DEPARTMENT OF CHEMISTRY
INDIAN INSTITUTE OF TECHNOLOGY, DELHI
New Delhi-16

REVISED SYLLABUS FOR
"MSc. IN CHEMISTRY"

Name of the Programme	**"MSc. in Chemistry"**			
Name of the Department offering the Programme	**Chemistry**			
Distribution of Total Credits:				
Program core PC	**Program/Open elective PE/OE**	**Total Credits**		
60	**15**	**75**		
Semester wise Distribution of credits				
Sem I	**Sem II**	**Sem III**	**Sem IV**	**Total Credits**
19	**22**	**18**	**16**	**75**

MSc. in Chemistry

Semester	Courses (Number, Abbreviated title, L-T-P, credits)								Lecture Courses	Contact h/week				Credits
										L	T	P	Total	
I	**CML511** *Physical I:* Quantum Chemistry (3-0-0) 3	**CML512** *Organic I:* Stereo-chemistry & Organic Reaction Mechanisms (3-0-0) 3	**CML513** *Organic II:* Photo-chemistry & Pericyclic Reactions (3-0-0) 3	**CML514** *Inorganic I:* Main Group Chemistry (3-0-0) 3	**CML515** *Analytical:* Instrumental Methods of Analysis (3-0-0) 3	**----**	**CMP511** *Lab I* (0-0-4) 2	**CMP512** *Lab II* (0-0-4) 2	5	15	0	8	23	**19**
II	**CML521** *Physical II:* Molecular Thermo-dynamics (3-0-0) 3	**CML522** *Physical III:* Chemical Dynamics & Surface Chemistry (3-0-0) 3	**CML523** *Organic III:* Organic Synthesis (3-0-0) 3	**CML524** *Inorganic II:* Transition and Inner Transition Metal Chemistry (3-0-0) 3	**CML525** *Inorganic III:* Basic Organo-metallic Chemistry (3-0-0) 3	**CML526** *Bio I:* Structure & Function of Cellular Biomolecules (3-0-0) 3	**CMP521** *Lab III* (0-0-4) 2	**CMP522** *Lab IV* (0-0-4) 2	6	18	0	8	26	**22**
III	**CML631** *Bio I:* Molecular Biochemistry (3-0-0) 3	**PE I** (3-0-0) 3	**PE II** (3-0-0) 3	**PE III** (0-0-0) 3	**CMD631** *Project Part I* (0-0-12) 6	**----**	**----**	**----**	4	12	0	12	24	**18**
IV	**OE-I** (3-0-0) 3	**OE-II** (3-0-0) 3	**CMD641** *Project Part II* (0-0-20) 10	**----**	**----**	**----**	**----**	**----**	2	6	0	20	26	**16**
								Total	17	51	0	48	99	**75**

Scheduling of Courses

Semester I

S. No.	Course No.	Title	Type	L-T-P	Credits
1	CML511	Quantum Chemistry	PC	(3-0-0)	3
2	CML512	Stereochemistry & Organic Reaction Mechanisms	PC	(3-0-0)	3
3	CML513	Photochemistry & Pericyclic Reactions	PC	(3-0-0)	3
4	CML514	Main Group Chemistry	PC	(3-0-0)	3
5	CML515	Instrumental Methods of Analysis	PC	(3-0-0)	3
6	CMP511	Lab I	PC	(0-0-4)	2
7	CMP512	Lab II	PC	(0-0-4)	2
				Total	19

Semester II

S. No.	Course No.	Title	Type	L-T-P	Credits
1	CML521	Molecular Thermodynamics	PC	(3-0-0)	3
2	CML522	Chemical Dynamics & Surface Chemistry	PC	(3-0-0)	3
3	CML523	Organic Synthesis	PC	(3-0-0)	3
4	CML524	Transition and Inner Transition Metal Chemistry	PC	(3-0-0)	3
5	CML525	Basic Organometalic Chemistry	PC	(3-0-0)	3
6	CML526	Structure & Function of Cellular Biomolecules	PC	(3-0-0)	3
7	CMP521	Lab III	PC	(0-0-4)	2
8	CMP522	Lab IV	PC	(0-0-4)	2
				Total	22

Semester III

S. No.	Course No.	Title	Type	L-T-P	Credits
1	CML631	Molecular Biochemistry	PC	(3-0-0)	3
2	PE I	PE I	PE	(3-0-0)	3
3	PE II	PE II	PE	(3-0-0)	3
4	PE III	PE III	PE	(3-0-0)	3
5	CMD631	Project Part I	PC	(0-0-12)	6
				Total	18

Semester IV

S. No.	Course No.	Title	Type	L-T-P	Credits
1	OE1	OE1	PC	(3-0-0)	3
2	OE1	OE1	PE	(3-0-0)	3
3	CMD641	Project Part II	PE	(0-0-20)	10
				Total	16

COURSE TEMPLATE

(Please avoid changing the number of tables, rows and columns or text in dark black, but fill only the columns relevant to the template by editing the columns in grey letters or blank columns: this would help in automating the processing of template information for curricular use)

1.	**Department/Centre/School proposing the course**	CHEMISTRY		
2.	**Course Title**	1. QUANTUM CHEMISTRY		
3.	**L-T-P structure**	3-0-0		
4.	**Credits**	3	**Non-graded Units**	Please fill appropriate details in S. No. 21
5.	**Course number**	CML511		
6.	**Course Status** (Course Category for Program) (list program codes: eg., EE1, CS5, *etc*.)			

Institute Core for all UG programs	No
Programme Linked Core for:	List of B.Tech. / Dual Degree Programs
Departmental Core for:	List of B.Tech. / Dual Degree Programs
Departmental Elective for:	List of B.Tech. / Dual Degree Programs
Minor Area / Interdisciplinary Specialization Core for:	Name of Minor Area / Specialization
Minor Area / Interdisciplinary Specialization Elective for:	Name of Minor Area / Specialization
Programme Core for:	List of M.Tech. / Dual Degree Programs
Programme Elective for:	List of M.Tech. / Dual Degree Programs
Open category Elective for all other programs (No if Institute Core)	(Yes / No)

7.	**Pre-requisite(s)**	NONE

8.	**Status vis-à-vis other courses**		
8.1	List of courses precluded by taking this course (significant overlap)		1. (course number)
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School	(course number)
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	(course number)
8.2	Supersedes any existing course		(course number)

9.	**Not allowed for**	(indicate program names)

10.	**1. Frequency of offering** (check one box)	☐ Every semester √ ☐ I sem ☐ II sem ☐ Either semester

11.	**Faculty who will teach the course** BJ, CC, NDK, SP, SD, SS, PKC, HK

12.	**Will the course require any visiting faculty?**	no

13.	**Course objectives** The understanding of chemical phenomena at the microscopic level requires a knowledge of the principles of quantum mechanics. These principles and their application to chemistry are presented in this course.

14.	**Course contents** Basic concepts and postulates of quantum mechanics. Hydrogen atom. Quantization of angular momentum. Many electron atoms. Variation theorem. Perturbation theory. Molecular orbital and valence bond theories. Introductory treatment of semi-empirical and ab initio calculations on molecular systems.

