Syllabus for Open Electives (OE)
in
Integrated Master of Technology (Int. M. Tech.)
Major: Chemical Engineering
and Multidisciplinary Minor (MDM)

(Under the National Education Policy 2020)

(NEP 2020)

in

(2023-2024)

Offered by

INSTITUTE OF CHEMICAL TECHNOLOGY MUMBAI
MARATHWADA CAMPUS, JALNA

(University Under Section-3 of UGC Act, 1956)

Elite Status and Center for Excellence

Government of Maharashtra

BT-5/6, Biotechnology Park, Additional MIDC Area,
Chhatrapati Sambhajinagar (Aurangabad) Road, Jalna: 431 203 (INDIA)

www.ictmumbai.edu.in, www.marj.ictmumbai.edu.in

Tel: (91-22) 3361 1111, Fax: 2414 5614

Syllabus for Open Electives (OE)

Under the New Education Policy (NEP 2020)

in

Biological Sciences

Offered by

INSTITUTE OF CHEMICAL TECHNOLOGY

(University Under Section-3 of UGC Act, 1956)
Elite Status and Center for Excellence
Government of Maharashtra
Nathalal Parekh Marg, Matunga, Mumbai 400 019 (INDIA)
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A. List of Open Electives offered by ICT MARJ on Biology

Subject Code	Semester	Subject	Credit	Hours/ Week			Marks for various Exams			
				L	T	P	CA	MS	ES	Total
BST4251	III	Introduction to Biological Science	2	2	0	0	20	30	50	100
BST4252	IV	Fundamentals of Biochemistry & Microbiology	2	2	0	0	20	30	50	100

B. List of Faculty members who will be engaged in teaching elective courses

Dr. Joyita Sarkar (JS)

C. Faculty members associated with each elective

Sr No	Semester	Course Credits	Name of the course	Faculty
1	III	2	Introduction to Biological Science	JS
2	IV	2	Fundamentals of Biochemistry & Microbiology	JS

D. Evaluation

Theory Courses

Continuous Assessment Test (CAT): Total 20

Flexible (Instructor specific); including but not limiting to Assignments, Quiz, problem statement, written test, presentation, short project, end of the class problem.

Mid semester: Total 30 Marks (Theory paper)

End semester: Total 50 Marks (Theory paper)

Semester III					
	Course Code: **BST4251**	**Course Title:** **Introduction to Biological Sciences**	**Credits 2**		
			L	**T**	**P**
	Semester: III	**Total contact hours: 30**	**2**	**0**	**0**
List of prerequisite courses					
	Fundamentals of Biochemistry & Microbiology, Biochemical Engineering				
List of courses where this course will be prerequisite					
	NA				
Description of relevance of this course in the Int. M. Tech. Program					
To introduce the students to the principles of Biological Sciences and its application.					
	Course contents (topics and subtopics)		**Reqd. hours**		
1	Introduction to cells and microscopy • Eukaryotes and prokaryotes, Cell architecture and organelles • Basic principle of microscopy, Light microscope (bright field, phase contrast, differential interference contrast, dark field, fluorescent, confocal, Electron microscope (scanning and transmission) • Chemical Components of the cell, An outline of some of the types of sugar, Fatty acids and other lipids, The 20 amino acids found in proteins, A survey of the nucleotides The principal types of weak noncovalent bonds		8		
2	Protein Structure and Function • Primary, secondary, tertiary and quaternary structure of protein • Cell breakage and initial fractionation of cell extracts • Protein separation by chromatography Protein analysis by electrophoresis		4		
3	DNA and Chromosomes • Structure of DNA, RNA and chromosomes • DNA replication, repair and recombination • From DNA to Protein: Transcription and Translation Control of Gene Expression		6		
4	Cellular Energetics • Energetics and Metabolism, Redox potentials • Glycolysis and citric acid cycle Energy Generation in Mitochondria and Chloroplasts		4		
5	Cell Division • Checkpoints of cell division and mitosis • Meiosis Sex and Genetics		4		
6	Cell communities • Extracellular matrix • Tissues • Stem cells Cancer		4		
	Total		**30**		
List of Textbooks/ Reference Books					
1	Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander D. Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. Essential Cell Biology, 2019				
2	Eduardo D.P.De Robertis, E.M.P.De Robertis. Cell and Molecular Biology, 2017				
Course Outcomes (students will be able to….)					
CO1	Learn structural and functional aspects of cell; the basic unit of life, and its different organelles and working of a cell as a factory.		K1		
CO2	Understand structure and functional aspects of macromolecules of cells		K2		

