Regulations and Syllabi for 2 years – 4 semesters Master of Technology (M. Tech.) Degree in Ceramic Engineering of Chemical Technology, University of Calcutta

1. A candidate who has passed the B. Tech. in Chemical Technology with specialization in Ceramic Engineering or an equivalent examination recognized by the Calcutta University or B.E./ B. Tech. in Ceramic Technology/Chemical Engg./Metallurgical Engg./Material Science & Technology from any recognized university/ AICTE recognized institution shall be eligible for admission to the Master of Technology (M. Tech.) course in Ceramic Engineering.
2. The duration of the M. Tech. course shall be of two academic years and the examination shall be held in four semesters (two semesters in each academic year).
3. A candidate shall be eligible to sit for the examination provided he/she pursues a regular course of studies in the Department of Chemical Technology and attends at least 65% of the working days in both theoretical and practical classes in each semester**.**
4. M. Tech. First Semester examination shall ordinarily commence at the end of six months. M. Tech. Second Semester examination shall ordinarily commence after six months of the M. Tech. First Semester examination. M. Tech. Third Semester examination shall ordinarily commence after six months of the M. Tech. Second Semester examination. M. Tech. Fourth Semester examination shall ordinarily commence after six months of the M. Tech. Third Semester examination.
5. A candidate for the M. Tech. in different semesters examination shall be examined in the subjects mentioned hereunder.
6. The credit based examination system will be followed for all Semester examinations. The Semester wise credit points are as follows:

Semester	I	II	III	IV	TOTAL
Credits	20	20	20	20	80

All theoretical and laboratory/practical papers will have a total 100 marks. Generally the credit points of theoretical and practical papers are 4 each. However different credit point may be assigned to some subjects involving project work and design etc., the detailed

structure with credit points is given in Schedule-I. The total marks for the Four Semester M. Tech. Examination in Ceramic Engineering shall be 2000.

7. Each theoretical paper carrying 100 marks (4 Credits) shall be of minimum of 60 hours duration spread over the each semester session.
8. The duration of semester examination for each theory question paper is three hours.
9. Research Project (Thesis) shall be assigned to a candidate at the beginning of Third Semester. He/she shall work on the assigned problem in a departmental laboratory under the guidance of a teacher of the department. However, a candidate may also be allowed to work on the assigned problem under the joint guidance of a teacher of the department and a person from a Research Institute/Industrial Organisation of repute if approved by the Board of Post-Graduate Studies. He/she shall prepare and submit three type- written and bound copies of the thesis on his/her project work to the Head of the Department of Chemical Technology at least one month before the commencement of M. Tech. Fourth Semester Examination to make him/her eligible to sit for the examination.
10. The total marks obtained in each subject whether theory or practical will be converted into grade points. The Semester grade sheets and transcripts of the first three semesters will have only credits, grades, grade points and SGPA. The final grade sheets will have only credits, grades, grade points, SGPA as well as CGPA and the total marks obtained out of 2000. The performance grading will be considered as follows:

Grades	Marks %	Grade points
Ex	90 and above	10
A	80-89	9
B	70-79	8
C	60-69	7
D	50-59	6
F (Fail)	49 and below	NIL

11. Eligibility of success/failure in a Semester Examination:

a) The student has to secure at least 50% or above marks (e.g. Grade-D) in each theoretical, practical papers and viva-voce individually in order to pass the examination.

b) If a student fails in more than two subjects having total credits more than 8, he/she will have to repeat the whole Semester and will not be allowed to continue his studies to the next Semester classes. The student will eventually face a year loss.

c) If a student fails in less than two subjects amounting 8 credits or less in a Semester but earns rest of the credits, he/she will be allowed to continue to the next Semester, ***provided that total of such backlog credits within the entire course period of four semesters is 16 or less***. [Example: In the *first and second* Semesters, one has to earn at least 20 - 8= 12 credits; this may vary in other Semesters]

d) Supplementary examinations of all papers of present Semester will be arranged soon after the publication of results of regular examinations of the present Semester. If the candidate fails to clear the supplementary paper(s), he / she will get another chance to clear the same in the corresponding semester in the next academic session.

e) Removal from a course: If a student fails to pass the same Semester examination two times, she/he will have to leave the course. To acquire 80 credits in 4 Semesters, a student will have to utilize all the allowed chances within four years (i.e. 8 consecutive Semesters).

f) Eligibility for a Degree: The total credits for M. Tech. courses are 80 for a 4 semester course. Thus a student who successfully could earn 80 credits in 4-Semester (i.e. 2-year) course would be eligible for a M. Tech. Degree in Ceramic Engineering.