15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours (not exceeding 5h per topic)
1	Dawn of Quantum Mechanics: black-body radiation, heat capacities, photoelectric and Compton effects, atomic and molecular spectra, particle diffraction, wave-matter duality	3
2	Foundation of Quantum Theory: Postulates of quantum mechanics, operators, specification and evolution of states	5
3	Translational Motion: Particle-in-a-box, penetration into and through barriers	5
4	Harmonic Oscillator	3
5	Roational Motion: Particle-on-a-ring, particle-on-a-sphere, motion in a coulombic field	3
6	Hydrogenic Atoms and Angular Momentum	5
7	Many Electron Atoms	3
8	Approximate Methods: Perturbation theory and variational methods	5
9	Introduction to Molecular Structure: Born-Oppenheimer approximation, molecular orbital theory and valence bond theory	5

10	Computational Chemistry: Semi-empirical and *ab initio* methods	5
Total Lecture hours (14 times 'L')		**42**

16. 2. Brief description of tutorial activities:

Module no.	Description	No. of hours
Total Tutorial hours (14 times 'T')		

17. 3. Brief description of Practical / Practice activities

Module no.	Description	No. of hours
Total Practical / Practice hours (14 times 'P')		

18. 4. Brief description of module-wise activities pertaining to self-learning component (Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	Description
(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)	

19. 5. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Quantum Chemistry, Donald A. McQuarrie, Viva Books.

Modern Quantum Chemistry, Attila Szabo & Neil S. Ostlund, Dover Publications.
Quantum Chemistry, Ira N. Levine, PHI Learning.
Quantum Chemistry and Molecular Interactions, Andrew Cooksy, Pearson Press.
Quantum Chemistry & Spectroscopy, Thomas Engel, Pearson Education.
Molecular Quantum Mechanics, Peter Atkins & Ronald Friedman, Oxford Press.
Elementary Quantum Mechanics, Frank L. Pilar, Dover Publications.
Fundamentals of Quantum Chemistry, James E. House, Elsevier/Academic Press.
Quantum Chemistry, John P. Lowe & Kirk A. Peterson, Elsevier/Academic Press.
Introduction to Quantum Chemistry, A. K. Chandra, Tata-McGraw Hill.

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	Name of software, number of licenses, etc.
20.2	Hardware	Nature of hardware, number of access points, etc.
20.3	Teaching aids (videos, etc.)	Description, Source , etc.
20.4	Laboratory	Type of facility required, number of students etc.
20.5	Equipment	Type of equipment required, number of access points, etc.
20.6	Classroom infrastructure	Type of facility required, number of students etc.
20.7	Site visits	Type of Industry/ Site, typical number of visits, number of students etc.
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	Eg. 25% of student time of practical / practice hours: sample Circuit Design exercises from industry
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date: (Signature of the Head of the Department/ Centre / School)

Date of Approval of Template by Senate	

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COURSE TEMPLATE

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1.	**Department/Centre/School proposing the course**	Department of Chemistry		
2.	**Course Title**	1. Stereochemistry and Organic Reaction Mechanisms		
3.	**L-T-P structure**	3-0-0		
4.	**Credits**	3	**Non-graded Units**	Please fill appropriate details in S. No. 21
5.	**Course number**	CYL512		
6.	**Course Status** (Course Category for Program) (list program codes: eg., EE1, CS5, *etc*.)			

Institute Core for all UG programs	No
Programme Linked Core for:	List of B.Tech. / Dual Degree Programs
Departmental Core for:	List of B.Tech. / Dual Degree Programs
Departmental Elective for:	List of B.Tech. / Dual Degree Programs
Minor Area / Interdisciplinary Specialization Core for:	Name of Minor Area / Specialization
Minor Area / Interdisciplinary Specialization Elective for:	Name of Minor Area / Specialization
Programme Core for:	MSc.
Programme Elective for:	List of M.Tech. / Dual Degree Programs
Open category Elective for all other programs (No if Institute Core)	No

7.	**Pre-requisite(s)**	combinations of courses: eg. (XYZ123 & XYW214) / XYZ234

8.	**Status vis-à-vis other courses**		
8.1	List of courses precluded by taking this course (significant overlap)		1. (course number)
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School	(course number)
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	(course number)
8.2	Supersedes any existing course		(course number)

9.	**Not allowed for**	(indicate program names)

10.	**1. Frequency of offering** (check one box)	☐Every semester √ ☐I sem ☐II sem ☐Either semester

11.	**Faculty who will teach the course** NP, NGR, VH, NJ, RPS, SLG

12.	**Will the course require any visiting faculty?**	No

13.	**Course objectives:** This course reviews the stereochemistry of organic compounds and organic reaction mechanisms at an advanced level. On successful completion of this module, the learner will be able to identify and explain the reaction mechanisms in organic chemistry. He will also understand the stereo chemical implications on the structure, and reactivity of organic molecules.

14.	**Course contents**: Stereochemistry of acyclic and cyclic compounds including chiral molecules without a chiral centre. Reaction mechanisms (polar and free radical) with stereochemical considerations. Reactive intermediates: generation, structure and reactivity.

15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours (not exceeding 5h per topic)
1.	Stereoisomers, symmetry elements, chiral molecules with one stereogenic centre: optical activity, sequence rules, absolute configuration, enantiomeric excess	4
2.	Molecules with two (or more) stereogenic centres: diastereomers, Newman, Fischer and Sawhorse formulae, erythro/threo, syn/anti configurations, meso configuration	3
3.	Stereochemistry of fused, bridged, and caged ring systems, resolution of enantiomers	3
4.	Chirality without stereogenic carbon: allenes, biphenyls, cyclophanes, helicenes, atropisomerism	3
5.	Steroisomerism in cyclic structures: cyclopropane, cyclobutane, cyclopentane, cyclohexane, decalins, anomeric effect, conformational analysis	4
6.	Prochirality, enantiotopic and diasterotopic groups and faces	3
7.	Reactive intermediates: carbocations, carbanions, enolates	5

8.	Carbenes, nitrenes, benzyne, free radicals	5
9.	Kinetic and Thermodynamic control of reactions	3
10.	Reaction mechanism: substitutions, eliminations, additions, rearrangements	5
11.	The Hammett relationship, stereochemistry and mechanism	4
Total Lecture hours (14 times 'L')		**42**

16. 2. Brief description of tutorial activities:

Module no.	Description	No. of hours
Total Tutorial hours (14 times 'T')		

17. 3. Brief description of Practical / Practice activities

Module no.	Description	No. of hours
Total Practical / Practice hours (14 times 'P')		

18. 4. Brief description of module-wise activities pertaining to self-learning component (Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	Description
(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)	

19. 5. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. F. A. Carey and R. J. Sundberg, "Advanced Organic Chemistry, Part A", fifth edition, Sp
2. E. L. Eliel, "Stereochemistry of Organic Compounds", John Wiley & Sons.
3. J. March, "Advanced Organic Chemistry", fifth edition, John Wiley & Sons.
4. J. Clayden, N. Greeves and S. Warren, "Organic Chemistry", Second Edition, University Press.

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	Name of software, number of licenses, etc.
20.2	Hardware	Nature of hardware, number of access points, etc.
20.3	Teaching aids (videos, etc.)	Description, Source , etc.
20.4	Laboratory	Type of facility required, number of students etc.
20.5	Equipment	Type of equipment required, number of access points, etc.
20.6	Classroom infrastructure	Type of facility required, number of students etc.
20.7	Site visits	Type of Industry/ Site, typical number of visits, number of students etc.
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	Eg. 25% of student time of practical / practice hours: sample Circuit Design exercises from industry
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date: (Signature of the Head of the Department/ Centre / School)

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COURSE TEMPLATE

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1.	**Department/Centre/School proposing the course**	CHEMISTRY		
2.	**Course Title**	2. INSTRUMENTAL METHODS OF ANALYSIS		
3.	**L-T-P structure**	3-0-0		
4.	**Credits**	3	**Non-graded Units**	Please fill appropriate details in S. No. 21
5.	**Course number**	CML515		
6.	**Course Status** (Course Category for Program) (list program codes: eg., EE1, CS5, *etc*.)			