CO3	Understand different types of cell metabolism, their regulation and correlate with cellular energetics	K2
CO4	Learn the fundamental of cell division and cell communities	K1
CO5	Understand the application of biological science in industry, social, etc.	K1
K1: Remembering, K2: Understanding, K3: Applying, K4: Analyzing, K5: Evaluating, K6: Creating		

Introduction to Biological Sciences: BST4251
Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1	1	2	1	1	2	1	1
CO2	3	2	2	2	1	1	2	1	1	1	1	-
CO3	3	2	2	2	1	1	2	1	1	1	-	-
CO4	3	2	2	2	1	1	2	1	1	1	1	1
CO5	3	2	2	2	1	1	2	1	1	1	-	-
3-Strong Contribution; 2-Moderate Contribution; 1-Low Contribution;												

Introduction to Biological Sciences: BST4251
Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	1	-
CO2	2	1	2	1	-
CO3	1	2	3	2	1
CO4	2	2	3	2	1
CO5	3	2	2	1	-
3-Strong Contribution; 2-Moderate Contribution; 1-Low Contribution;					

<table>
<tr><th colspan="6">Semester IV</th></tr>
<tr><td rowspan="2"></td><td>Course Code:
BST4252</td><td>Course Title:
Fundamentals of Biochemistry & Microbiology</td><td colspan="3">Credits 2</td></tr>
<tr><td>Semester: IV</td><td>Total contact hours: 30</td><td>L
2</td><td>T
0</td><td>P
0</td></tr>
<tr><th colspan="6">List of prerequisite courses</th></tr>
<tr><td></td><td colspan="3">Introduction to Biological Sciences (BST4251)</td><td colspan="2"></td></tr>
<tr><th colspan="6">List of courses where this course will be prerequisite</th></tr>
<tr><td></td><td colspan="3">Food Additives and Toxicology, Food Preservation & Packaging, Food Analysis Lab, Biochemical Engineering</td><td colspan="2"></td></tr>
<tr><th colspan="6">Description of relevance of this course in the Int. M. Tech. Program</th></tr>
<tr><td colspan="6">To introduce the students to the Fundamentals of Biochemistry & Microbiology.</td></tr>
<tr><td></td><td colspan="4">Course contents (topics and subtopics)</td><td>Reqd. hours</td></tr>
<tr><td>1</td><td colspan="4">Introduction to basic concepts of biochemistry and microbiology, Applications of biochemistry and microbiology in food and pharmaceutical industries</td><td>2</td></tr>
<tr><td>2</td><td colspan="4">Enzymology
• Enzymes- definition, structure, function, nomenclature, classification. mechanism of action, specificity
• Enzyme kinetics and inhibition (competitive, non-competitive)
• Catalytic and regulatory strategies of enzymes
Allosteric enzymes</td><td>6</td></tr>
<tr><td>3</td><td colspan="4">Metabolic pathways
• Glycolysis and Citric acid cycle, Gluconeogenesis, Glycogen Metabolism, Oxidative phosphorylation
• Fatty acid metabolism, Lipid biosynthesis
• Protein Turnover and amino acid catabolism, amino acid synthesis
Nucleotide biosynthesis</td><td>8</td></tr>
<tr><td>4</td><td colspan="4">Inborn errors in metabolism; Hormones and its roles</td><td>2</td></tr>
<tr><td>5</td><td colspan="4">Introduction to Microbiology
• Major groups of microorganisms
• Components of microbial cell: Cell wall, Inclusion bodies, Capsule, slime layer & S-layer, Pili and fimbrae, Flagella, Endospore
• Nutrient requirements of microorganisms: Nutritional types, Media
Isolation of pure culture: Streak plate, spread plate and pour plate technique</td><td>6</td></tr>
<tr><td>6</td><td colspan="4">Microbial growth
• The growth curve, measurement of cell numbers and cell mass
• Influence of environmental factors on growth: Extremophiles (Solute and water activity, pH, Temperature, Oxygen concentration, Pressure)
• Control of microbial growth, physical and chemical antimicrobial agents
Antimicrobial chemotherapy, Different types of antibiotics, Determining level of antimicrobial activity, MIC, MBC, zone of inhibition.</td><td>6</td></tr>
<tr><td></td><td colspan="4">Total</td><td>30</td></tr>
<tr><th colspan="6">List of Textbooks/ Reference Books</th></tr>
<tr><td>1</td><td colspan="4">Prescott's Microbiology 11th Edition, Joanne Willey, Kathleen Sandman, Dorothy Wood; McGraw-Hill Education (2019)</td><td></td></tr>
<tr><td>2</td><td colspan="4">Biochemistry, Jeremy M. Berg , Lubert Stryer , John Tymoczko , Gregory Gatto; WH Freeman; 9th ed. 2019 edition</td><td></td></tr>
<tr><th colspan="6">Course Outcomes (students will be able to….)</th></tr>
<tr><td>CO1</td><td colspan="4">Acquire basic and applied understanding of biochemistry and microbiology</td><td>K1</td></tr>
<tr><td>CO2</td><td colspan="4">Interpret enzyme kinetics data and calculate enzyme parameters</td><td>K2</td></tr>
<tr><td>CO3</td><td colspan="4">Correlate metabolic pathways with disorders</td><td>K2</td></tr>
<tr><td>CO4</td><td colspan="4">Articulate microbial growth and its pathways</td><td>K1</td></tr>
<tr><td colspan="6">K1: Remembering, K2: Understanding, K3: Applying, K4: Analyzing, K5: Evaluating, K6: Creating</td></tr>
</table>

