceramic industries.
- Understanding to determination of thickness of rock layer/beds.

**Contents of the Subject**

1. Determination of specific gravity of mineral by Pycnometer.
2. Identification in hand specimen of important Rock forming minerals.
3. Study of a polarizing microscope and its different parts, setting of a polarizing microscope and centering of the object.
4. Study of Becke's effect and refractive index of given materials.
5. To Identify the following minerals in thin section used in ceramic industries: Quartz, Orthoclase, Albite, Silimanite, kyanite, Andalusite,
6. To Identify the following minerals in thin section used in ceramic industries: Gypsum Calcite, Hornblende, Tourmaline, Muscovite, Biotite, Quartzite, Limestone, Labradorite and other Ceramic Minerals.
7. Identification of rocks in thin section under microscope such as: Quartzite, Gypsum, Dolomite, Limestone.
8. Preparation and identification of rocks in thin section under microscope such as: Granite, Gabbro, Basalt, Schist, Gneiss.

# 3CR4-22: Mechanical Operation of Ceramic Raw Material Lab

**Credit: 1** **Max. Marks: 100 (IA: 60, ETE: 40)**
**0L+0T+2P**

**Course Objectives**

- Knowledge of various Crushing and grinding instruments for particle size distributions and reduction for ceramics operations.

**Course Outcomes**

- Students able to know through laboratory experiment by grading, size reduction, Sieve shaker(Dry/Wet Method), particle size distribution and Study of Filter Press and preparation of filter cake

**Contents of the Subject**

1. To classify particles/grains based on size, shape, density and surface properties.
2. To determine the terminal velocity of Cyclone separator.
3. Size reduction using Jaw crusher and calculation of equivalent diameter of solid particle.
4. Size reduction using roller crusher and calculation of equivalent diameter of solid particle.
5. Study of size reduction using ball mill.
6. To analyze the given product for its particle size distribution using Sieve shaker (Dry Method).
7. To analyze the given product for its particle size distribution using Sieve shaker (Wet Method).
8. Study of Filter Press and preparation of filter cake.

# 3CR4-23: Particle and Fluid Mechanics Lab

**Credit: 1** **Max. Marks: 100 (IA: 60, ETE: 40)**
**0L+0T+2P**

## Course Objectives

- To determination and knowledge of flow rate and coefficient of discharge using Venturimeter/ Orificemeter in the laboratory.
- Knowledge of Bernoulli's equation experimentally, Calibration of orifice/notch and Study of nature of flow using Heleshow's apparatus

## Course Outcomes

- Students able to understanding the coefficient of viscosity, Bernoulli's equation, pressure gauge, flow rate & coefficient of discharge and Calibration through testing apparatus/equipment.

| **Contents of the Subject** |
|---|
| **1.** To determine coefficient of viscosity of a given sample. |
| **2.** Determination of pressure using pressure gauge and other devices. |
| **3.** To verify Bernoulli's equation experimentally. |
| **4.** To determine the flow rate and coefficient of discharge using Venturimeter. |
| **5.** To determine the flow rate and coefficient of discharge using Orificemeter. |
| **6.** Calibration of orifice/notch. |
| **7.** Study of nature of flow using Heleshow's apparatus. |

# 3CR4-24: Computer Programming Lab

**Credit: 1** **Max. Marks: 100 (IA: 60, ETE: 40)**
**0L+0T+2P**

## Course Objectives

- To perform and knowledge of programming of C++ and Java Software through analysis the complex and rational number arithmetic.

## Course Outcomes

- To perform program to perform the matrix operations. (Transpose, addition, subtraction, multiplication, test if a matrix is symmetric/ lower triangular/ upper triangular).
- Students able to implement spell checker using dictionary, color selector, shape selector, calculator with its functionality and graph & display BFS/DFS order of nodes

| **Contents of the Subject** |
|---|
| **Programs in C++**<br>1. Write a program to perform the complex arithmetic.<br>2. Write a program to perform the rational number arithmetic.<br>3. Write a program to perform the matrix operations. (Transpose, addition, subtraction, multiplication, test if a matrix is symmetric/ lower triangular/ upper triangular)<br>4. Implement Morse code to text conversion and vice-versa.<br>5. To calculate Greatest Common Divisor of given numbers.<br>6. To implement tower of Hanoi problem.<br>**Program in Java**<br>7. To implement spell checker using dictionary.<br>8. To implement a color selector from a given set of colors.<br>9. To implement a shape selector from a given set of shapes.<br>10. By mapping keys to pens of different colors, implement turtle graphics.<br>11. To implement a calculator with its functionality.<br>12. To implement a graph and display BFS/DFS order of nodes. |