Institute Core for all UG programs	No
Programme Linked Core for:	List of B.Tech. / Dual Degree Programs
Departmental Core for:	List of B.Tech. / Dual Degree Programs
Departmental Elective for:	List of B.Tech. / Dual Degree Programs
Minor Area / Interdisciplinary Specialization Core for:	Name of Minor Area / Specialization
Minor Area / Interdisciplinary Specialization Elective for:	Name of Minor Area / Specialization
Programme Core for:	List of M.Tech. / Dual Degree Programs
Programme Elective for:	List of M.Tech. / Dual Degree Programs
Open category Elective for all other programs (No if Institute Core)	(Yes / No)

7.	**Pre-requisite(s)**	NONE

8.	**Status vis-à-vis other courses**		
8.1	List of courses precluded by taking this course (significant overlap)		1. (course number)
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School	(course number)
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	(course number)
8.2	Supersedes any existing course		(course number)

9.	**Not allowed for**	(indicate program names)

10.	**1. Frequency of offering** (check one box)	☐ Every semester ☑ I sem ☐ II sem ☐ Either semester

11.	**Faculty who will teach the course** A. K. Singh, S. Pandey, S. Deep, P. K. Chowdhury, P. P. Ingole

12.	**Will the course require any visiting faculty?**	No

13.	**Course objectives** Upon completion of the course students will learn (a) the fundamental principles of instrumental measurements, (b) applications of these principles to specific types of chemical measurements (types of samples analyzed, figures of merit, strengths and limitations), (c) examples of modern instrumentation, and (d) the use of instruments to solve real analytical problems.

14.	**Course contents** Measurement basics and data analysis. Introduction to spectrometric methods and components of optical instruments. Atomic absorption, fluorescence, emission, mass, and X-ray spectrometry. Introduction to and applications of uv-vis molecular absorption, luminescence, infrared, Raman, nuclear magnetic resonance, and mass spectroscopy/ spectrometry. Introduction to electroanalytical methods: potentiometry, coulometry, and voltammetry. Introduction to chromatographic separation: gas, high-performance liquid, supercritical fluid, and capillary electrophoresis chromatography. Introduction to thermal methods of analysis.

15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours (not exceeding 5h per topic)
1	**Measurement Basics and Data Analysis:** Classification and Selection of Analytical Methods, Types and Calibration of Instruments, Signals and Noise, Linear and Nonlinear Regression Analysis.	4
2	**Introduction to Spectrometric Methods:** General properties of electromagnetic radiation, qualitative and quantitative aspects of spectrochemical measurements.	2
3	**Components of Optical Instruments:** General Designs of Optical Instruments, Sources of Radiation, Wavelength Selectors, Sample Containers, Radiation Transducers, Signal Processors and Readouts, Types of Optical Instruments, Principles of Fourier Transform Optical Measurements	2
4	**Atomic Absorption, Fluorescence, Emission, Mass, and X-Ray**	3

	Spectrometry: Sample Atomization Techniques, Atomic Absorption Instrumentation, Interferences in Atomic Absorption Spectroscopy, Atomic Absorption Analytical Techniques, Atomic Fluorescence Spectroscopy, Emission Spectroscopy Based on Plasma Sources, Emission Spectroscopy Based on Arc and Spark Sources, Introduction to Atomic Mass and X-Ray Spectrometry	
5	**An Introduction to and Applications of UV-VIS Molecular Absorption Spectrometry:** Measurement of Transmittance and Absorbance, Beer's Law, The Effects of Instrumental Noise on Spectrophotometric Analyses, Instrumentation, The Magnitude of Molar Absorptivities, Absorbing Species, Application of Absorption Measurement to Qualitative Analysis, Quantitative Analysis by Absorption Measurements, Photometric Titrations.	5
6	**Molecular Luminescence Spectrometry:** Theory of Fluorescence and Phosphorescence, Instruments for Measuring Fluorescence and Phosphorescence, Applications and Photoluminescence Methods, Chemiluminescence.	3
7	**An Introduction to and Applications of Infrared Spectrometry:** Theory of Infrared Absorption Spectrometry, Infrared Sources and Transducers, Infrared Instruments, Mid-Infrared Absorption Spectrometry, Mid-Infrared Reflection Spectrometry, Photoacoustic Infrared Spectroscopy, Near-Infrared Spectroscopy, Far-Infrared Spectroscopy, Infrared Emission Spectroscopy, Infrared Microspectrometry.	3
8	**Raman Spectroscopy:** Theory of Raman Spectroscopy, Instrumentation, Applications of Raman Spectroscopy, Types of Raman Spectroscopy.	2
9	**Nuclear Magnetic Resonance Spectroscopy:** Theory of Nuclear Magnetic Resonance (NMR), Environmental Effects on NMR Spectra, NMR Spectrometers, Applications of Proton NMR, Carbon-13 NMR, Application of NMR to Other Nuclei, Two-Dimensional Fourier Transform NMR, Magnetic Resonance Imaging.	3
10	**Mass Spectrometry:** Molecular Mass Spectra, Ion Sources, Mass Spectrometers, Applications of Molecular Mass Spectrometry, Quantitative Applications of Mass Spectrometry.	3
11	**Introduction to Electroanalytical Methods - Potentiometry, Coulometry, and Voltammetry:** Electrochemical Cells, Potentials in Electroanalytical Cells, Electrode Potentials, Calculation of Cell Potentials from Electrode Potentials, Currents in Electrochemical Cells, Types of Electroanalytical Methods, Reference Electrodes, Metallic Indicator Electrodes, Membrane Indicator Electrodes, Ion-Selective Field-Effect Transistors (ISFETs), Molecular-Selective Electrode Systems, Instruments for Measuring Cell Potentials, Direct Potentiometrie Measurements, Potentiometrie Titrations, Current-Voltage Relationships During an Electrolysis, An Introduction to Coulometric Methods of Analysis, Potentiostatic Coulometry,	5

	Coulometric Titrations (Amperostatic Coulometry), Excitation Signals in Voltammetry, Voltammetric Instrumentation, Hydrodynamic Voltammetry, Cyclic Voltammetry, Polarography, Stripping Methods, Voltammetry with Ultramicroelectrodes.	
12	**Introduction to Chromatographic Separations - Gas, High Performance Liquid, and Supercritical Fluid Chormatography and Capillary Electrophoresis:** A General Description of Chromatography, Migration Rates of Solutes, Zone Broadening and Column Efficiency, Optimization of Column Performance, Summary of Important Relationships for Chromatography, Applications of Chromatography, Principles of Gas-Liquid Chromatography, Instruments for Gas-Liquid Chromatography, Gas Chromatographic Columns and Stationary Phases, Applications of Gas-Liquid Chromatography (GLC), Gas-Solid Chromatography, Scope of HPLC, Column Efficiency in Liquid Chromatography, Instruments for Liquid Chromatography, Partition Chromatography, Adsorption Chromatography, Ion-Exchange Chromatography, Size-Exclusion Chromatography, Thin-Layer Chromatography, Properties of Supercritical Fluids, Supercritical Fluid Chromatography, Supercritical Fluid Extraction, An Overview of Electrophoresis, Capillary Electrophoresis, Applications of Capillary Electrophoresis, Capillary Electrochromatography.	5
13.	**Introduction to Thermal Methods of Analysis:** Thermogravimetric Methods (TG), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC).	2
Total Lecture hours (14 times 'L')		**42**

16. 2. Brief description of tutorial activities:

Module no.	Description	No. of hours
Total Tutorial hours (14 times 'T')		

17. 3. Brief description of Practical / Practice activities

Module no.	Description	No. of hours

Total Practical / Practice hours (14 times 'P')		

18. 4. **Brief description of module-wise activities pertaining to self-learning component** (Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	Description
(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)	

19. 5. **Suggested texts and reference materials**

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Skoog, D. A.; Holler, F. J.; Nieman, T. A. Principles of Instrumental Analysis, 5th Ed., Thomson Brooks/Cole, 1998.