Fundamentals of Biochemistry & Microbiology: BST4252 Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	2	3	1	1	1	-	-
CO2	3	3	3	2	2	2	3	1	1	2	1	2
CO3	3	3	3	2	2	2	3	1	1	2	1	2
CO4	3	3	3	2	2	2	3	1	1	1	2	1
3-Strong Contribution; 2-Moderate Contribution; 1-Low Contribution;												

Fundamentals of Biochemistry & Microbiology: BST4252 Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	1	3	2	1
CO2	1	1	2	2	-
CO3	2	3	3	1	2
CO4	1	3	3	1	-
3-Strong Contribution; 2-Moderate Contribution; 1-Low Contribution;					

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Syllabus for Open electives in Chemical Sciences
(Under the New Education Policy (NEP 2020))
in
(2023-2024)

List of Open Electives (Chemical Sciences)

Subject Code	Semester	Course Title	Credits	Hrs/Week			Marks for various Exams			
				L	T	P	CA	MS	ES	Total
CHT4251	III	Analytical Chemistry	02	2	0	0	20	30	50	100
CHP4251	III	Analytical Chemistry Laboratory	02	0	0	4	20	30	50	100
CHT4252	IV	Advanced Analytical Chemistry	02	2	0	0	20	30	50	100

Open Elective Course – Instructor

- Analytical Chemistry: Dr. M. M. Jadhao
- Analytical Chemistry Lab: Dr. M. M. Jadhao
- Advanced Analytical Chemistry: Dr. M. M. Jadhao

Semester III					
	Course Code: CHT4351	**Course Title:** Analytical Chemistry	**Credits 2**		
			L	**T**	**P**
	Semester: III	**Total contact hours: 30**	**2**	**0**	**0**
List of prerequisite courses					
	Standard XII Chemistry				
List of courses where this course will be prerequisite					
	This course will be prerequisite for Advance analytical Course (Sem IV), Design and Analysis of Experiments. Course is also required for In-plant training (IPT).				
Description of relevance of this course in the Int. M. Tech. Program					
Analytical Chemistry is a vital component of the Int. M. Tech. Program program, imparting essential skills for precise measurement and quality control. It equips students to excel in industries like pharmaceuticals and petrochemicals, where accurate analysis is crucial for product quality and compliance. This course ensures a seamless integration of theoretical knowledge and practical applications, preparing students for impactful contributions in chemical engineering.					
	Course contents (topics and subtopics)		**Reqd. hours**		
1	**Introduction to Analytical Chemistry:** Concepts: Accuracy, Precision, Qualitative and Quantitative Analysis, Analytical Perspective and Chemical Concentrations Emphasis on Good Laboratory Practices		4		
2	**Errors in Analysis:** Statistical Treatment of Experimental Results (definition of mean, median, mode, variance, standard deviation, standard error) need for performing replicates/repeats, reproducibility. Classification and sources of errors, error propagation, scientific reporting data (significant figures), error curves		4		
3	**Conventional Methods of Analysis:** Classical Techniques Volumetric and Gravimetric Methods Principle and applications of titration Techniques: Colorimetric, Conductometric, Potentiometric, Complexometric, Precipitation titrations		8		
4	**Spectroscopic Methods:** Principles of Spectroscopy, Instrumentation: UV-Vis Spectrophotometer, Applications: Practical Examples of UV-Vis Spectrophotometry		6		
5	**Chromatographic Separation Methods:** General Principle of Chromatography Techniques: Paper, Thin Layer, Ion Exchange Chromatography		4		
6	**Modern Techniques:** HPLC, GC Principle, Instrumentation, Applications		4		
	Total		**30**		
List of Textbooks/ Reference Books					
1	Fundamentals of Analytical Chemistry by D. A. Skoog, D. M. West, F. James Holler and S. R. Crouch, Cengage Learning, 2014.				
2	Principles of Instrumental Analysis by D. A. Skoog, F. James Holler and S. R. Crouch, Cengage Learning, 2007				
3	Instrumental methods of analysis, B. Sivasankar, Oxford University Press				
4	Vogel's Textbook of quantitative chemical analysis, J. Mendham, Pearson Education; 6th edition, 2009.				
5	Analytical Chemistry: A Chemist and Laboratory Technician's Toolkit, Aihui MaHam, Bryan M. Ham, Wiley; 1st edition, 2015.				
6	Instrumental methods of Chemical Analysis, E.W. Ewing, McGraw Hill.				
Course Outcomes (students will be able to….)					
CO1	Demonstrate a solid understanding of foundational analytical chemistry concepts and principles.		K1		
CO2	Apply Good Laboratory Practices (GLP) for reliable and reproducible analytical results, addressing errors and enhancing accuracy.		K4		
CO3	Utilize statistical methods for analyzing and interpreting experimental data.		K4		