# 3CR4-30: Industrial Training

**Credit: 1**
**0L+0T+2P**

**Max. Marks: 100 (IA: 60, ETE: 40)**

# B.Tech.: Ceramic Engineering and Technology
## 2nd Year - IV Semester

| SN | Category | Course Code | Course Title | Hours | | | Marks | | | | Cr |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Exm Hrs | IA | ETE | Total | |
| **THEORY** | | | | | | | | | | | |
| 1 | UCB | 4CR1 – 01 | Advance Engineering Mathematics-II | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 2 | DC | 4CR4 – 02 | Physical Ceramics-I (Structure of Ceramic materials) | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 3 | | 4CR4 – 03 | Ceramic Processing | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 4 | | 4CR4 – 04 | Ceramic Characterization and Instrumentation | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 5 | | 4CR4 – 05 | Cement Technology | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| 6 | | 4CR4 – 06 | Heat and Mass Transfer | 3 | 0 | 0 | 3 | 30 | 70 | **100** | **3** |
| | | | **Sub Total** | 18 | 0 | 0 | - | 180 | 420 | **600** | **18** |
| **PRACTICAL & SESSIONAL** | | | | | | | | | | | |
| 7 | DC | 4CR4 – 20 | Ceramic Processing Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 8 | | 4CR4 – 21 | Ceramic Characterization and Instrumentation Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 9 | | 4CR4 – 22 | Cement Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 10 | | 4CR4 – 23 | Heat and Mass Transfer Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 11 | | 4CR4 – 24 | Electric Properties of Materials Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 12 | | 4CR4– 25 | MATLAB & Simulink Lab | 0 | 0 | 2 | - | 60 | 40 | **100** | **1** |
| 13 | UGE/CA | 4CR8 – 00 | | | | | | | | | **1** |
| | | | **Sub- Total** | 0 | 0 | 10 | - | 360 | 240 | **600** | **7** |
| | | **TOTAL OF IV SEMESTER** | | 18 | 0 | 10 | - | 540 | 660 | **1200** | **25** |

***L:** Lecture, **T:** Tutorial, **P:** Practical, **Cr:** Credits, **ETE:** End Term Exam, **IA:** Internal Assessment*

# 4CR4-01: Advance Engineering Mathematics-II

**Credit: 3**
**3L+0T+0P**

**Max. Marks: 100(IA: 30, ETE: 70)**
**End Term Exam: 3 Hours**

**Course Objectives**:
This course aims to impart the knowledge of fundamental concepts of Laplace transform, fourier transform, fourier series and introduction to the theory of functions of complex variables.

**Course Outcomes:** Upon successful completion of the course the students will be able to

**CO-1** To understand the concepts and to solve the problems of Laplace transform and Fourier transform along with their properties.

**CO-2** To understand and learn about convergence of power series, sequence and series including various tests.

**CO-3** To study and understand about the fourier series, half range fourier sine and cosine series

**CO-4** To study the techniques of complex variables together with other concepts and properties of analytic function, complex integration, classification of singularities and calculus of residues.

| SN | Contents | Hours |
|---|---|---|
| 1 | **Laplace Transform**: Definition of Laplace transform, Properties of Laplace Transforms, Laplace transform of Unit step, Dirac delta and periodic functions. Inverse Laplace transforms, Inverse Laplace transform by partial fraction method, convolution theorem. Solving ODEs by Laplace transforms method. | **10** |
| 2 | **Fourier Transform**: Fourier Complex, Sine and Cosine transform, properties and formulae, inverse Fourier transforms, Convolution theorem, application of Fourier transforms to one dimensional heat and wave equations only. | **6** |
| 3 | **Sequences and Series**: Convergence of sequence and series, tests for convergence for series of positive terms – comparison test, ratio test, root test, Leibniz test for convergence of alternating series. Power series, Taylor's series for exponential, trigonometric and logarithmic functions. | **8** |
| 4 | **Fourier Series**: Periodic functions, Fourier series, Change of intervals, Half range sine and cosine series, Parseval's theorem. | **6** |
| 5 | **Complex Analysis**: Analytic functions, Cauchy-Riemann equations, Harmonic functions. Complex Line integral, Cauchy theorem, Cauchy integral formulae, Taylor and Laurent's Theorem, Zeros and Singularities, residues at poles and infinity, Cauchy residue theorem. | **10** |
| | **Total** | **40** |