Strobel, H. A.; Heineman, W. R. Chemical Instrumentation: A Systematic Approach, 3rd Ed., John Wiley and Sons, 1989.

Willard, H. H.; Merritt, Jr., L. L.; Dean, J. A.; Settle, Jr., F. A. Instrumental Methods of Analysis, 7th Ed., Wadsworth, 1988.

Rubinson, K. A.; Rubinson, J. F. Contemporary Instrumental Analysis , 1st Ed., Prentice Hall, 2000.

Rouessac, F.; Rouessac, A. Chemical Analysis: Modern Instrumentation Methods and Techniques, 4th Ed., John Wiley and Sons, 1998.

Settle, F. A. Handbook of Instrumental Techniques for Analytical Chemistry, 1st Ed., Prentice Hall, 1997.

Kaur, H. Instrumental Methods of Chemical Analysis, 1st Ed., Pragati Prakashan, 2001.

Ewing, G. W. Instrumental Methods of Chemical Analysis, 5th Ed., Mcgraw-Hill, 1985.

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	Name of software, number of licenses, etc.
20.2	Hardware	Nature of hardware, number of access points, etc.
20.3	Teaching aids (videos, etc.)	Description, Source , etc.
20.4	Laboratory	Type of facility required, number of students etc.
20.5	Equipment	Type of equipment required, number of access points, etc.
20.6	Classroom infrastructure	Type of facility required, number of students etc.

20.7	Site visits	Type of Industry/ Site, typical number of visits, number of students etc.
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	Eg. 25% of student time of practical / practice hours: sample Circuit Design exercises from industry
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date: (Signature of the Head of the Department/ Centre / School)

Date of Approval of Template by Senate	

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1.	**Department/Centre/School proposing the course**	Chemistry		
2.	**Course Title**	Laboratory 1		
3.	**L-T-P structure**	0-0-4		
4.	**Credits**	2	**Non-graded Units**	N/A
5.	**Course number**	II. CMP511		
6.	**Course Status** (Course Category for Program) (list program codes: eg., EE1, CS5, *etc*.)			

Institute Core for all UG programs	No
Programme Linked Core for:	
Departmental Core for:	List of B.Tech. / Dual Degree Programs
Departmental Elective for:	List of B.Tech. / Dual Degree Programs
Minor Area / Interdisciplinary Specialization Core for:	Name of Minor Area / Specialization
Minor Area / Interdisciplinary Specialization Elective for:	Name of Minor Area / Specialization
Programme Core for:	M. Sc. (Chemistry)
Programme Elective for:	List of M.Tech. / Dual Degree Programs
Open category Elective for all other programs (No if Institute Core)	(Yes / No)

7.	**Pre-requisite(s)**	combinations of courses: eg. (XYZ123 & XYW214) / XYZ234

8.	**Status vis-à-vis other courses**		
8.1	List of courses precluded by taking this course (significant overlap)		(course number)
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School	(course number)
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	(course number)
8.2	Supersedes any existing course		CYP501 and CYP561

9.	**Not allowed for**	(indicate program names)

10.	**Frequency of offering** (check one box)	☐Every semester ☐I sem ☐II sem ☒Either semester

11.	**Faculty who will teach the course** C. Chakravarty, P. K. Chowdhury, S. Deep, P. P. Ingole, B. Jayaram, H. K. Kashyap, N. D. Kurur, S. Pandey, A. Ramanan, S. Sapra

12.	**Will the course require any visiting faculty?**	NO

13.	**Course objectives** (about 50 words. "On successful completion of this course, a student should be able to…")**:** Chemistry is an experimental science. This course introduces students to experimental methods in physical chemistry. Data analysis and instrumental methods of analysis feature prominently in the course.

14.	**Course contents** (about 100 words; Topics to appear as course contents in the Courses of Study booklet) (Include Practical / Practice activities)**:** Experiments highlighting the principles of thermodynamics and chemical equilibrium, electrochemistry, chemical kinetics, spectroscopy, and computer simulations. Examples include thermodynamics of micellization, synthesis, stablization and spectroscopy of nanoparticles, steady-state and time resolved fluorescence, cyclic and linear sweep voltammetry, and electronic structure calculations.

15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours (not exceeding 5h per topic)

16. Brief description of tutorial activities:

Module no.	Description	No. of hours

Total Tutorial hours (14 times 'T')		

17. Brief description of Practical / Practice activities

Module no.	Description	No. of hours
1	Spectroscopy related	16
2	Thermodynamics and chemical equilibrium	12
3	Chemical kinetics	12
4	Quantum chemistry	8
5	Surface and electrochemistry	8
Total Practical / Practice hours (14 times 'P')		56

18. Brief description of module-wise activities pertaining to self-learning component

(Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	Description
(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)	

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. A. L. Halpern and G. C. McBane, Experimental Physical Chemistry, W H Freeman, 2006
2. C. Garland, J. Nibler, D. Shoemaker, Experiments in Physical Chemistry, McGraw-Hill, 2008
3. D. A. Skoog, F. J. Holler, S. R. Crouch, Principles of Instrumental Analysis, Brooks Cole, 2006
4. J. Miller and J. C. Miller, Statistics and Chemometrics for Analytical Chemistry, Pearson, 2010

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	Name of software, number of licenses, etc.
20.2	Hardware	Nature of hardware, number of access points, etc.
20.3	Teaching aids (videos, etc.)	Description, Source , etc.
20.4	Laboratory	Type of facility required, number of students etc.
20.5	Equipment	Type of equipment required, number of access points, etc.
20.6	Classroom infrastructure	Projector
20.7	Site visits	Type of Industry/ Site, typical number of visits, number of students etc.
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	Eg. 25% of student time of practical / practice hours: sample Circuit Design exercises from industry
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date: (Signature of the Head of the Department/ Centre / School)

Date of Approval of Template by Senate	

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COURSE TEMPLATE

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1.	**Department/Centre/School proposing the course**		Chemistry		
2.	**Course Title**	**1.** Biochemistry Laboratory			
3.	**L-T-P structure**	0-0-4			
4.	**Credits**	4.0	**Non-graded Units**		
5.	**Course number**	CMP512			
6.	**Course Status** (Course Category for Program)	Laboratory			

Institute Core for all UG programs	(No)
Programme Linked Core for:	
Departmental Core for:	
Departmental Elective for:	
Minor Area / Interdisciplinary Specialization Core for:	
Minor Area / Interdisciplinary Specialization Elective for:	
Programme Core for:	M.Sc. Chemistry
Programme Elective for:	
Open category Elective for all other programs (No if Institute Core)	(No)

7.	**Pre-requisite(s)**	

8.	**Status vis-à-vis other courses**		
8.1	List of courses precluded by taking this course (significant overlap)		1.
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School	
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	<10%
8.2	Supersedes any existing course		

9.	**Not allowed for**	NIL

10.	**1. Frequency of offering** (check one box)	☐Every semester ☐I sem ☐ II sem ☒Either semester

11.	**Faculty who will teach the course** Prof. S. K. Khare and Dr. Tanmay Dutta

12.	**Will the course require any visiting faculty?**	NO

13.	**Course objectives** (about 50 words. "On successful completion of this course, a student should be able to…")**:** Students will learn different techniques to purify and characterize enzymes. This course will also include how to measure microbial growth rate and how to isolate nucleic acids (DNA/RNA) from bacteria. Some immunological techniques will also be covered in this course.