CO4	Proficiently apply classical and titration techniques for practical analysis.	K4
CO5	Gain proficiency in both classical and modern chromatographic separation methods, understanding their principles and applications.	K4
K1: Remembering, K2: Understanding, K3: Applying, K4: Analyzing, K5: Evaluating, K6: Creating		

Analytical Chemistry: CHT4351
Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	0	1	1	3	1	1	1	-	-
CO2	3	3	2	2	2	2	3	1	1	2	1	2
CO3	1	1	1	0	1	1	3	1	1	2	1	2
CO4	1	2	2	0	1	1	3	1	1	1	2	1
CO5	2	2	2	1	3	3	3	1	1	1	1	1
3-Strong Contribution; 2-Moderate Contribution; 1-Low Contribution;												

Analytical Chemistry: CHT4351
Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	2	2	1
CO2	1	1	1	2	1
CO3	2	2	2	1	2
CO4	3	2	1	1	1
CO5	2	1	2	1	2
3-Strong Contribution; 2-Moderate Contribution; 1-Low Contribution;					

Semester III					
	Course Code: CHP4351	**Course Title:** Analytical Chemistry Laboratory	**Credits 2**		
			L	**T**	**P**
	Semester: III	**Total contact hours: 30**	**0**	**0**	**4**
List of prerequisite courses					
	Standard XII Chemistry				
List of courses where this course will be prerequisite					
	This course will be prerequisite for Advance analytical Course (Sem IV), Design and Analysis of Experiments. Course is also required for In-plant training (IPT).				
Description of relevance of this course in the Int. M. Tech. Program					
Analytical Chemistry is a vital component of the Chem. Engg. program, imparting essential skills for precise measurement and quality control. It equips students to excel in industries like pharmaceuticals and petrochemicals, where accurate analysis is crucial for product quality and compliance. This course ensures a seamless integration of theoretical knowledge and practical applications, preparing students for impactful contributions in chemical engineering.					
	Course contents (topics and subtopics)		**Reqd. hours**		
	• Experiments based on Preparation and standardization of volumetric solutions. • Determination of alkalinity of water samples by volumetric titrations. • To determine the Ca concentration by complexometric titration • To determine the Ni concentration by Gravimetric analysis. • Potentiometric titration: Determination of the strength of weak and strong acids in a mixture of acids. • Conductometric titration: Determination of total dissolved sulphate in water sample • Determination of critical micelle concentration (cmc) of a surfactant • Use of pH meter- Use of a pH meter to determine dissociation constant of an acid, isoelectric point of an amino acid. • UV-Vis spectroscopy: i) to find out the absorption maxima, ii) Beers Lambert Law verification and iii) concentration of a substance from a given sample. • Separation of organic compounds by Thin layer chromatography. • Gas Chromatography: Determination of concentration of a known organic compound in a suitable solvent. • High pressure liquid Chromatography (HPLC) Determining the concentration of an active ingredient in a marketed product, for Example: caffeine (food products), vitamin C, paracetamol (pharmaceutical product), and the like.		4 hr for each Practicals		
	Total		**30**		
List of Textbooks/ Reference Books					
1	Instrumental methods of Chemical Analysis, E.W. Ewing, McGraw Hill.				
2	Instrumental methods of analysis, B. Sivasankar, Oxford University Press				
3	Vogel's Textbook of quantitative chemical analysis, J. Mendham, Pearson Education; 6th edition, 2009.				
Course Outcomes (students will be able to….)					
CO1	Demonstrate practical expertise in classical titration methods.		K3		
CO2	Apply principles of spectroscopic and chromatographic methods for qualitative and quantitative analysis.		K4		
CO3	Able to clearly communicate the results of experimental work in oral and written formats.		K4		
CO4	Modify existing protocols or evolve robust analytical procedures / protocols to address the limitations of current methods		K4		
K1: Remembering, K2: Understanding, K3: Applying, K4: Analyzing, K5: Evaluating, K6: Creating					