REFERENCES:

1. Advanced Engineering Mathematics, R.K. Jain and S.R.K. Iyengar, Fifth Edition, Narosa Publishing House
2. Advanced Engineering Mathematics, Erwin O. Kreyszig, Tenth Edition, Wiley
3. Advanced Engineering Mathematics, H.K. Dass, 22nd Edition, S. Chand

# 4CR4-02: Physical Ceramics-I (Structure of Ceramic materials)

**Credit: 3**
**3L+0T+0P**

**Max. Marks: 100(IA: 30, ETE: 70)**
**End Term Exam: 3 Hours**

**Course Objectives**

- To impart knowledge on structure, electrical and magnetic properties of ceramic materials.
- To know about Electromagnetic waves in ceramics, Refractive Index & Dispersion and Opacity & Translucency

**Course Outcomes**

- To learn the structure of ceramic material and crystallography of material
- To acquire knowledge of different defects of ceramic and study of electrical, magnetic and optical properties of ceramic materials.

| SN | Contents | Hours |
|---|---|---|
| 1 | **Structure of ceramic materials**<br>Bonding in ceramics: electronegativity; ionic and covalent bonding, Energy versus distance curves for an ionic bond. Lattice Energy and Madelung constant. Face-centered cubic (FCC), body-centered cubic (BCC), and hexagonal close-packed (HCP) structure. Grouping of ions and Pauling's rule, coordination number, factors affecting structure | 9 |
| 2 | **Defects in Ceramics:** Kroger Vink notations for point defect. Schottky and Frenkel defects. Defect Reactions. Stoichiometric defect reactions. Nonstoichiometric defects. Extrinsic defects. Electronic Defects. Defect Equilibria and Kroger- Vink Diagrams. Stoichiometric Versus Nonstoichiometric Compounds. | 7 |
| 3 | **Diffusion and Electrical properties**<br>Diffusion: Atomistics of Solid State Diffusion, self-diffusivity, Diffusion in a Chemical Potential, Electric Potential and Electrochemical Potential Gradient. Electrical Conductivity: Electric mobility, Transference or transport number. Ionic Conductivity, Electronic Conductivity; Intrinsic semiconductors, Extrinsic semiconductors, Nonstoichiometric semiconductors | 7 |
| 4 | **Magnetic properties**<br>Paramagnetism, Ferromagnetism, Antiferromagnetism, and Ferrimagnetism, Curie-Weiss law, Curie temperature, Neel temperature, Magnetic Domains and the Hysteresis Curve, saturation & remnant magnetization coercive magnetic field, soft and hard magnet, orientation anisotropy, magnetostriction, Magnetic Ceramics: Cubic Ferrites, Garnets, Hexagonal Ferrites. | 9 |
| 5 | **Optical Properties** Electromagnetic waves in ceramics, Refractive Index & Dispersion, Reflection & Refraction. Scattering, Refractive Index & Dispersion in Dielectric materials, Boundary Reflectance & Surface gloss.<br>Opacity & Translucency, Absorption & Color, Bands, Color, Ligand-Field Chemistry Colorants, Ceramic Stains, Color specifications, Lasers, Phosphors, Fiber optics. | 8 |
| | **Total** | **40** |

**TEXTBOOKS**

1. Fundamentals of Ceramics By: Michel W Barsoum, Published by Institute of Physics Publishing, The Institute of Physics, London
2. Introduction to Ceramics by: W. D. Kingery, H. K. Brown and D. R. Uhlmann, Wiley Interscience Publication, John Wiley & Sons.