12. Eligibility to appear for additional Semester Examination

a) A student who does not appear in some or all the examinations in a Semester for representing the University in sports, cultural activities, NSS or any other reason considered valid under exceptional circumstances and to the satisfaction of the Head of the Department and subsequently Head of the Institute is eligible to appear for additional examination within three months and may continue in the next Semester courses.

b) If a candidate discontinues his/her studies after any individual semester examination he/she will be allowed to appear at the next M. Tech. semester examination in the following two years from the date of M. Tech. semester examination, the candidate appeared last after getting prior approval from PG Board of Studies.

13. Calculation of SGPA and CGPA and award of Degree:

a) Each Semester Grade point average is calculated by dividing the sum of products of Grade point and course credit by sum of all course credit in the Semester.

$$SGPA = \Sigma CG/\Sigma C$$

Where, G is grade and C is credit for a paper/subject.

Similarly CGPA can be calculated using the same formula considering all subjects and credit for all Semesters taken together.

Though grade in a particular subject will be obtained by conversion of absolute marks obtained in that subject, the Grade Sheet will however have no mention of marks and it would show only grades and SGPA.

b) All successful candidates will be issued consolidated Grade Sheets (having CGPA) together with 4^{th} Semester Grade Sheet (having SGPA) along with the consolidated marks in 4 semesters. They will be awarded the Degree Certificate in the following format .

UNIVERSITY OF CALCUTTA

SEAL

The Degree of Masters of ------- Engineering/Technology has been awarded to Sri/Smt ---- after successful completion of the course whose final Semester Examination was held on --- . He/She has been placed in the --- Class.

Senate House Vice Chancellor

Course Structure and Syllabus for 2-year 4-semester M. Tech. Course in Ceramic Engineering

Schedule - I

1st Semester:

Paper No	Sub Code	Subject	Periods			Cr	Marks		
			L	T	P		IA	UE	TM
Theory									
I	**CHT101**	Process Modeling and Simulation	4	1	-	4	-	100	100
II	**CER102**	Ceramic Science and Technology	4	-	-	4	-	100	100
III	**CER103**	Refractories & Structural Ceramics	4	-	-	4	-	100	100
Practical									
IV	**CHT104**	Computer Application in Chemical Industries	-	-	4	4		100	100
V	**CER105**	Chemical & Instrumental Analysis	-	-	4	4		100	100
		Total	12	1	8	20		500	500

2nd Semester:

Paper No	Sub Code	Subject	Periods			Cr	Marks		
			L	T	P		IA	UE	TM
Theory									
VI	**CHT201**	Optimization	4	1	-	4	-	100	100
VII	**CER202**	Glass and Vitreous Coating	4	-	-	4	-	100	100
VIII	**CER203**	Electrical and Electronic ceramics	4	-	-	4	-	100	100
IX	**CER204**	Advanced clay-based ceramics and Ceramic Machines	4	-	-	4	-	100	100
Practical									
X	**CER205**	Ceramic Engineering Laboratory: Synthesis & Characterisation of ceramic materials	-	-	4	4	-	100	100
		Total	16	1	4	20	-	500	500

3rd Semester:

Paper No	Sub Code	Subject	Periods			Cr	Marks		
			L	T	P		IA	UE	TM
XI	**CER301**	a. Project Feasibility – Report	-	3	8	8	-	200	200
		b. Project Feasibility – Viva Voce	-	-	-	4	-	100	100
XII	**CER302**	Seminar	-	3	-	4	-	100	100
XIII	**CER303**	General Viva Voce	-	-	-	4	-	100	100
		Total	-	6	8	20	-	500	500

4th Semester:

Paper No	Sub Code	Subject	Periods			Cr	Marks		
			L	T	P		IA	UE	TM
XIV	**CER401**	a. Research Project – Thesis	-	5	10	15	-	400	400
		b. Research Project – Viva Voce	-	-	-	5	-	100	100
		Total	-	5	10	20	-	500	500

Total Credit Point: 20 + 20 + 20 + 20 = 80; **Grand Total:** 2000

IA: Internal Assessment; UE: University Examination; TM: Total Marks

NB. Both Research Project assignment and the Project Feasibility assignment will be allotted at the beginning of 3rd Semester. The Research Project assignment to be evaluated at the end of the 4th Semester while Project Feasibility assignment to be evaluated at the end of 3rd Semester.