Analytical Chemistry Laboratory: CHP4351 Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	0	1	1	3	1	1	1	-	-
CO2	3	3	2	2	2	2	3	1	1	2	1	2
CO3	1	1	1	0	1	1	3	1	1	2	1	2
CO4	1	2	2	0	1	1	3	1	1	1	2	1
3-Strong Contribution; 2-Moderate Contribution; 1-Low Contribution;												

Analytical Chemistry Laboratory: CHP4351 Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	2	2	1
CO2	1	1	1	2	1
CO3	2	2	2	1	2
CO4	3	2	1	1	1
3-Strong Contribution; 2-Moderate Contribution; 1-Low Contribution;					

Semester IV					
	Course Code: CHT4352	**Course Title:** Advanced Analytical Chemistry	**Credits 2**		
			L	**T**	**P**
	Semester: IV	**Total contact hours: 30**	**2**	**0**	**0**
List of prerequisite courses					
	Analytical Chemistry (CHT4351)				
List of courses where this course will be prerequisite					
	This course is a prerequisite for subjects such as Material Technology. It proves highly beneficial for Int.-M. Tech students, particularly during their master's thesis, as it equips them with essential skills for material characterizations.				
Description of relevance of this course in the Int. M. Tech. Program					
The course introduces the students to advanced analytical techniques with a particular focus on techniques related to materials characterization. The knowledge gained in the course will have relevance to many industrial and R&D applications.					
	Course contents (topics and subtopics)		**Reqd. hours**		
1	**Emission Spectroscopy:** Electronic transition, Jablonski diagrams: radiative and non-radiative processes, energy diagram, internal conversion, Frank Condon principle, Kasha's rule, and solvent effect, and Stokes Shift, fluorescence quenching, lifetime and quantum yield. Application in biological and chemical industry.		6		
2	**Thermal methods:** Principle, different methods of thermal analysis, Principles and instrumentation of thermogravimetric analysis (TGA), Differential Thermal Analysis (DTA) and Differential Scanning Calorimetry (DSC), Interpretation of data – thermogram and information from thermogram, factors affecting, thermogram, applications with examples, thermometric titrations, Evolved gas analysis		8		
3	**Structural analysis using X-ray diffraction:** Principle, Theory- X-ray spectral lines, X-ray tube, X-ray emission, Absorptive apparatus: Sources, Collimation, sample handling, wavelength dispersive devices, Energy dispersive devices, detectors, readout device, Principle instrumentation, Bragg's law, crystal lattices, related parameters, example's structure analysis		8		
4	**Surface Analysis / Imaging Methods:** Electron microscopy, scanning electron microscopy (SEM) -solid and liquid sample preparation, morphology. Principle and examples of application for EDS and TEM Principle, instrumentation, and applications of Atomic Force Microscopy (AFM)		8		
	Total		**30**		
List of Textbooks/ Reference Books					
1	Instrumental Methods of Chemical Analysis by Willard, Dean and Merritte- Sixth edition, Wadsworth Publishing, USA				
2	Quantitative Analysis by R. A. Day and A. L. Underwood, Prentice Hall of India, 2001.				
3	Fundamentals of Analytical Chemistry by D. A. Skoog, D. M. West, F. James Holler and S. R. Crouch, Cengage Learning, 2014				
4	Patrick Echlin, Handbook of sample preparation for scanning electron microscopy and X-ray microanalysis, DOI: 10.1007/978-0-387-85731-2				
5	David Williams, Berry Carter, Transmission electron microscopy**,** Volume- I, II, II & IV. Springer				
6	Electron microscopy in the study of material, P. J Grundy, and G. A Jones, Edward Arnold				
Course Outcomes (students will be able to….)					
CO1	Understand application of molecular emission techniques for biological and material characterization		K3		
CO2	Describe the fundamental concepts related to surface analysis techniques		K1		
CO3	Apply principles of thermal methods for interpretation of data and practical applications		K3		
CO4	Demonstrate proficiency in structural analysis using SEM, TEM and X-ray diffraction.		K4		

CO5	Analyze the data to identify any potential sources of errors and plausible ways to minimize the same	K4
K1: Remembering, K2: Understanding, K3: Applying, K4: Analyzing, K5: Evaluating, K6: Creating		

Advanced Analytical Chemistry: CHT4352
Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	2	2	1	1	3	1	1
CO2	2	1	2	2	1	1	3	2	1	2	2	1
CO3	2	2	1	1	1	2	2	2	2	1	1	2
CO4	2	3	2	3	2	3	2	2	1	1	2	2
CO5	1	1	1	2	2	2	2	1	2	1	1	1
3-Strong Contribution; 2-Moderate Contribution; 1-Low Contribution;												