**REFERENCE BOOKS**

1. Solid State Chemistry and its Applications By: A. R. West, John Wiley & Sons (Asia) Pte. Ltd.

# 4CR4-03: Ceramic Processing

**Credit: 3**
**3L+0T+0P**

**Max. Marks: 100(IA: 30, ETE: 70)**
**End Term Exam: 3 Hours**

**Course Objectives**

- Knowledge of various ceramic fabrication process and know about Science of colloidal processing of ceramics
- To provide essential knowledge of various Forming of ceramics and powder consolidation method
- To aware the Binders & Additives and Drying & Calcinations of Ceramics

**Course Outcomes:**

- To able to learn various methods of ceramic processing and Detailed study of rheology of ceramic systems
- To understanding casting and forming methods of ceramics
- To Handling the ceramic product through drying and sintering methods.

| S. No. | Contents | Hours |
|---|---|---|
| 1 | Ceramic Fabrication Processes: Introduction, Ceramic fabrication processes & their classification viz. Gas phase reactions, Liquid precursor methods etc. Production of polycrystalline ceramics from powders: An overview, A case study in processing | 8 |
| 2 | Science of colloidal processing of ceramics: Introduction, Types of colloids, Attractive surface forces, Electrostatic, Steric and electrostatic stabilizations, Structure of consolidated colloids<br>Rheology: Detailed study of rheology of ceramic systems. Particle solgel processing | 7 |
| 3 | Forming of ceramics and powder consolidation method: Introduction, Characteristics of solid particles, Particle shapes, Size, Equivalent particle diameter, Surface area, Average particle size & size distribution. | 8 |
| 4 | Binders & Additives: Packing of particles, Additives in forming processes, Selection of additives; Solvent, Binder, Plasticizers, deflocculants and lubricant, Dry and semidry pressing methods: Dry and semidry pressing methods, Die compaction and isostatic compaction, Casting methods: slip casting, pressure casting and tape casting, Plastic forming method: extrusion and injection molding. | 9 |
| 5 | Drying & Calcination: Drying of cast or extruded articles, Binder removal, Calcinations & affecting factors, Sintering: Introduction to sintering of ceramics, Hot and iso-static processing of ceramics. | 8 |
| | **Total** | **40** |

**TEXT BOOKS**

1. M. N. Rahaman/ Ceramic Processing and Sintering/ 2nd Ed/ CRC Press, 2003.
2. J.S. Reed/ Introduction to the Principles of Ceramic Processing/ 2nd Ed./ John Wiley & Sons, 1995.

**REFERENCE BOOKS**

1. D. W. Richerson/ Modern Ceramic Engineering: Properties, Processing, and Use in Design/ 3rd ed/ CRC Press 2005.
2. D. A. Brosan and G. C. Robinson/ Introduction to Drying of Ceramics: with laboratory exercises/Net Library/ Incorporated, 2003.
3. H. Mehrer/ Diffusion in Solids: Fundamentals, Methods, Materials, Diffusion-Controlled Processes/ Springer, 2007
4. David Segal/ Chemical Synthesis of Advanced Ceramic Materials/ Cambridge University Press 1989.
5. A. J. Moulson and J. M. Herbert./Electroceramics: Materials, Properties and Applications/ John Wiley & Sons 2003

# 4CR4-04: Ceramic Characterization and Instrumentation

Credit: 3
3L+0T+0P

Max. Marks: 100(IA: 30, ETE: 70)
End Term Exam: 3 Hours

Course Objectives

- To understand the Crystallography and applications of X-ray diffraction in ceramic systems & X-ray fluorescence (XRF).
- Briefly knowledge for sample preparation and characterization of ceramic materials for SEM, TEM and EPMA.
- To know the principal, working and construction of different types of Gas and liquid analyzers.
- To study the particle size distribution through various instruments.

