POOJYA DODDAPPA APPA COLLEGE OF ENGINEERING, KALABURAGI

Scheme of Teaching and Examinations – 2024

M.Tech., Materials Science and Technology (MST)

Choice Based Credit System (CBCS) and Outcome-Based Education(OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical/Seminar	Tutorial/ Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1	BSC/PCC	24MAT11A	Computational Methods	03	00	00	03	50	50	100	3
2	IPCC/PCC/PBLC	24MST12	Synthesis and Processing of Powders	03	02	00	03	50	50	100	4
3	PCC	24MST13	Advances in Cement Materials	03	00	02	03	50	50	100	4
4	PCC	24MST14	Concepts in Materials Science	02	00	02	03	50	50	100	3
5	PCC	24MST15	Non-Traditional Machining	02	00	02	03	50	50	100	3
6	PCCL	24MSTL16	Cement Testing lab.	01	02	00	03	50	50	100	2
7	PCCL	24MSTL17	Materials Processing and testing Lab.	01	02	00	03	50	50	100	2
8	PCC	**24SEM18**	Technical Seminar	00	01	01	03	100	---	100	1
9	NCMC	24RMI19	Research Methodology and IPR (**Online**)	Online courses (online.vtu.ac.in)							PP
				15	**07**	**07**	**24**	**450**	**350**	**800**	**22**

Note: **BSC**-Basic Science Courses, **PCC**: Professional core.**IPCC**-Integrated Professional Core Courses,**NCMC**- None Credit MandatoryCourse, **PCCL**-Professional Core Course lab **AUD/AEC** –Audit Course / Ability Enhancement Course, **L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities**(Hours are for Interaction between faculty and students)**PBLC**: Project Based Learning Course

Integrated Professional Core Course (IPCC): Refers to a Professional Theory Core Course Integrated with practicals of the same course. The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

Project Based Learning Course (PBLC): Project Based Learning Courseis a professional core Course onlyStudents have to complete a project out of learning from the course and SEE will be viva voce on project work.

Skill development activities:Under Skill development activities in a concerning course, the students should

1. Interact with industry (small, medium, and large).
2. Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.
3. Involve in case studies and field visits/ fieldwork.
4. Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
5. Handle advanced instruments to enhance technical talent.
6. Gain confidence in modeling of systems and algorithms for transient and steady-state operations, thermal study, etc.
7. Work on different software/s (tools) to simulate, analyse and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Students and the course instructor/s to be involved either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of the course teacher can take up relevant technical –activities that will enhance their skills. The prepared report shall be evaluated for CIE marks.

24RMI19-Research Methodology and IPR- None Credit Mandatory Course (NCMC) if students have not studied this course in their undergraduate program then he /she has to take this course at **http://online.vtu.ac.in** and qualifying in this course is compulsory before completion of the minimum duration of the program (Two years), however, this course will not be considered for vertical progression.

Technical Seminar: Students have to finalize the technical topic for the seminar in consultation with a faculty mentor, Preparation of the seminar report, and presentation slides to be presented at the end of the semester.

Course Title: Computational Methods
(Common to PG Str.Engg., Env. Engg., TPE, Prod.Engg.,MST)

Subject Code	24PMAT11A			CIE: 50
Number of Lecture Hours/Week	3 (Theory)	Credits	3	SEE: 50
Total Number of Lecture Hours	40			SEE Hours: 03

Prerequisite: Basic materials science knowledge at the undergraduate level

Course Objective:

Modules	Contents	Teaching Hours
I	**Linear Algebra**: System of Linear Algebraic equations by triangularization method ,Cholesky method, Partitions method, Gauss Jacobi, Gauss- Sidel's method and Power method for eigen values and eigen vectors.(RBT Levels:L1&L2)	**08 Hours**
II	**Roots of equations**: Muller method, Graeffe's root squaring method. Numerical solution of ordinary differential equation by Picards method of successive approximation, first order simultaneous equation by Picard and Runge-Kutta method. Second order equation by Picard's method. (RBT Levels:L2&L3)	**08 Hours**
III	**Partial Differential Equations**: Numerical solution of one dimensional wave equation, Heat equation,(Schmidt's explicit formula) & Laplace equation (Gauss-Seidel process) by finite difference schemes. Illustrative examples on each method. .(RBT Levels:L2&L3)	**08 Hours**
IV	**Probability distribution**: Random variables , probability mass and probability distribution function, Probability distributions: Binomial Normal and Gaussian distributions & examples. (RBT Levels: L2 & L3)	**08 Hours**
V	**Sampling Theory**: Testing of hypothesis: Chi square test and F-test. Analysis of Variance (ANOVA):one way classification, Design of experiments, RBD. (RBT Levels:L2&L3)	**08 Hours**