Advanced Analytical Chemistry: CHT4352
Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	3	1	1
CO2	3	2	2	3	2
CO3	3	2	2	1	1
CO4	2	2	2	1	1
CO5	2	1	2	1	1
3-Strong Contribution; 2-Moderate Contribution; 1-Low Contribution;					

*****

Syllabus for Open Electives (OE)

Under the New Education Policy (NEP 2020)

in

Applied Mathematics

Offered by

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Syllabus for Open electives in Chemical Sciences
(Under the New Education Policy (NEP 2020))
in
(2023-2024)

Open Elective offered by the Department of Mathematics:

Subject Code	Semester	Subject	Credits	Hours/ Week			Marks for various Exams			
				L	T	P	CA	MS	ES	Total
MAT4251	**IV**	**Mathematical Modelling**	**2**	2	0	0	20	30	50	**100**

Note:

This elective - Mathematical Modelling (MAT4251) is available for all Integrated M Tech students having cleared Mathematics-I, Mathematics-II from first year.

Course Instructor: Dr. Sandeep P Bhairat (SPB)

Semester IV					
	Course Code: MAT4251	**Course Title:** Mathematical Modelling	**Credits 2**		
			L	**T**	**P**
	Semester: IV	**Total contact hours: 30**	**2**	**0**	**0**
List of prerequisite courses					
	Mathematics – I (MAT4151), Mathematics – II (MAT4252)				
List of courses where this course will be prerequisite					
	Nil				
Description of relevance of this course in the Int. M. Tech. Program					
This course enables the students to apply the theory of ordinary and partial differential equations to solve real life problems arising from engineering, biology, medicine etc.					
	Course contents (topics and subtopics)		**Reqd. hours**		
1	Introduction to Mathematical modelling using linear and nonlinear discrete dynamical systems: qualitative analysis of discrete dynamical systems, One dimensional map, two dimensional maps, Lyapunov exponents and chaotic attractor, examples from engineering and natural sciences.		8		
2	Qualitative analysis of mathematical models governed by differential equations: Planar Systems: Canonical forms, Eigenvectors defining stable and unstable manifolds, Phase portraits, Linearization and Hartman's theorem, Construction of phase plane diagram, Lyapunov functions, applications to natural and engineering sciences		8		
3	Stability analysis for mathematical models: Equilibrium points and their classifications, Lyapunov and asymptotic stability. Limit cycles: Existence and uniqueness of limit cycles in the plane, stability of limit cycles, Poincare- Bendixson theorem, worked examples from chemical kinetics, ecology, disease models		8		
4	Elements of bifurcation theory and applications to analyze mathematical models: diverse types of bifurcations and their analysis using computational software tools		6		
	Total		**30**		
List of Textbooks/ Reference Books					
1	Sandip Banerjee, 2022, Mathematical Modelling: Models, Analysis and Applications, Second Edition, CRC Press				
2	Stephen Lynch, 2014. Dynamical Systems with Applications using MATLAB. Springer.				
3	Yuri A. Kuznetsov, 1998. Elements of Applied Bifurcation Theory, Second Edition, Springer.				
4	L. Perko, Differential Equations and Dynamical Systems, Vol. 7, 2nd Ed., Springer Verlag.				
5	Reinhard Illner, C. Sean Bohun, Samantha McCollum, Thea Van Roode, 2005, Mathematical Modelling: A Case studies approach, American Mathematical Society.				
6	James T Sandefur, Discrete dynamical systems Theory and applications, Clarendon press.				
7	M W Hirsch and S Smale - Differential Equations, Dynamical Systems, Academic.				
8	R. Clark Robinson. An Introduction to Dynamical Systems Continuous and Discrete, Second edition. American Mathematical Society, Rhode Island.				
9	Rudiger Seydel, Practical Bifurcation and Stability analysis. Springer (3rd Ed).				
10	Alligood, Sauer, and Yorke. Chaos: An Introduction to Dynamical Systems. Springer, Springer-Verlag New York.				
Course Outcomes (students will be able to….)					
CO1	Construct mathematical models for real life problems		K3		
CO2	Analyze the qualitative features of mathematical models using techniques from dynamical systems		K5		
CO3	Perform local and global stability analysis of the mathematical models		K6		
CO4	Perform local and global bifurcation analysis for nonlinear systems.		K6		
CO5	Use symbolic mathematical software to analyze the mathematical models		K6		
K1: Remembering, K2: Understanding, K3: Applying, K4: Analyzing, K5: Evaluating, K6: Creating					