14.	**Course contents** (about 100 words; Topics to appear as course contents in the Courses of Study booklet) (Include Practical / Practice activities)**:** Determination of enzyme activity in biological samples, protein purification and characterization, Microbial growth experiments, DNA and RNA isolation, gel electrophoresis

15. Lecture Outline(with topics and number of lectures)

Module no.	**Topic**	**No. of hours** (not exceeding 5h per topic)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
Total Lecture hours (14 times 'L')		

16. 2. Brief description of tutorial activities:

Module no.	Description	No. of hours
Not Applicable		

17. 3. Brief description of Practical / Practice activities

Module no.	Description	No. of hours
1	Determination of enzyme activity in biological samples	4
2	Protein purification and characterization	8
3	Microbial growth experiment	4
4	Isolation of DNA and RNA	4
5	Gel electrophoresis	4
Total Practical / Practice hours (14 times 'P')		24

18. 4. Brief description of module-wise activities pertaining to self-learning component (Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	Description

(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)

19. 5. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Deutscher MP, Methods in Enzymology volume 182, Academic press, 1990
2. Harvey Lodish, Arnold Berk , Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Matthew P. Scott, Molecular Cell Biology, Seventh Edition, WH Freeman and Company–2012
3. An Introduction to Practical BiochemistryMay 1987 by David T. Plummer, Mc Graw Hill

4. Principles and Techniques of Practical Biochemistry 2000 by Keith Wilson and John Walker, Cambridge University Press

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	Microsoft offices
20.2	Hardware	Desktop PC
20.3	Teaching aids (videos, etc.)	Chalk and Board
20.4	Laboratory	
20.5	Equipment	
20.6	Classroom infrastructure	LCD Projector
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	Eg. 25% of student time of practical / practice hours: sample Circuit Design exercises from industry
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

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1.	**Department/Centre/School proposing the course**	Chemistry		
2.	**Course Title**	Thermodynamics		
3.	**L-T-P structure**	3-0-0		
4.	**Credits**	3	**Non-graded Units**	N/A
5.	**Course number**	III. CML521		
6.	**Course Status** (Course Category for Program) (list program codes: eg., EE1, CS5, *etc*.)			

Institute Core for all UG programs	No
Programme Linked Core for:	
Departmental Core for:	List of B.Tech. / Dual Degree Programs
Departmental Elective for:	List of B.Tech. / Dual Degree Programs
Minor Area / Interdisciplinary Specialization Core for:	Name of Minor Area / Specialization
Minor Area / Interdisciplinary Specialization Elective for:	Name of Minor Area / Specialization
Programme Core for:	M. Sc. (Chemistry)
Programme Elective for:	List of M.Tech. / Dual Degree Programs
Open category Elective for all other programs (No if Institute Core)	(Yes / No)

7.	**Pre-requisite(s)**	combinations of courses: eg. (XYZ123 & XYW214) / XYZ234

8.	**Status vis-à-vis other courses**		
8.1	List of courses precluded by taking this course (significant overlap)		(course number)
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School	(course number)
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	(course number)
8.2	Supersedes any existing course		CYL565

9.	**Not allowed for**	(indicate program names)

10.	**Frequency of offering** (check one box)	☐Every semester ☐I sem ☒II sem ☐Either semester

11.	**Faculty who will teach the course** C. Chakravarty, P. K. Chowdhury, S. Deep, P. P. Ingole, B. Jayaram, H. K. Kashyap, N. D. Kurur, S. Pandey, A. Ramanan, S. Sapra

12.	**Will the course require any visiting faculty?**	NO

13.	**Course objectives** (about 50 words. "On successful completion of this course, a student should be able to…")**:** Laws of thermodynamics are very simple yet can explain feasibility of every physical and chemical process. Understanding the laws and their application to understand processes are the objective of this course.

14.	**Course contents** (about 100 words; Topics to appear as course contents in the Courses of Study booklet) (Include Practical / Practice activities)**:** Basics concepts, Review of First, Second law of thermodynamics, and Third law of thermodynamics, Gibb's free energy, extra work , chemical potential, ideal and non ideal solution, phase rule, phase diagram, Solutions, chemical equilibrium. Postulates of statistical thermodynamics, ensembles, monoatomic and polyatomic ideal gases, molar heat capacities, classical statistical mechanics.

15. Lecture Outline(with topics and number of lectures)

Module no.	**Topic**	**No. of hours** (not exceeding 5h per topic)
1	Basic concepts (State function, mixed derivative, Equations of gases). Review of First law of thermodynamics (internal energy, enthalpy, heat capacity, Joule Thomson experiment)	4
2	Review of Second and Third law of thermodynamics (entropy change, clausius inequality, probability, absolute entropy)	6
3	Gibb's free energy, extra work (EMF, surface energy etc.)	6
4	Chemical potential, Clausius euation, Change of chemical potential with Temperature, pressure and addition of solute	4
5	Phase Rule	2
6	Phase diagram, solutions (liquid-liquid and solid-liquid solution)	6
7	Chemical equilibrium	4
8	Statistical thermodynamics, ensembles, monoatomic and polyatomic ideal gases, molar heat capacities	6
9	Classical Statistical mechanics	4
Total Lecture hours		**42**

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
Total Tutorial hours (14 times 'T')		

17. Brief description of Practical / Practice activities

Module no.	Description	No. of hours
Total Practical / Practice hours (14 times 'P')		

18. Brief description of module-wise activities pertaining to self-learning component (Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	Description
(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)	

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. D.A. McQuarrie, J.D. Simon, Molecular Thermodynamics, University Science Book
2. P Atkins, J.D. Paula, Physical chemistry, Oxford, 2010
3. I.N. Levine, Physical Chemistry, Tata McGraw-Hill, 2002
4. K.A. Dill, S. Bromberg, Molecular Driving Forces, Garland Science, Taylor and Francis Group, 2010

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	Name of software, number of licenses, etc.
20.2	Hardware	Nature of hardware, number of access points, etc.
20.3	Teaching aids (videos, etc.)	Description, Source , etc.
20.4	Laboratory	Type of facility required, number of students etc.
20.5	Equipment	Type of equipment required, number of access points, etc.
20.6	Classroom infrastructure	Projector
20.7	Site visits	Type of Industry/ Site, typical number of visits, number of students etc.
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	Eg. 25% of student time of practical / practice hours: sample Circuit Design exercises from industry
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

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1.	**Department/Centre/School proposing the course**	Chemistry		
2.	**Course Title**	Chemical Dynamics and Surface Chemistry		
3.	**L-T-P structure**	3-0-0		
4.	**Credits**	3	**Non-graded Units**	N/A
5.	**Course number**	IV. CML522		
6.	**Course Status** (Course Category for Program) (list program codes: eg., EE1, CS5, *etc*.)			

Institute Core for all UG programs	No
Programme Linked Core for:	
Departmental Core for:	List of B.Tech. / Dual Degree Programs
Departmental Elective for:	List of B.Tech. / Dual Degree Programs
Minor Area / Interdisciplinary Specialization Core for:	Name of Minor Area / Specialization
Minor Area / Interdisciplinary Specialization Elective for:	Name of Minor Area / Specialization
Programme Core for:	M. Sc. (Chemistry)
Programme Elective for:	List of M.Tech. / Dual Degree Programs
Open category Elective for all other programs (No if Institute Core)	(Yes / No)

7.	**Pre-requisite(s)**	combinations of courses: eg. (XYZ123 & XYW214) / XYZ234

8.	**Status vis-à-vis other courses**		
8.1	List of courses precluded by taking this course (significant overlap)		(course number)
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School	(course number)
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	(course number)
8.2	Supersedes any existing course		CYL565

9.	**Not allowed for**	(indicate program names)

10.	**Frequency of offering** (check one box)	☐Every semester ☐I sem ☒II sem ☐Either semester

11.	**Faculty who will teach the course** C. Chakravarty, P. K. Chowdhury, S. Deep, P. P. Ingole, B. Jayaram, H. K. Kashyap, N. D. Kurur, S. Pandey, A. Ramanan, S. Sapra

12.	**Will the course require any visiting faculty?**	NO

13.	**Course objectives** (about 50 words. "On successful completion of this course, a student should be able to…")**:** Chemical kinetics and reaction dynamics is concerned with the "how, why, and when" of chemical reactions. It is central to the discipline of chemistry and yet is of enormous practical importance. Understanding the facts and theories relating to the rates at which chemical reactions occur in the gas phase, liquid phase, and on surfaces is the objective of this course.