Course outcomes:
At the end of this course, students will be able to:
CO1. Acquire the idea of significant figures, types of errors during numerical computation.
CO2. Understand statistical and probabilistic concepts required to test the hypothesis and designing the experiments using RBD.
CO3. Learn various numerical methods to solve system of linear equations.
CO4. Understand the roots of algebraic/transcendental equations and solve PDE's numerically.
CO5. Analyze and solve PDE's related to wave equation arising in vibration analysis

Question paper pattern:
Question paper to be framed for hundred marks containing ten questions of twenty marks each and mandatorily two questions from each module. Each question may be split up to maximum four subdivisions. The student to answer mandatorily one full question from each module so that students will answer five questions which maximize marks to one hundred**.**

Reference Books:

1.S.S .Shastry, Introductory Methods of Numerical Analysis , PHI, 2005.
2.David C. Lay, "Linear Algebra and its applications", 3rd Edition , Pearson Education, 2002.
3.T.Veerarajan "Probability, Statistics and Random Process", 3rd Edition, Tata Mc-Graw Hill Co.,2016
4.Kenneth Hoffman and Ray Kunze, "Linear Algebra", 2nd Edition,PHI, 2011
5.B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers,44Th Ed,2017
6.E.Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley,2015

Course Title: Synthesis and Processing of Powders				
Integrated Professional Core Course				
Subject Code	**24MST12**			CIE: 50
Number of Lecture Hours/Week	3 (Theory) 2 (Practical/Seminar)	Credits	4	SEE: 50
Total Number of Hours	50			SEE Hours: 03
Prerequisite: Basic materials science knowledge at the undergraduate level				
Course Objective: To impart knowledge and enable students to understand 1. To conceptualize various techniques and methods adopted for preparation of ceramics, metals and alloys fine particles 2. To establish structure-property correlations by inferring the characteristics of ceramic, metal and alloys fine particles 3. To identify the various processing steps to prepare ceramic/metal powder compact in to sintered products				

Modules	**Contents**	**Teaching Hours**
I	Historical perspective of engineering ceramic evolution and classification of ceramic/metal powder products, category of ceramic raw materials, specifications of ceramic raw materials, significance of objectives of ceramic processing from science and engineering point of view. General ceramic/metal processing flow diagram and steps of manufacturing process units for ceramic and metal powders.	**10 Hours**
II	Ceramic powder preparation methods; Mechanical comminuting, chemical route synthesis such as precipitation, co-precipitation, hydrothermal synthesis, sol-gel technique, solution combustion synthesis and vapor phase reaction. Characterization of powders by X-ray diffraction techniques, Thermal gravimetric analysis, Differential thermal analysis, Dilatometer, Mercury porosimetry, Transmission electron microscopy, density measurement by pyconometric method, specific surface area by physical adsorption of gas at cryogenic temperature (type IV adsorption isotherm) and Fourier transform infrared spectroscopy	**10 Hours**
III	Metal powder preparation methods; mechanical communition of solid materials mechanical alloying. Disintegration of liquid metals and alloys i.e.atomization techniques such as gas atomization, water atomization, centrifugal atomization and atomization limitation. Production of metals powders by reduction of oxides and electrolytic method. Characterization of metal powders; physical characteristics such as particle shape and particle size distribution, surface area analysis, apparent and tap density and compressibility of metal powders.	**10 Hours**

IV	Particle packing characteristics, hindered packing, granulation of ceramic powders, spray-drying and consolidation of ceramic fine powders in to different shapes by various fabrication techniques. Powder compaction and pressureless powder shaping of metal powders. Sintering mechanisms of metals and ceramic powders.	**10 Hours**
V	Colloidal processing of ceramic fine particles, attractive surface forces, electrostatic stabilization, polymeric stabilization, stabilization of ceramic particulate suspension and rheological properties of colloidal suspension and shaping techniques by colloidal processing route and densification. Applications of powder metallurgy and engineering ceramic products	**10 Hours**

Question paper pattern:

Question paper to be framed for hundred marks containing ten questions of twenty marks each and mandatorily two questions from each module. Each question may be split up to maximum four subdivisions. The student to answer mandatorily one full question from each module so that students will answer five questions which maximize marks to one hundred**.**

Text books:

Reference Books:

1. James Reed "Princples of Ceramic Processing" 2nd Editions, Wiley-Blackwel Publishers New York 1995
2. Mohamed N. Rahaman "Ceramic Processing and Sintering" 2nd Edition CRC Press Taylor and Francis group 2013
3. B. K. Datta "Powder Metallurgy" 2nd Edition PHI Learning Pvt Ltd.Delhi 2014

Course outcomes:

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

Course Code	CO #	Course Outcome (CO)	Bloom Level
24MST12	**CO1**	Significance of objectives of science and engineering of ceramic and metals powders.	**L2**
	CO2	Analysis of ceramic fine powders characteristics that are prepared using different techniques	**L4**
	CO3	Correlations of metal powders preparation and characteristics	**L4**
	CO4	Analysis of batch compositions, processing techniques, compaction and sintering of fine powders in to final or desired products	**L4**
	CO5	Analysis and applications of metal, ceramic powders and colloidal processing products.	**L4**

Course Title: Advances in Cement Materials				
Professional Core Course				
Subject Code	**24MST13**			CIE: 50
Number of Lecture Hours/Week	3 (Theory) + 2 (SDA)	Credits	3	SEE: 50
Total Number of Lecture Hours	42			SEE Hours: 03
Prerequisite: Basic materials science knowledge at the undergraduate level				
Course Objective: To impart science and technology of Portland cement and other alternative and newer cementing materials				

Modules	**Contents**	**Teaching Hours**
I	Cement definitions and various types of cement, development of Portland cement, types of Portland cement. General manufacturing process of Portland cement. Calcareous and Argillaceous materials, corrective materials, Portland cement clinker phases, silica modulus, alumnia modulus and lime saturation factor, study of $CaO\text{-}Al_2O_3$ and $CaO\text{-}SiO_2$ binary phase diagram, burnability factors, reaction sequence of cement phase formation, calculations for Portland cement phases. Setting and hardening of Portland cement	**10 Hours**
II	Steps of dry process to manufacture Portland cement; methods of prehomogenization, homogenization, preheaters, precalciners, coolers and dust collectors. Refractory for cement rotary kiln, installation of refractories in rotary kiln.	**8 Hours**
III	Cement quality testing methods; fineness, setting time, density, specific gravity, soundness of cement by Lechatliers apparatus and length comparator autoclave test, heat of hydration test, compressive strength of cement and concrete. Infrared spectroscopy studies of cement and raw materials.	**8 Hours**
IV	Overview of modern grinding practices in cement industries. Advances in special and newer cement: High Alumina cement (HAC); composition and mineralogy, manufacturing, phase formation, hydration of Aluminous phases, hydration of blends of calcium aluminates with additives and setting of HAC.	**8 Hours**
V	Types and properties of fly ash, Portland flyash cement; Heat resistance, hydration and properties of fly ash concrete. Silica fume- a supplementary cementious materials, Rice-husk ash based cement. Review and development of modern cementing materials.	**8 Hours**

Question paper pattern:

Question paper to be framed for hundred marks containing ten questions of twenty marks each and mandatorily two questions from each module. Each question may be split up to maximum four subdivisions. The student to answer mandatorily one full question from each module so that students will answer five questions which maximize marks to one hundred**.**

Text books:

Reference Books:

1. S. N. Ghosh editor "Cement and Concrete Science and Technology" Volume-I part-I, ABI Book Private Ltd New Delhi 1992
2. S. N. Ghosh editor "Cement and Concrete Science and Technology" Volume-I part-II, ABI Book Private Ltd New Delhi 1992
3. S. N. Ghosh editor Mineral Admixture in Cement and Concrete Volume-4, ABI Book Private Ltd New Delhi 1992

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

Course Code	CO #	Course Outcome (CO)
24MST13	CO1	Summarize raw materials composition for manufacturing of Portland cement and determine clinker phase analysis
	CO2	Summarize dry process manufacturing of Portland cement and explain components and working of cement rotary kiln
	CO3	Describe cement testing methods and determine quality of cement
	CO4	Explain various types of cements and their applications
	CO5	Explain analysis of admixture compositions and their effect on cement properties and summarize modern zeolites for cement applicaions

Course Title: Concepts in Materials Science

Subject Code	**24MST14**			CIE: 50
Number of Lecture Hours/Week	3 (Theory)	Credits	3	SEE: 50
Total Number of Lecture Hours	42			SEE Hours: 03

Prerequisite: Basic materials science knowledge at the undergraduate level

Course Objective: To impart knowledge and enable students to understand
a) Types of materials, atomic structure, crystal systems and chemical bonds
b) Crystal Imperfections, diffusion in solids and phase-diagrams
c) Nucleation kinetics solidification and transformations in steel
d) Simple Ceramic and polymeric structures
e) Corrosion, electronic magnetic properties of materials