SYLLABI OF 2 YEARS (FOUR SEMESTER) M.TECH. COURSE IN CERAMIC ENGINEERING.

First Semester

Paper I

Course CHT 101 **100 Marks/ 4 credits**

Process Modeling & Simulation

Module 1: Mathematical Modeling Fundamentals: Art of modeling, laws, assumptions, degrees of freedom, consistent modeling, synthesis, analysis and optimization. General purpose modeling, specific purpose modeling, scientific modeling, engineering modeling.

Module 2: Models of equipment, unit operation/unit process; material & energy balance, property relations, Constraints, steady state and unsteady state models. Specific Equipment Design models: Batch reactor, continuous tank reactor, Continuous tubular, catalytic reactor, heat exchanger, Distillation column.

Module 3: Plant modeling, stream variable and stream properties, tear stream and tear variable, modular approaches: sequential, simultaneous and equation solving approaches. Sequencing and ordering of solving equations.

Plant modeling: A plant with/without a recycle stream, plant with controlling elements.

Module 4: Solution algorithm and flow chart development for various mathematical models.

Computer simulation**:** Programming languages, sequences and algorithm development.

Specific simulators**:** Binary distillation column, Heat exchanger, reactor, flasher.

Plant flowsheeting: Three CSTR in series, Propylene dimerization plant, sulfuric acid plant, etc.

Paper II

Course CER 102 **100 Marks/ 4 credits**

Ceramic Science and Technology

Module 1: Structure of ceramic solid-crystalline solids and their defects, non-crystalline solids, multiphase materials. Physical principles of ceramic processes, diffusion, solid state reaction, sintering and related phenomena.

Ceramics microstructure: nucleation, grain growth transformation, sintering methods and mechanisms, control of microstructure. Application in advanced ceramics systems like toughened ceramics, silicon nitrides, sialons etc.

Technological aspects of advanced ceramic materials viz. Ceramic-matrixcomposites, Ceramic membranes, Solid oxide fuel cell, Cermets, Bioceramics, Ceramics in nuclear field.

Module 2: Mechanical properties of ceramics: Modes of failure fracture, fatigue and creep mechanisms of failure, theoretical fracture strength, Griffith flaws in brittle failure, nucleation

and propagation of microcracks. Viscous and Viscoelastic behavior. Strengthening methods, composite materials, FRP's.

Thermal properties of ceramics, thermal expansion, heat capacity and thermal conductivity. Thermal behavoiur and microstructure, thermal stresses and deformations. Electrons in solid-

band theory, semi-conductors and devices, semiconductor materials. Preparation of single crystals and simple devices, MOS, Zone melting techniques.

Dielectrics, their properties and characterization, ceramic dielectric materials, ferroelectric ceramics, magnetic materials-origin of magnetism, classification of magnetic materials, ferrites, and related materials, ceramic super conductors. Optical properties of glasses and ceramics, optical materials, luminescence, lasing action and fibre communication.

Paper III

Course CER 103 **100 Marks/ 4 credits**

Refractories and Structural Ceramics

Module 1: Pure oxide Refractories – Magnesia, Alumina, zirconia, Beryllia and Thoria. Mullite and mullite containing Refractories. Spinel and Spinel containing refractories. Graphites – evaluation, natural and artificial. Different types of composites refractories, Refractory metals, Cermets. Fabrication and properties of these refractories.

Non oxide refractories – their structure, preparation, properties, applications and evaluation and microstructures. Carbides, Nitrides, Silicides and Borides, fabrication and properties of Sialon and Sialon Composites. Fabrication and properties of these refractories.