14.	**Course contents** (about 100 words; Topics to appear as course contents in the Courses of Study booklet) (Include Practical / Practice activities)**:** Kinetics of simple and complex reactions; Transport properties; theories of reaction rates and dynamics of gas and liquid phase reactions; experimental techniques to study fast reactions; photochemical reactions; surface phenomena and physical methods for studying surfaces; heterogeneous and homogeneous catalysis.

15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours (not exceeding 5h per topic)
1	Kinetic theory of gases	3
2	Rates of chemical reactions	5
3	Transport properties: thermal conductivity, viscosity, diffusion	4
4	Collision theory, Potential energy surfaces, transition state theory	5
5	Experimental techniques for the study of fast reactions	4
6	Homogeneous Catalysis: Acid-base, enzymes, etc.	3
7	Photochemical reactions	3
8	Surface phenomena: Adsorption isotherms, surface area, porosity	3
9	Surface characterization techniques	3
10	Heterogeneous catalysis: types of catalysts and characterization, BEP	4
11	Heterogeneous catalysis in industry: Acid-base, oxidation, hydrogenation, Haber-Bosch process, etc.	5
Total Lecture hours (14 times 'L')		**42**

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
Total Tutorial hours (14 times 'T')		

17. Brief description of Practical / Practice activities

Module no.	Description	No. of hours
Total Practical / Practice hours (14 times 'P')		

18. Brief description of module-wise activities pertaining to self-learning component

(Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	Description
(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)	

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. P. L. Houston, Chemical Kinetics and Reaction Dynamics, Dover, 2006
2. J. I. Steinfeld, J. S. Francisco, and W. L. Hase,Chemical Kinetics and Dynamics, 2nd Edition, Prentice Hall, 1998
3. R. D. Levine, Molecular Reaction Dynamics, Cambridge University Press, 2006
4. G. Rothenberg, Catalysis: Concepts and Green Applications, Wiley-VCH, 2008
5. J. M. Thomas, W. J. Thomas, Principles and Practice of Heterogeneous Catalysis, Wiley, 2015

6. I. Chorkendorff, J. W. Niemantsverdriet, Concepts of Modern Catalysis and Kinetics, Wiley, 2007
7. M. W. Wright, Introduction to Chemical Kinetics, Wiley, 2004
8. K. J. Laidler, Chemical Kinetics, Pearson, 1987

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	Name of software, number of licenses, etc.
20.2	Hardware	Nature of hardware, number of access points, etc.
20.3	Teaching aids (videos, etc.)	Description, Source , etc.
20.4	Laboratory	Type of facility required, number of students etc.
20.5	Equipment	Type of equipment required, number of access points, etc.
20.6	Classroom infrastructure	Projector
20.7	Site visits	Type of Industry/ Site, typical number of visits, number of students etc.
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	Eg. 25% of student time of practical / practice hours: sample Circuit Design exercises from industry
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date: (Signature of the Head of the Department/ Centre / School)

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1.	**Department/Centre/School proposing the course**	Chemistry		
2.	**Course Title**	1. Organometallic Chemistry		
3.	**L-T-P structure**	3-0-0		
4.	**Credits**	3	**Non-graded Units**	Please fill appropriate details in S. No. 21
5.	**Course number**	CML525		
6.	**Course Status** (Course Category for Program) (list program codes: eg., EE1, CS5, *etc*.)			

Institute Core for all UG programs	(No)
Programme Linked Core for:	List of B.Tech. / Dual Degree Programs
Departmental Core for:	M.Sc Chem
Departmental Elective for:	List of B.Tech. / Dual Degree Programs
Minor Area / Interdisciplinary Specialization Core for:	Name of Minor Area / Specialization
Minor Area / Interdisciplinary Specialization Elective for:	Name of Minor Area / Specialization
Programme Core for:	List of M.Tech. / Dual Degree Programs
Programme Elective for:	List of M.Tech. / Dual Degree Programs
Open category Elective for all other programs (No if Institute Core)	(Yes / No)

7.	**Pre-requisite(s)**	nil

8.	**Status vis-à-vis other courses**		
8.1	List of courses precluded by taking this course (significant overlap)		1. (course number)
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School	(course number)
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	(course number)
8.2	Supersedes any existing course		CYL603

9.	**Not allowed for**	B.Tech, M.Tech, Ph.D

10.	**1. Frequency of offering** (check one box)	☐ II sem

11.	**Faculty who will teach the course**	S. Nagendran, J.D. Singh, A.J. Elias, D. Bandhyopadhyay, Ravi Shankar, A.K. Singh

12.	**Will the course require any visiting faculty?**	(no)

13.	**Course objectives** On successful completion of this course, a student should be able to understand and appreciate basic concepts of organometallic chemistry in general and its applications in industry, especially homogeneous catalysis in particular. He /she should be able predict stability of organometallic compounds, use spectroscopy to differentiate between different types of bonding of carbon based ligands (e.g carbonyls, alkenes), propose mechanisms for organometallic reactions using unique reactions shown by organometallic compounds (e.g. oxidative addition) and select suitable ligands (e.g. phosphines, NHC's) for designing homogeneous catalysts. He/she should also be able to propose reagents for organic synthesis using organometallic compounds (e.g. BuLi).

14.	**Course contents** Organometallic chemistry of main group, transition and inner transition metals. Synthesis and applications of BuLi, Grignard, organoaluminum and organozinc reagents, 18 electron rule, Metal carbonyls- bonding and infrared spectra, phosphines and NHC's, Alkenes and alkynes, carbenes and carbynes, Hapto ligands with hapticity from 2-8, oxidative addition and reductive elimination, 1,1 and 1,2-migratory insertions and beta hydrogen elimination, mechanism of substitution reactions, fluxionality and hapticity change, organometallic clusters, C-H activation- agostic and anagostic interactions, Homogeneous catalysis: hydrogenation, hydroformylation, methanol to acetic acid processes, Wacker oxidation. Introduction to cross coupling and olefin metathesis reactions. Olefin oligomerizarion and polymerization

15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours (not exceeding 5h per topic)
1	Synthesis, reactions and applications of BuLi, Grignard, organoaluminum and organozinc reagents,	4
2	18 electron rule: counting methods and ligand contributions	2
3	Metal carbonyls and nitrosyls- bonding and infrared spectra	3
4	Spectator ligands :Phosphines and NHC's: classification and properties	4
5	Alkenes and alkynes , Carbenes and carbynes (Fisher and Schrock)	5
6	Hapto ligands with hapticity from 2-8, sandwich and half sandwich compounds, planar chirality	5
7	Oxidative addition and reductive elimination, 1,1 and 1,2-migratory insertions and beta hydrogen elimination, mechanism of substitution reactions	5
8	Fluxionality and hapticity change, organometallic clusters, C-H activation- agostic and anagostic interactions,	4
9	Homogeneous catalysis using organoTM and inner TM catalysts: TON and TOF, hydrogenation, hydroformylation, methanol to acetic acid processes, Wacker oxidation.	5
10	Introduction to cross coupling and olefin metathesis reactions.	2

11	Olefin oligomerizarion and polymerization using organometallics	1
Total Lecture hours (14 times 'L')		**40**

16. 2. Brief description of tutorial activities:

Module no.	Description	No. of hours
Total Tutorial hours (14 times 'T')		

17. 3. Brief description of Practical / Practice activities

Module no.	Description	No. of hours
Total Practical / Practice hours (14 times 'P')		

18. 4. Brief description of module-wise activities pertaining to self-learning component (Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	Description

(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)

19. 5. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1.Gupta, B.D, Elias, A J; Basic Organometallic Chemistry, Concepts, syntheses and applications, 2nd edn, Universities Press, 2013.