Course outcomes

- The students able to understand basics of diffraction theory and utilize in characterizing real samples) using X-ray or electron beam.
- To understand the principal, working and construction of scanning electron microscope, transmission electron microscope and Gas & Liquid analyzers.
- To understand by using X-ray line broadening and sedimentation method for particle size measurements, surface area and porosity measurements, BET surface area measurements, etc.

| SN | Contents | Hours |
|---|---|---|
| 1 | Crystallography: Continuous and characteristic emission of Xrays, absorption filters, diffraction, Bragg's Law powder and single crystal X-ray diffractometer, atomic scattering factor,geometrical structure factor. Indexing of diffraction patterns, determination of structure and lattice parameters. Applications of XRD & XRF: Applications of X-ray diffraction in ceramic systems, X-ray fluorescence (XRF). | 8 |
| 2 | Spectroscopic Analysis: Introduction, absorption and reflection techniques, atomic techniques: emission, absorption and fluorescence, Photo acoustic spectroscopy, Microwave spectroscopy and mass spectrometers. Atomic Absorption spectrometer, IR, FTIR and Raman– Basic principle, instrumentation and analysis of data. | 8 |
| 4 | Gas and Liquid Analysis: Infrared and ultraviolet absorption analyzers, Paramagnetic oxygen analyzers, Thermal conductivity analyzers, Chemical luminescence analyzers and flame photometer and its uses in analysis. PH meters, conductivity meter, analyzers for measurement of ammonia, silica, sodium and dissolved oxygen. | 7 |
| 5 | Electron Microscopy: Principle, construction and operation of scanning electron microscope (SEM), Principle construction and working of transmission electron microscope (TEM), electron diffraction, bright field and dark field images, SAD, sample preparation of ceramic materials for SEM, TEM and EPMA. | 8 |
| 6 | Particle Size: Light scattering, Coulter counter, sieving, X-ray line broadening and sedimentation method for particle size measurements, surface area and porosity measurements, BET surface area measurements, gas adsorption, Mercury porosimetry and pycnometry for porosity of powders. | 9 |
| | **Total** | **40** |

**TEXT BOOKS**

1. B. D. Cullity/ Elements of X-ray Diffraction/ Addison Wesley Publishing Company; 2nd edition 1978
2. R. F. Speyer/ Thermal Analysis of Materials/ CRC Press, 1994
3. M. N. Rahaman/ Ceramic Processing and Sintering, 2nd Ed/ CRC Press 2003
4. Willard ,Dean, Merit/ Instrumental Methods of Analysis/ CBS 1988

**REFERENCE BOOKS**

**1.** P.J. Goodhew, J. Humphreys and R. Beanland/ Electron Microscopy and Analysis/, Third Edition, Taylor & Francis, 2001
**2.** H. P. Klug and L. E. Alexander/ X-ray Diffraction procedures for Polycrystalline and Amorphous Materials/ 2nd Edition, John Wiley, 1974.
**3.** Dally/ Instrumentaton for Engineering Measurement/ Willey 1984
**4.** D. A. Skoog, F. J. Holler and T. A. Nieman/ Principles of Instrumental Analysis, 5th Ed./ Hartcourt College Publishers. 1998

# 4CR4-05: Cement Technology

**Credit: 3**
**3L+0T+0P**

**Max. Marks: 100(IA: 30, ETE: 70)**
**End Term Exam: 3 Hours**

## Course Objectives

- To know about procedure for manufacturing of lime and cements with properties and its application.
- To provides knowledge of Testing of Cements and concept of quality control of cement.
- To understand the burning process of preheater and pre-calcinators in cement industry, heat recovery devices and waste heat utilization
- To aware the different types of Cement, packing and dispatch of cement and setting and hardening of plaster of paris.

## Course outcomes

- Understanding the origin, types and development of cement and cementatious materials.
- To aware of different classes of building lime & Gypsum and their properties.
- Knowledge about the concrete & testing of cement.

| SN | Contents | Hours |
|---|---|---|
| 1 | Introduction: Origin and development of cement and cementatious materials. Batch preparation: Raw materials and their classification, selection of raw materials, crushing of lime stone and other calcareous materials, proportioning of raw materials, grinding of raw materials and preparation of raw meal, blending & beneficiations of raw materials. | 8 |
| 2 | Lime: Different classes of building lime and their properties. Processing: Burning of raw mix, reactions occurring in cement making at different temperature, preheater and pre-calcinators in cement industry, heat recovery devices and waste heat utilization, Firing system and kiln residence time. Working of rotary kiln and clinkering reactions, clinker coolers. Clinker and their storage, cement grinding mills, cement storage and silos, conveying, packing and dispatch of cement, cement packing machines. Dust and dust collection in cement industries. | 9 |
| 3 | Concrete & Testing: Introduction, classification, properties of concrete, grades of concrete, advantages and disadvantages of concrete, concept of quality control, concrete industry, challenges faced by concrete industries. Testing of cement. | 8 |
| 4. | Types of cements: Different types of cement:- Quick setting cement, low heat cement, blast furnace slag cement, trief cement , sorrel cement, white and colored cement, Iron ore cement, oil well cement, hydrophobic cement, water proof cement. Masonry cement, expanding and self stressing cement, sulphate resisting cement, super sulphate cement, high alumina and other refractory cements, refractory castables, pozzolana and pozzolanic cements. | 7 |