Mathematical Modelling: MAT4251 Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	2	2	1	1	3	1	1
CO2	2	1	2	2	1	1	3	2	1	2	2	1
CO3	2	2	1	1	1	2	2	2	2	1	1	2
CO4	2	3	2	3	2	3	2	2	1	1	2	2
CO5	1	1	1	2	2	2	2	1	2	1	1	1
3-Strong Contribution; 2-Moderate Contribution; 1-Low Contribution;												

Mathematical Modelling: MAT4251 Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	3	1	1
CO2	3	2	2	3	2
CO3	3	2	2	1	1
CO4	2	2	2	1	1
CO5	2	1	2	1	1
3-Strong Contribution; 2-Moderate Contribution; 1-Low Contribution;					

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Syllabus for Open Electives (OE)

Under the New Education Policy (NEP 2020)

in

Physics

Offered by

INSTITUTE OF CHEMICAL TECHNOLOGY

(University Under Section-3 of UGC Act, 1956)
Elite Status and Center for Excellence
Government of Maharashtra
Nathalal Parekh Marg, Matunga, Mumbai 400 019 (INDIA)
www.ictmumbai.edu.in, Tel: (91-22) 3361 1111, Fax: 2414 5614

Syllabus for Open electives in Chemical Sciences
(Under the New Education Policy (NEP 2020))
in
(2023-2024)

The maximum number of students enrolling will be limited to 60 for any open elective offered by the Department of Physics.

Eligibility:
The students enrolled for a minor degree programme in Materials Science will **not be allowed** to take following open elective courses:

1. Applied Physics-II (MAT 1301)
2. Introduction to Materials Physics (MAT 1401)

Some of the courses have their **individual eligible criteria**, kindly check before enrolling.

Open Electives offered by the Physics Department							
Sr. No.	**Subject Code**	**Course**	**Credits**	**Semester**	**L**	**T**	**P**
1.	PST4251	Engineering Physics	2	III	2	-	-
2.	PST4252	Introduction to Materials Physics	2	IV	2	-	-

L= lecture; T= tutorial; P= Practical;

Semester III					
	Course Code: PST4251	**Course Title:** Engineering Physics	**Credits 2**		
			L	**T**	**P**
	Semester: III	**Total contact hours: 30**	**2**	**0**	**0**
List of prerequisite courses					
	10+2 level Physics, Applied Physics-I				
List of courses where this course will be prerequisite					
	Materials Technology (Sem-VI), Materials Science Minor program courses (Sem-III - VII)				
Description of relevance of this course in the Int. M. Tech. Program					
This course enables the students to apply the knowledge of engineering physics.					
	Course contents (topics and subtopics)		**Reqd. hours**		
1	**Quantum Mechanics** Introduction to quantum physics blackbody radiation, explanation using the photon concept, photoelectric effect, Compton effect, DE Broglie hypothesis, wave-particle duality, Born's interpretation of the wave function, verification of matter waves, uncertainty principle, Schrodinger wave equation, particle in box, quantum harmonic oscillator, hydrogen atom (no detailed derivation), tunnelling effect and scanning tunnelling microscopy, probe microscopy		10		
2	**Fluid Mechanics** 2.1 Basic concepts of density and pressure in a fluid, ideal and real fluids 2.2 Pascal's law, absolute pressure, and pressure gauges 2.3 Basic concepts of surface tension and buoyancy 2.4 Equation of continuity, Bernoulli's equation 2.5 Viscosity, Newton's Law of viscosity, non-Newtonian fluids		5		
3	**Fibre Optics:** Introduction, optical fibre as a dielectric wave guide: total internal reflection, numerical aperture and various fibre parameters, losses associated with optical fibres, step and graded index fibres, application of optical fibres.		4		
4	**Lasers:** 4.1 Introduction to interaction of radiation with matter, principles and working of laser 4.2 population inversion, pumping, various modes, threshold population inversion 4.3 types of lasers: solid state, semiconductor, gas 4.4 Holography and engineering applications		7		
5	**Ultrasound: 5.1 I**ntroduction, Generation of ultrasound: mechanical, electromechanical transducers 5.2 Propagation of ultrasound, attenuation, velocity of ultrasound and parameters affecting it, measurement of velocity 5.3 Applications of ultrasound		4		
	Total		**30**		
List of Textbooks/ Reference Books					
1	Fundamentals of Modern Physics, Robert Martin Eisberg, 1961, John Wiley.				
2	Fundamentals of Physics - Halliday, Resnick, Walker - 6th Edition - John Wiley				
3	Sears and Zeemansky's University Physics - Young and Freedman - 12th Edition - Pearson Education				
4	A Textbook of Engineering Physics, MN Avadhanulu, PG Kshirsagar, TVS Arunmurthy, S. Chand.				
5	Engineering Physics - V Rajendran - 6th Edition - McGraw Hill Publishers				
Course Outcomes (students will be able to….)					
CO1	Understand basic concepts of Quantum mechanics		K2		
CO2	Understand basic principles of Fluid Mechanics.		K3		
CO3	Explain basics of optical fibre analyzed the NA.		K3		
CO4	Understand the principle of LASER and classify the diverse types of LASERS		K3		
CO5	Understand the method for generation of ultrasonic wave and its measurement. Understand the concept for various applications.		K2		
K1: Remembering, K2: Understanding, K3: Applying, K4: Analyzing, K5: Evaluating, K6: Creating					