2. Organometallics, Elschenbroich,Ch, 3rd edn, Wiley VCH, 1989.

3. Organometallics and catalysis An introduction. Bochmann, M, 1st edn, Oxford, 2014.

4. The organometallic chemistry of the transition metals, Crabtree R H, 6th edn, Wiley, 2014.
5. Organo transition metal chemistry: From bonding to catalysis, Hartwig, J.F, 1st edn, University science books, 2010.

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	Name of software, number of licenses, etc.
20.2	Hardware	Nature of hardware, number of access points, etc.
20.3	Teaching aids (videos, etc.)	Description, Source , etc.
20.4	Laboratory	Type of facility required, number of students etc.
20.5	Equipment	Type of equipment required, number of access points, etc.
20.6	Classroom infrastructure	Type of facility required, number of students etc.
20.7	Site visits	Type of Industry/ Site, typical number of visits, number of students etc.
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	Eg. 25% of student time of practical / practice hours: sample Circuit Design exercises from industry
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date: (Signature of the Head of the Department/ Centre / School)

Date of Approval of Template by Senate	

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1.	**Department/Centre/School proposing the course**	Chemistry		
2.	**Course Title**	2. Biochemistry I: Structure & Function of Cellular Biomolecules		
3.	**L-T-P structure**	3-0-0		
4.	**Credits**	3	**Non-graded Units**	Please fill appropriate details in S. No. 21
5.	**Course number**	CML526		
6.	**Course Status** (Course Category for Program)	**CORE**		

Institute Core for all UG programs	No
Programme Linked Core for:	
Departmental Core for:	
Departmental Elective for:	
Minor Area / Interdisciplinary Specialization Core for:	
Minor Area / Interdisciplinary Specialization Elective for:	
Programme Core for:	M.Sc Chemistry
Programme Elective for:	
Open category Elective for all other programs (No if Institute Core)	(Yes / No)

7.	**Pre-requisite(s)**	Nil

8.	**Status vis-à-vis other courses**		
8.1	List of courses precluded by taking this course (significant overlap)		1. No
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School	No
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	>10%
8.2	Supersedes any existing course		No

9.	**Not allowed for**	Nil

10.	**1. Frequency of offering** (check one box)	☐Every semester ☐ I sem ☒II sem ☐Either semester

11.	**Faculty who will teach the course** 1. Prof. S. K. Khare 2. Dr. Tanmay Dutta

12.	**Will the course require any visiting faculty?**	NO

13.	**Course objectives** (about 50 words. "On successful completion of this course, a student should be able to…")**:** To understand the chemical principles of living cells, their biomolecules and biocatalytic reactions.

14.	**Course contents** (about 100 words; Topics to appear as course contents in the Courses of Study booklet) (Include Practical / Practice activities)**:** Prokaryotic and eukaryotic cells. Structure and function of proteins, carbohydrates, nucleic acids and lipids. Biological membranes. Enzymes: classification, kinetics, mechanism and applications. Basic concepts of microbial culture, growth and physiology.

15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours (not exceeding 5h per topic)
1	Prokaryotic and eukaryotic cells: organization, structure of organelles and their function	5
2	Structure and function of proteins: amino acids, peptide and proteins; Overview of protein structure: Primary, secondary, tertiary and quaternary structures; Protein denaturation and folding	5
3	Structure and function of carbohydrates: mono-, di-, oligo- and poly- saccharides	5
4	Structure and function of nucleic acids: Nucleic acid structure: double helical structure of DNA; Chemistry and function of nucleic acids	4
5	Structure and function of lipids: Fatty acids; role of lipid as structural and signal molecule	4
6	Biological membranes: composition of membrane; transport across	4

	membranes	
7	Enzymes: classification, kinetics, mechanism and applications	5
8	Basic concepts of microbial culture and growth	5
9	Microbial Physiology	5
Total Lecture hours (14 times 'L')		**42**

16. 2. Brief description of tutorial activities: None

Module no.	Description	No. of hours
Total Tutorial hours (14 times 'T')		

17. 3. Brief description of Practical / Practice activities None

Module no.	Description	No. of hours
Total Practical / Practice hours (14 times 'P')		

18. 4. Brief description of module-wise activities pertaining to self-learning component (Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.) None

Module no.	Description

(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)

19. 5. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Nelson DL and Cox MM; Lehninger principles of biochemistry, Sixth edition, WH Freeman and company, 2012
2. Berg JM, Tymoczko JL and Stryer L; Biochemistry, Seventh edition, WH Freeman and company, 2011
3. Voet D and Voet JG; Biochemistry, Fourth edition, John Wiley and Sons, 2011
4. Pelczar MJ, Chan ECS and Krieg NR; Microbiology, Tata McGraw-Hill, Fifth edition, 2008 (37^{Th} reprint)

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	
20.2	Hardware	
20.3	Teaching aids (videos, etc.)	LCD Projector
20.4	Laboratory	
20.5	Equipment	
20.6	Classroom infrastructure	Standard Classroom
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible) None

21.1	Design-type problems	Eg. 25% of student time of practical / practice hours: sample Circuit Design exercises from industry
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date: (Signature of the Head of the Department/ Centre / School)

Date of Approval of Template by Senate	

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COURSE TEMPLATE

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1.	**Department/Centre/School proposing the course**	Chemistry		
2.	**Course Title**	**3.** Molecular Biochemistry		
3.	**L-T-P structure**	3-0-0		
4.	**Credits**	3.0	**Non-graded Units**	
5.	**Course number**	CYL631		
6.	**Course Status** (Course Category for Program) Core			

Institute Core for all UG programs	(No)
Programme Linked Core for:	
Departmental Core for:	
Departmental Elective for:	
Minor Area / Interdisciplinary Specialization Core for:	
Minor Area / Interdisciplinary Specialization Elective for:	
Programme Core for:	M.Sc. Chemistry
Programme Elective for:	
Open category Elective for all other programs (No if Institute Core)	(No)

7.	**Pre-requisite(s)**	

8.	**Status vis-à-vis other courses**		
8.1	List of courses precluded by taking this course (significant overlap)		1.
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School	

	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	<10%
8.2	Supersedes any existing course		

9.	**Not allowed for**	NIL

10.	**1. Frequency of offering** (check one box)	☐Every semester ☒I sem ☐II sem ☐Either semester

11.	**Faculty who will teach the course**	Prof. S. K. Khare and Dr. Tanmay Dutta

12.	**Will the course require any visiting faculty?**	NO

13.	**Course objectives** (about 50 words. "On successful completion of this course, a student should be able to…")**:** Students will be able to understand the central dogma of molecular biology which explains the detail transfer of sequential information from DNA to protein. This course will also enrich their knowledge on why and how gene expression occurs in a living cell. They will also learn the basic concept of metabolism in a cell.