Module 2: Different types of castables, plastics, gunning materials and their application in steel plants. Application of nanomaterials in refractory castables. Particle size distribution and firing practice of monolithic refractories. Phase diagrams of important refractory/ceramic systems.

Paper IV

Lab – I

Course CHT 104 **100 marks/4 credits**

Computer Application in Chemical Industries

Writing computer program to solve complex design and modeling problems like heat exchangers, flashers, reactors, distillation columns, plant simulation problems etc.

Paper V

Lab – II

Course CER 105 **100 marks/4 credits**

Chemical and Instrumental Analysis

Analysis of trace elements in ceramic materials by spectroscopic analysis – AAS, UV-VIS, Flame Photometry etc.

Analysis of Lithium bearing materials. Direct estimation of different constituents in Portland Cement. Analysis of some high performance refractory materials — sintered mullite, Brown and White Tabular alumina, Zircon, Silica in silicon carbide. Analysis of some synthetic hydrogel, Dead burnt magnesite. Estimation of different constituents in dehydroxylated clays.

Chemical analysis of some redox systems in ceramic materials: Fe^{+2} — Fe^{+3}, Cr^{+3} — Cr^{+6}, Cu^{+} — Cu^{+2}, Mn^{+2} — Mn^{+7}.Thermal analysis: Differential thermal and Differential thermo-gravimetric analysis of ceramic raw materials and products.

Second Semester

Paper VI

Course CHT 201 **100 marks/4 credits**

Optimization

Module 1: Indroductory concepts : Objective function, single valued function, multivalued function, non-linear function, linear function, stationary point, relative and absolute extreme, convex, concave and unimodal functions, gradient reduction method, jacobian and hessian matrix.

Module 2: Optimization of univariate system using analytical method. Search techniques, quadratic interpolation, cubic interpolation. Optimization of multivariate unconstrained system using.

Module 3: Search techniques. First order methods and second order methods. Optimization of multivariate constrained systems using Lagrange multipliers, penalty function, linear programming and non-linear programming.

Module 4: Computer programming of optimization of specific problems related with chemical industry.

Paper VII

Course CER 202 **100 marks/4 credits**

Glass and vitreous coating

Module 1: Concept of vitreous state, kinetics of high temperature reactions during glass formation. Different glass forming systems and their stability. Phase transformation in glass-crystallisation and glass formation, controlled crystallisation in glass ceramics, liquid-liquid phase separation. Conventional glass fabrication process. Glass formation by sol-gel processes and their application.

Coloured glasses- Redox distribution, Anionic substitution in glass, Absorption spectra of transition metal ions. Radiation shielding of glass, IR absorbing and reflecting glasses. Surface tension, optical & electrical properties, strength of glass, toughening of glass. Glass durability: Mechanism of reactions of glasses with aqueous solutions.

Module 2: Photosensitive and photo conducting glasses. Chalcogenide glass, metallic glass, damage tolerant glass, laser glasses and its application and bio-glasses. Glass-ceramics: glassceramics armour, radioactive waste disposal glasses, machinable glass-ceramics.

Concept of adhesion of vitreous coatings on metal surface. Physico-chemical characteristics of metals and alloys suitable for enamelling. Opacification of glass and its mechanism. Enamelling of gold, silver, copper and other alloys. Deposition of films and high temperature coatings-different method of application and heat sources.

Paper VIII
Course CER 203 **100 marks/4 credits**
Electrical and Electronic Ceramics
Module 1: Insulator Porcelain: high and low tension, constitution and translucency of porcelain. Ceramic colours and stains. Steatite, Cordierite and Lithia Ceramics, Ceramic Insulators. High permittivity Ceramics, Ceramic Substrates, Piezoelectric and Pyroelectric Ceramics, Ferroelectric ceramics and devices, Application and characterization of Varistors, Electro-optic Ceramics, Ceramic Semiconductors, packaging of semiconductor devices.

Module 2: MEMS, integrated circuits, obstacles to integration – thermal, chemical and mechanical factors, overview of other functional devices. Thin film technology, polycrystalline conducting thin films. Deposition and properties of insulating film. Materials for solar cells. Failure analysis, structure and composition of microelectronic materials, Capacitor Ceramics, Ferromagnetic Ceramics, Magnetic recording media, High temperature super conducting ceramics. Metallized Ceramics, Multilayer ceramics, various Sensors and their application.