Modules	**Contents**	**Teaching Hours**
I	Classification of materials, Ceramics, Polymers, Metals & their salient properties, applications, periodic table. Electron configuration, Atomic structure, chemical bonds. Space lattice, Unit cell, crystalline & amorphous materials, crystal systems, Bravis lattices, crystal planes & miller indices Atomic packing efficiencies, density calculations, polymorphism, crystal structure analysis (XRD) and crystal symmetry	**10 Hours**
II	Crystal Imperfections: point, line and volume . Diffusion in solids; Ficks laws of diffusion applications of Ficks laws, Kirkendall effect Phase diagrams (Binary,Ternary) & their applications, lever rule, Al_2O_3-SiO_2, Fe-C, Pb-Sn phase diagrams	**8 Hours**
III	Phase transformation; Nucleation and growth, nucleation kinetics, the growth and overall transformation kinetics and applications, Transformations in steel, precipitation process, solidification and crystallization, the glass transition, recovery recrystallization and grain growth	**8 Hours**
IV	Structural materials - metals, ferrous, non ferrous, polymer. Classification, properties application and processing of ceramics , simple ceramic structures; clay, silicates ,spinel, fluorite etc. Paulings rules for ionic solids	**8 Hours**
V	Corrosion, principles types preventions of corrosion. Electronic, mechanical and magnetic properties of materials. selection of materials and materials design	**8 Hours**

Question paper pattern:
Question paper to be framed for hundred marks containing ten questions of twenty marks each and mandatorily two questions from each module. Each question may be split up to maximum four subdivisions. The student to answer mandatorily one full question from each module so that students will answer five questions which maximize marks to one hundred**.**

Text books:

Williams F Smith, Javad Hashemi and Ravi Prakash, " Materials Science and Engineering" 5th Edition, McGraw Hill Education New Delhi 2014

Reference Books:

1.W.D.Kingery, H.K.Bowen and D.R.Uhlmann “Introduction to Ceramics” WILEY(John Wiley and Sons) Publications

2. Sidney H. Avner "Introduction to Physical Metallurgy" 2nd edition, Tata McGraw Hill Edition

3. V. Raghavan ,"Materials Science and Engineering" Prentice Hall of India Pvt. Ltd

One hour tutorials for demonstration of models of crystals and computation of crystal structure determination techniques

Course Code	CO #	Course Outcome (CO)	Blooms Level
24MST14	**CO1**	Explain Bravis lattice crystal system, chemical bonding, Miller indices planes and directions	**L2**
	CO2	Explain crystal imperfections, diffusion in solids	**L2**
	CO3	Interpretation and computation of binary phase diagram	**L4**
	CO4	Differentiate properties of different kinds of materials	**L4**
	CO5	Analysis and selection of suitable material for given applications	**L4**

24MST15: NON TRADITIONAL MACHING

Course Title: Non-Traditional Machining				
Subject Code	**24MST15**			CIE: 50
Number of Lecture Hours/Week	3 (Theory)	Credits	3	SEE: 50
Total Number of Lecture Hours	42			SEE Hours: 03
Prerequisite: Basic materials science knowledge at the undergraduate level				

Course Objective: To impart knowledge and enable students to understand:

1) Importance of non-traditional machining
2) Abrasive jet machining working methodology, its uses and limitations
3) Working of electrochemical machining process their importance and limitations
4) Working of plasma arc machining and electron beam machining process their advantages and limitations
5) Basic heat transfer, evaporator calculations, drying and dimensional analysis

Modules	**Contents**	**Teaching Hours**
I	Introduction: Need for non-traditional machining processes. Processes selection classification on-comparative study of different processes Ultrasonic Machining - Definition-Mechanism of metal elements of the process-Tool feed mechanism, theories of mechanics of causing effect of parameter applications.	**8 Hours**
II	Abrasive Jet Machining: Principles – parameters of the process applications-advantages and disadvantages. Thermal Metal Removal Processes: Electric discharge machining - Process, Operation principles, electrode material, equipment, Wire cut electro discharge machine, process parameters and their effects, Gap flushing, Operational summery.	**8 Hours**
III	Electro chemical and chemical processes**:** Electro chemical machining (ECM) Classification ECM process-principle of ECM – Chemistry of the ECM parameters of the processes-determination of the metal removal rate – dynamics of ECM process-Hydrodynamics of ECM process-polarization-Tool Design-advantages and disadvantages-applications. Electro Chemical Grinding-Electro Chemical holding Electrochemical deburring. Chemical Machining Introduction-fundamental principle types of chemical machining Maskants-Etchentes-Advantages and disadvantages-applications**.**	**8 Hours**
IV	Plasma Machining: Introduction-Plasma-Generation of Plasma and equipment Mechanism of metals removal, PAN parameters - process characteristics – type of torches applications. Electron beam machining (EBM): Introduction-	**8 Hours**