Engineering Physics: PST4251 Mapping of Course Outcomes (COs) with Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	2	3	2	-	-	2	1
CO2	3	2	2	2	2	2	3	2	1	2	2	1
CO3	3	2	2	2	2	3	2	2	-	-	2	2
CO4	2	3	2	3	2	2	3	2	1	-	2	
CO5	3	2	2	3	2	3	2	2	2	1	1	1
3-Strong Contribution; 2-Moderate Contribution; 1-Low Contribution;												

Engineering Physics: PST4251 Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)					
	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	2	3	2
CO2	2	2	2	3	2
CO3	2	2	3	2	2
CO4	3	2	2	3	2
CO5	3	2	3	2	2
3-Strong Contribution; 2-Moderate Contribution; 1-Low Contribution;					

Semester IV					
	Course Code: PST4252	**Course Title:** Introduction to Materials Science	**Credits 2**		
			L	**T**	**P**
	Semester: IV	**Total contact hours: 30**	**2**	**0**	**0**
List of prerequisite courses					
	Applied Physics (PHT4151), Engineering Properties of Materials				
List of courses where this course will be prerequisite					
	Introduction to Nanophysics and Applications, Introduction to Polymer Physics, Ceramic Science and Technology				
Description of relevance of this course in the Int. M. Tech. Program					
This course enables the students to apply the knowledge of material Science.					
	Course contents (topics and subtopics)		**Reqd. hours**		
1	**Classification and properties of materials:** Classification of materials: metals, intermetallic, metallic alloys, ceramics, polymers, composites, silicates, carbon-based materials. Bonding-structure-property correlations to classify materials. Significant properties of materials: mechanical (defects and their implications to mechanical behavior), physical (electrical, optical, etc.), chemical, thermal etc.		05 05		
2	**Overview of smart materials and structures:** Classification of smart materials, Components of a smart system, Applications of smart materials. Piezoelectricity, Piezo-resistivity, Electro strictive materials, Electro-rheological fluids, Chromic materials, Conductive polymer, Shape memory alloys, Shape memory ceramics and polymers. Principles of magnetostriction, Magneto rheological fluids, Materials for energy applications: energy harvesting, conversion, and energy storage.		05 10 05		
	Total		**30**		
List of Textbooks/ Reference Books					
1	1) Materials Science and Engineering: An Introduction by William Callister & David Rethwisch., Wiley, 2013				
2	Smart Structures and Materials by Brian Culshaw, Artech House Publishers, 2004				
3	Smart Structures by Gauenzi, P., Wiley, 2009.				
4	Ultrasonic methods and application by Jack Blitz., Newnes-Butterworth, 1971				
Course Outcomes (students will be able to….)					
CO1	Identify and classify distinct types of materials based on their composition, structure, and properties.		K4		
CO2	Understand the underlying principles governing the material properties.		K2		
CO3	Gain exposure to various smart materials and their technological applications		K2		
CO4	Analyze correlations between properties of materials and their microstructures.		K3		
CO5	Select appropriate smart materials for specific applications		K4		
K1: Remembering, K2: Understanding, K3: Applying, K4: Analyzing, K5: Evaluating, K6: Creating					

Introduction to Materials Science: PST4252
Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	3	3	3	3	2	2	2
CO2	2	2	2	2	3	2	2	2	2	2	2	3
CO3	2	2	3	2	2	2	2	2	2	3	2	2
CO4	2	3	2	3	2	2	3	2	3	2	3	2

CO5	3	3	2	3	3	3	3	3	3	2	3	3
3-Strong Contribution; 2-Moderate Contribution; 1-Low Contribution;												

Introduction to Materials Science: PST4252
Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2
CO2	2	2	2	2	3
CO3	2	2	3	2	2
CO4	2	3	2	3	2
CO5	3	3	2	3	3
3-Strong Contribution; 2-Moderate Contribution; 1-Low Contribution;					