Paper IX
Course CER 204 **100 marks/4 credits**
Advanced clay-based ceramics and Ceramic Machines
Module 1: Structures, Properties associated with different types of atomic bonds. Geology of

clays. Mixed layered minerals, Chlorites, Attapulgite and Palygorskite. Size and shape of the clay minerals. Factors determining the shape and size in the genesis and diagnosis of clay minerals. Identification and Separation of clay minerals. Electrometric processes, X-ray and infra red method of analysis.

Plasticity of Clays: Relationship with the structures, Different theories relating to plasticity. Rheological behaviour of clays and clay based system: Reiner Riwlin equation. Classification of flow system. Different types of multipoint consistency curves. Thixotropic systems and the flow behaviour. Stability of clay Suspensions: Mechanism of peptization, Role of interaction with the aqueous phase. Particle association in clay suspensions. Technical applications of stability control. Interaction of clay organic compounds.

Nanoclays, Clay-polymer-composites, Layered double hydroxides, Modification of clays and clay minerals properties by thermal, physical and chemical treatments, Synthesis of novel materials (such as zeolites, geopolymers etc.) starting from clay minerals.

Module 2: Equipment of size reduction and grading of ceramic materials. Different types of static and dynamic mixing equipments. Pressure fabrication Machines: Different types of semi-automatic and automatic presses. Vibratory compaction machines. Iso-static and Hot isostatic pressing. Extrusion and pugging machines.

Different types of driers and their design. Machineries used for semi-automatic and automatic fabrication of glass articles. Kilns and Furnaces: Continuous glass tank furnaces, Down and Updraft Kilns, Chamber and Hoffman Kilns, Tunnel Kiln, Rotary Kiln.

Paper X
Lab – III
Course CER 205 **100 marks/4 credits**
Ceramic Engineering Lab
Synthesis & Characterisation of ceramic materials

Processing of some ceramic precursors: Refractory applications of synthetic hydrogels, co-precipitation and sol-gel techniques for ceramic powder preparation. Compaction of single and multicomponent precursors, sintering behavior of fabricated composites. Value added ceramic materials from industrial wastes- fly ash, blast furnace slag, red mud and phospho-gypsum. Preparation of special glasses and glass-ceramics.

Bulk density, Apparent porosity and true porosity. Reheat shrinkage and thermal shock resistance of refractories. Fired strength of some refractory castables. Static slag corrosion resistance of unshaped refractories. Glass-aqueous phase reaction in presence of different solutions. Surface area and particle size distribution of ceramic materials. Determination of dielectric constant, Break-down voltage of ceramic insulator, capacitance. Cation exchange kinetics of clays and synthetic inorganic exchangers. Non-destructive testing of ceramic materials.

Microscopic studies (Optical, SEM, TEM etc.), FTIR, Ultrasonic Testing of ceramic materials.

Third Semester

Paper XI
Course CER 301 **(200+100) Marks/(8+4) credits**

a) **Project Feasibility**

Each student shall be required to submit two bound type written copies of a project report on a proposed chemical plant manufacturing product/products related to one's course/subject to be worked out under the supervision of a faculty member. The report shall include mass and energy balances, type and capacity of equipment selected and recommended, plant layout, feasibility analysis highlighting market survey, pattern of assistance available from the central and state government agencies, bank and financial institutions. Assistance for technology, raw materials, finance.

Legal obligation.

b) The student is to appear in a **Viva-Voce** examination.

Paper XII

Course CER 302 **100 Marks/4 credits**

Seminar

Each student will be required to prepare and submit an assay or review paper on selected technological topic related to subject under the supervision of a faculty member. He/She shall give a talk based on his/her paper before the Seminar. The attendance in the seminar is compulsory for all the students.

Paper XIII

Course CER 303 **100 Marks/4 credits**

General Viva Voce

Fourth Semester

Paper XIV

Course CER 401 **(400+100) Marks/ (15+5) credits**

Research Project

(a) Each student shall be required to carry out under the supervision of a faculty member original investigation on an industrial problem related to subject. He/She shall submit three type-written bound copies of thesis embodying the results of his/her investigations

(b) The student shall defend his/her thesis in a **viva-voce** examination.