	Equipment for production of Electron beam – Theory of electron beam machining – Thermal & Non thermal types characteristics – applications**.**	
V	Laser Beam Machining (LBM): Introduction-principle of generation of lasers Equipment and Machining procedure-Types of Lasers-Process characteristics-advantages and limitations-applications. Ion Beam Machining: Introduction-Mechanism of metal removal and associated equipment-process characteristics applications. High Velocity forming process: introduction – development of specific process selection-comparison of conventional and high velocity forming methods – Types of high velocity forming methods-explosion forming process-elector hydraulics forming magnetic pulse forming**.**	**10 Hours**

Question paper pattern:
Question paper to be framed for hundred marks containing ten questions of twenty marks each and mandatorily two questions from each module. Each question may be split up to maximum four subdivisions. The student to answer mandatorily one full question from each module so that students will answer five questions which maximize marks to one hundred**.**

Text books:

Reference books:

1. Chemical process principles (Part 1) – O.A. Hougen, K.M. Watson, R.A. Ragatz, Asia Publishing House.
2. Chemical Process Calculations - D.C. Sarkar, PHI Publications
3. Unit operations of Chemical Engineering (7th Ed.) – W.L. McCabe, J.C. Smith, P. Harriott, McGraw Hill International Ed.
4. Nonconventional Machining - P.K.Mishra, volume-1, Narosa Publishing House, The institution of engineers (India) text book series

One hour tutorials for demonstration of models of crystals and computation of crystal structure determination techniques

Course Code	**CO #**	**Course Outcome (CO)**	**Blooms Level**
24MST15	**CO1**	Identify the basic differences between nontraditional and traditional machining operations.	L1
	CO2	Describe, abrasive and electric discharge machining operations	L2
	CO3	Explain, electro chemical and chemical machining operations	L3
	CO4	Experiment with plasma and electron beam machining methodology	L3, L4
	CO5	Explain, laser beam, ion beam machining methods and high velocity forming methods	L5

Course Title: Cement Testing Laboratory				
Professional Core Course Laboratory				
Subject Code	**24MST176**			CIE: 50
Number of Lecture Hours/Week	1 (Theory) 2 (Practical)	Credits	2	SEE: 50
Total Number of Hours	28			SEE Hours: 03
Prerequisite: Basic materials science knowledge at the undergraduate level				
Course Objective: To impart knowledge and enable students to understand 1. To acquire skills of conducting experiments individually regarding materials preparation and testing				

Experiment No.	**Contents**	**Teaching Hours**
1	Determination of Fineness of Cement	2
II	Determination of consistency of water in cement	2
III	Determination of Initial Setting Time of cement	2
IV	Determination of Final Setting Time of Cement	2
V	Determination of Soundess of Cement by Lechatliers Principles	2
VI	Determination of Soundess of Cement using Autoclave	2
VII	Determination of heat of Hydration of cement	2
VIII	Determination of surface area by Blaine's permeability apparatus	2
IX	Determination of density of cement by Pycnometer method	2
X	Determination of compressive strength of cement mortar	2

Course Title: Materials Testing Laboratory				
Professional Core Course Laboratory				
Subject Code	**24MST17**			CIE: 50
Number of Lecture Hours/Week	1 (Theory) 2 (Practical)	Credits	2	SEE: 50
Total Number of Hours	30			SEE Hours: 03
Prerequisite: Basic materials science knowledge at the undergraduate level				
Course Objective: To impart knowledge and enable students to understand 2. To acquire skills of conducting experiments individually regarding materials preparation and testing				

Experiment No.	**Contents**	**Teaching Hours**
1	Particle size analysis of raw materials	2
II	Determination of Chemically Combined water in clays	2
III	Determination of Loss on Ignition of ceramics materials	2
IV	Determination of Drying Shrinkage of clay bodies /ceramic bodies	2
V	Preparation of clay bodies	2
VI	Preparation of Triaxial bodies	2
VII	Determination of Bulk Density of Ceramic/Metal product	2
VIII	Determination of Apparent Porosity of Ceramic product	2
IX	Determination of Specific Gravity of Ceramic products/raw materials	2
X	Fabrication and sintering of refractory samples	2
XI	Thermal Spalling resistance of refractory samples	2