| | | |
|---|---|---|
| **5.** | Gypsum: Gypsum, plaster of paris (POP), its properties and uses, manufacture of plaster of paris, setting and hardening of plaster of paris. | **8** |
| | **Total** | **40** |

**TEXT BOOKS:**

1. P. Hewlett/Lea's Chemistry of Cement and Concrete/ Fourth Edition, Butterworth Heinemann 2004

**REFERENCE BOOK:**

1. H. F. W. Taylor/ Chemistry of Cement/ Thomas Telford, 1997
2. M.L. Gambhir/ Concrete Technology/ Tata Mcgraw Hill Education Private Limited, New Delhi, 2009
3. K.E. Peray/ Cement Manufacturer's Handbook/Chemical Publishing Company, 1979
4. E. M. Gartner and M. Uchikawa/Cement Technology/ The American Ceramic Society, 1994

# 4CR4-06: Heat and Mass Transfer

**Credit: 3**
**3L+0T+0P**

**Max. Marks: 100(IA: 30, ETE: 70)**
**End Term Exam: 3 Hours**

**Course Objectives**

- To make aware on conduction convection and radiation through heat transfer.
- To know about the state of matter and utilization of fuel in different types of driers, kilns and furnaces.
- To provide essential knowledge on different types of heat exchanger and diffusion and diffusivity of mass transfer.

**Course outcomes**

- Know the importance of fourier's law, newton's law and boltzmann law with derivation & expression of heat & mass transfer
- To know the solid, liquid and gaseous fuels, their feeding devices, complete combustion of furnace.
- To understand the Mean temperature difference in co-current and countercurrent flows and correction factor for different heat exchanger.
- Know the concept of mass transfer co-efficients, their experimental determination and use of dimensionless numbers and detail study of the various driers used in ceramic industries

| SN | Contents | Hours |
|---|---|---|
| 1 | Conduction: Heat transfer by conduction. Fourier's law, thermal resistances in series, conduction through infinites slab, thick walled cylinder and thick sphere, variation of conductivity with temperature. Convection: Heat transfer through liquid. Newton's law, film coefficient, natural and forced, overall heat transfer coefficient, heat transfer coefficient based on inside and outside areas, dirt and foul factors, elementary concepts of dimensionless numbers, their use in predicting film coefficient, heat transfer to liquid under laminar and turbulent flows, forced convection outside tubes. Radiation and furnace: Stefan Boltzmann law, emissivity and absorbability, black and grey bodies, view factors, gas radiation, radiant heat transfer in glass melting. | **10** |
| 2 | Furnaces: solid, liquid and gaseous fuels, their feeding devices, primary and secondary air for combustion, complete and partial combustion, calculation of radiant heat transfer in furnaces. Fuel gas: analysis and its utility, purpose of furnace linings and higher chimneys, application to steam boilers. | **7** |
| 3 | Heat Exchanger: Shell and tube heat exchangers, baffles, design of heat exchanger and their relative advantages, multi pass heat exchangers. LMTD: Mean temperature difference in co-current and countercurrent flows, LMTD correction factor for multi pass heat exchanger, plate heat exchanger, current, counter current and crossflow heat exchangers. | **7** |
| 4 | Diffusion and Diffusivity: Fick's law, mass and molar rates of flow, different velocities and fluxes under static and moving co-ordinate system, concentration gradients in dimensional concurrent and counter current flows, two film theory, analogy between mass momentum and heat transfer. | **9** |

| | | |
|---|---|---|
| | Mass transfer co-efficients: Mass transfer co-efficients, their experimental determination, use of dimensionless numbers, Sherwood, Lewis, Schmidt numbers. Absorption: absorption and desorption in packed beds and in plate columns, relative advantages. | |
| 5 | Drying: Internal flow of moisture within the solids surface evaporation drying shrinkage estimation of drying rates and achievement of maximum drying rate. Dryers: Detail study of the various driers used in ceramic industries; tray driers, tunnel driers drum driers vacuum driers and spray driers. | **7** |
| | **Total** | **40** |

**TEXT BOOKS**

1. P.K. Nag/Heat & Mass Transfer, 1966.
2. D.S. Kumar/Heat and Mass Transfer/S.K.Kataria & Sons, 2007

**REFERENCE BOOKS**

1. D. Q. Kern/Process Heat Transfer/McGraw Hill International Auckland Bogota 1986.
2. Dutta, Heat Transfer/ Prentice-Hall of India Pvt.Ltd 2004
3. Anantharaman/.Element of Mass Transfer/ PHI Learning Pvt. Ltd. 2005
4. Sharma.Principles/ of Mass Transfer/ PHI Learning Pvt. Ltd. 2007

# 4CR4-20: Ceramic Processing Lab

**Credit: 1** **Max. Marks: 100 (IA: 60 ETE: 40)**
**0L+0T+2P**

**Course Objectives**

- To understand by experimental practices of Calibration of thermocouple isothermal/non-isothermal sintering techniques and decomposition kinetics/phase transformation kinetics trough TGA/DTA Instruments

**Course Outcomes**

- To know the application and procedure of each experiment and be able to do given processing techniques by using suitable apparatus/equipment and ceramic raw materials.

**Contents of the Subject**

1. Calibration of thermocouple and determination of temperature profile of the furnaces.
2. Effect of process parameters on the response behaviour of PID controller.
3. Calibration of PID temperature Controller.
4. Study of sintering behaviour of ceramic materials.
5. Study of non-isothermal sintering behaviour of ceramic materials.
6. Study of decomposition kinetics of a material from its isothermal weight loss behaviour.
7. Study of phase transformation kinetics from differential thermal analysis.
8. Study of the heating rate on constant rate heating densification behaviour.
9. Study of binder burnt out behaviour by TGA.
10. Study of recrystallization behaviour of materials.

# 4CR4-21: Ceramic Characterization and Instrumentation Lab

**Credit: 1** **Max. Marks: 100 (IA: 60, ETE: 40)**
**0L+0T+2P**

**Objective Outcomes**

- To understand by experimental practices and study of Processes, Methods, Measurements, Monitoring Instruments and Techniques of ceramic instrumentation.

**Course Outcomes**

- Student has knowledge to performance the experiments with different instruments, calculations, measurements and methods by using DTA,TGA, SEM, TEM XRD, Spectrophotometric, etc.
- To know the thin layer chromatographic separation and particle size distribution of following samples.

**Contents of the Subject**

1. Demonstration of DTA/Differential Enthalpy Analysis and determination of the enthalpy of a reaction and percentage weight change.
2. Demonstration of X-ray diffractometer.
3. Indexing of XRD patterns and calculation of lattice parameter for cubic crystal system.
4. Sample preparation of ceramic Materials for microstructure observation by optical microscope.
5. Spectrophotometric analysis of ceramic samples and glasses.
6. Demonstration of SEM/EPMA/TEM.
7. Determination of the following elements using Flame Photometer: a. Sodium and Potassium when present together. b. Lithium/calcium/barium/strontium. c. Cadmium and magnesium in tap water.
8. Thin layer chromatographic separation and identification of nickel, manganese, cobalt and zinc.
9. Determination of particles size in the given sample by using sedimentation laser method/Andresen Pipette.
10. Determination of porosity in the given ceramic samples by using mercury porosity meter/pycnometer.
11. Measurement of dissolve oxygen in given sample using dissolve oxygen meter.
12. Determination of conductance and specific conductance of given sample using conductivity meter.

# 4CR4-22: Cement Lab

**Credit: 1** **Max. Marks: 100 (IA: 60, ETE: 40)**
**0L+0T+2P**

**Course Objectives**

- To impart knowledge in different experiments related to cement.

**Course Outcomes**

- To enhance the knowledge and concept on different testing and characterization of cement.

**Contents of the Subject**

1. Determination of consistency of standard cement paste.
2. Determination of Initial setting time and final setting time of given mix.
3. Determination of fineness of cement by dry sieving.
4. Determination of specific gravity of cement.
5. Determination of tensile strength of cement.
6. Mixing of plaster & making of moulds for slip casting.
7. Determination of setting time of given plaster of paris
8. Determination of soundness of cement by autoclave test method.
9. Determination of compressive strength of cement.
10. Workability of concrete.
11. Chemical analysis of ordinary portland cement.

# 4CR4-23: Heat and Mass Transfer Lab

**Credit: 1** **Max. Marks: 100 (IA: 60, ETE: 40)**
**0L+0T+2P**

**Course Objectives**

- To provide essential knowledge with experiments to know the Fourier's law, Newton's law and Boltzmann law with data calculation, derivation & expression of heat & mass transfer.
- Study of Gas inducing type agitators & Cyclone separators and effect of direction of mass heat transfer on coalescence foaming.

**Course Outcomes**

- Fundamental concepts of Temperature measurement systems and test on heat transferring apparatus
- Knowledge on conduction heat transfer, convection heat transfer and Radiation heat transfer

**Contents of the Subject**

1. To determine (a) Thermal conductivity (b) Critical thickness (c) Thermal resistance of given ceramic material / insulating powder.
2. To determine the Stefan-Boltzmann constant.
3. Determination of heat transfer coefficient in natural and forced convection.
4. Determination of overall heat transfer coefficient and effectiveness for parallel and counter flowheat exchangers.
5. Determination of emissivity of a given test plate made by ceramic material with respect to blackplate (standard).
6. Obtain the extraction efficiency of an agitating extractor for liquid- liquid system.
7. Study of (I) Gas inducing type agitators & (II) Cyclone separators.
8. Demonstration of effect of direction of mass heat transfer on coalescence foaming.

# 4CR4-24: Electric Properties of Materials Lab

**Credit: 1** **Max. Marks: 100 (IA: 60, ETE: 40)**
**0L+0T+2P**

**Course Objectives**

- To impart the knowledge to the students about the determination of various electric properties in the laboratory.

**Course Outcomes**

- Understanding the concept of conductivity and band gap of insulator/semiconductor.
- Knowledge of dielectric constant and loss of dielectric by LCR testing apparatus/equipment.
- Practical experience on ferromagnetic sample in laboratory to determine of Curie temperature.

**Contents of the Subject**

1. Study of temperature dependent conductivity of insulator/semiconductor.
2. Determination of band gap of insulator/semiconductor.
3. Determine the initial permeability of given sample.
4. Study of hysteresis behaviour of ferro/ferri magnetic material.
5. Determination of dielectric constant and loss of dielectric.
6. Study of frequency dependent dielectric behaviour of dielectric.
7. Determination of relaxation time of given dielectric material.
8. Determination of Curie temperature of given ferromagnetic sample.

# 4CR4-25: MATLAB & Simulink Lab

Credit: 1 Max. Marks: 100 (IA: 60, ETE: 40)
0L+0T+2P

**Course Objectives**

1. This course provides knowledge of solving introductory linear algebra, differential equations and Laplace transforms through MATLAB.
2. For solving different problems in fundamental mechanics, circuit analysis and thermodynamics
3. The course will provide the mathematical models for typical mechanical and thermodynamic systems

**Course Outcomes**

- Students able to analysis of data of ceramic characterization for ceramic industries.
- Students able to understanding the concept of MATLAB for solving different mechanical and thermodynamic problems of Ceramic as well as Engineering
- To know the modeling discrete and continuous system of ceramic process control

**Contents of the Subject**

1. Study of Introduction to MATLAB.
2. Study of basic matrix operations
3. To solve linear equation.
4. Command and Scripts, Managing Data files, Developing functions.
5. Data analysis of experimental data of ceramic characterization.
6. Creation and simulation of models for ceramic processing.
7. Programming for a modeling of ceramic process control.
8. Modeling discrete and continuous system.

**TEXTBOOK**

**1.** Rudra Pratap, Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers, Oxford Edition ,2010