14.	**Course contents** (about 100 words; Topics to appear as course contents in the Courses of Study booklet) (Include Practical / Practice activities)**:** Central Dogma, DNA Replication and Repair, Transcription, Translation, Recombinant DNA Technology, Basic concept of Metabolism: Glycolysis, TCA Cycle, ß-oxidation, Amino acid transamination and urea cycle

15. Lecture Outline(with topics and number of lectures)

Module no.	**Topic**	**No. of hours** (not exceeding 5h per topic)
1	Central dogma	2
2	DNA replication	5
3	DNA Repair	3
4	Transcription	5
5	Translation	5
6	Recombinant DNA Technology	3
7	Basic concept of Metabolism	3
8	Glycolysis	3
9	TCA Cycle	3

10	ß-oxidation	3
11	Amino acid transamination and urea cycle	4
Total Lecture hours (14 times 'L')		**42**

16. 2. Brief description of tutorial activities:

Module no.	Description	No. of hours
Not Applicable		

17. 3. Brief description of Practical / Practice activities

Module no.	Description	No. of hours
Total Practical / Practice hours (14 times 'P')		

18. 4. Brief description of module-wise activities pertaining to self-learning component (Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	Description
(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)	

19. 5. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter, Molecular Biology of the Cell, Sixth addition, Garland Science, Taylor & Francis, 2014
2. Gerald Carp, Cell and Molecular Biology: Concepts and Experiments, 7th edition,

2013

3. Harvey Lodish, Arnold Berk , Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Matthew P. Scott, Molecular Cell Biology, Seventh Edition, WH Freeman and Company–2012
4. Lehninger Principles of Biochemistry, David L. Nelson and Michael M. Cox Freeman ,Press 2012

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	Microsoft offices
20.2	Hardware	Desktop PC
20.3	Teaching aids (videos, etc.)	Chalk and Board
20.4	Laboratory	
20.5	Equipment	
20.6	Classroom infrastructure	LCD Projector
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	Eg. 25% of student time of practical / practice hours: sample Circuit Design exercises from industry
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date: (Signature of the Head of the Department/ Centre / School)

Date of Approval of Template by Senate	

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1.	**Department/Centre/School proposing the course**	**Chemistry**		
2.	**Course Title**	**4. Solid State Chemistry**		
3.	**L-T-P structure**	**3-0-0**		
4.	**Credits**	**3**	**Non-graded Units**	**Please fill appropriate details in S. No. 21**
5.	**Course number**	**CML665**		
6.	**Course Status (Course Category for Program) Program Elective**			

Institute Core for all UG programs	**No**
Programme Linked Core for:	
Departmental Core for:	
Departmental Elective for:	**M.Sc. Chemistry**
Minor Area / Interdisciplinary Specialization Core for:	
Minor Area / Interdisciplinary Specialization Elective for:	
Programme Core for:	
Programme Elective for:	**M.Sc. Chemistry**
Open category Elective for all other programs (No if Institute	**Yes**

7.	**Pre-requisite(s)**	Quantum chemistry, chemical thermodynamics

8.	**Status vis-à-vis other courses**		
8.1	List of courses precluded by taking this course (significant overlap)		1. None
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School	None
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	None
8.2	Supersedes any existing course		None

9.	**Not allowed for**	None

10.	**1. Frequency of offering** (check one box)	☐Every semester ☐I sem ☐II sem ☒Either semester

11.	**Faculty who will teach the course**	A Ramanan, Sameer Sapra, Pravin P Ingole, Ashok K Ganguli

12.	**Will the course require any visiting faculty?**	no

13.	**Course objectives** (about 50 words. "On successful completion of this course, a student should be able to…")**: Gain and understanding of solids, crystals, diffraction, bonding in solids, electronic structure of solids, magnetic properties of solids, superconductivity, luminescence and some recent trends in the subject.**

14.	**Course contents** (about 100 words; Topics to appear as course contents in the Courses of Study booklet) (Include Practical / Practice activities)**:** **Crystal chemistry (8 lectures); bonding in solids (3 lectures); defects and non stoichiometry (3 lectures); X-ray diffraction of solids (6 lectures); synthesis of solids (5 lectures); electronic and magnetic properties of solids (5 lectures); superconductivity (2 lectures); optical properties (3 lectures); luminescence and lasers (1 lecture); recent trends in solid state chemistry(6 lectures)**

15. Lecture Outline(with topics and number of lectures)

Module no.	**Topic**	**No. of hours** (not exceeding 5h per topic)
	Crystal chemistry	8
	Bonding in solids	3
	Defects and non-stoichiometry	3
	x-ray diffraction in solids	6
	Synthesis of solids	5
	Electronic and magnetic properties of solids	5
	Superconductivity	2
	Optical properties	3
	Luminescence and lasers	1
	Recent trends in solid state chemistry	6

Total Lecture hours (14 times 'L')		**42**

16. 2. Brief description of tutorial activities:

Module no.	Description	No. of hours
Total Tutorial hours (14 times 'T')		

17. 3. Brief description of Practical / Practice activities

Module no.	Description	No. of hours
Total Practical / Practice hours (14 times 'P')		

18. 4. Brief description of module-wise activities pertaining to self-learning component (Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	Description
(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)	

19. 5. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Solid State Chemistry, A. R. West, paperback edition, Wiley (2007)
2. Solid State Chemistry, L. E. Moore and E. A. Smart, 3rd edition, Taylor and Francis (2005)
3. Solid State Physics, N. W. Ashcroft and N. D. Mermin, Harcourt College Publishers (1976)
4. Current journal articles

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	Diamond, JCPDS, quantum espresso
20.2	Hardware	20 computers for the students to practice
20.3	Teaching aids (videos, etc.)	Projector, tablet laptop
20.4	Laboratory	Lab for solid state characterization
20.5	Equipment	Benchtop XRD, TEM, SEM, Magnetometer, ESCA
20.6	Classroom infrastructure	54 students
20.7	Site visits	Ore extraction and refinement – 2 visits, semiconductor industry – 2 visits
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	10% Design a particular solid with calculated properties
21.2	Open-ended problems	10% Journal paper based
21.3	Project-type activity	Projects on the synthesis and characterization of solids
21.4	Open-ended laboratory work	Good exposure to the above mentioned instruments
21.5	Others (please specify)	

Date: (Signature of the Head of the Department/ Centre / School)

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1.	**Department/Centre/School proposing the course**	Chemistry		
2.	**Course Title**	5. Statistical Mechanics & Molecular Simulation Methods		
3.	**L-T-P structure**	3-0-0		
4.	**Credits**	3	**Non-graded Units**	Please fill appropriate details in S. No. 21
5.	**Course number**	CML668		
6.	**Course Status** (Course Category for Program) Program elective			

Institute Core for all UG programs	No
Programme Linked Core for:	
Departmental Core for:	
Departmental Elective for:	
Minor Area / Interdisciplinary Specialization Core for:	
Minor Area / Interdisciplinary Specialization Elective for:	
Programme Core for:	
Programme Elective for:	
Open category Elective for all other programs (No if Institute Core)	No

7.	**Pre-requisite(s)**	None

8.	**Status vis-à-vis other courses**		
8.1	List of courses precluded by taking this course (significant overlap)		1. (course number)
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School	This is prelude of CYL726 and CYL801 and it has less than 10% overlap with both the courses.
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	None
8.2	Supersedes any existing course		CYL668

9.	**Not allowed for**	(indicate program names)

10.	**1. Frequency of offering** (check one box)	☐Every semester ☐I sem ☐II sem ☒Either semester

11.	**Faculty who will teach the course** (Minimum 2 names for core courses / 1 name for electives) Hemant K. Kashyap, Charusita Chakravarty and B. Jayaram

12.	**Will the course require any visiting faculty?**	No

13.	**Course objectives:** On successful completion of this course, a student should be able to appreciate microscopic connection between classical mechanics and thermodynamics. Students will be familiar with a high-level programming language and have a background in basic thermodynamics, statistical mechanics at the level of a standard physical chemistry. They will get acquainted with basics of molecular simulations which they can use to characterize any condensed phase system.

14.	**Course contents** Micro- and macroscopic state of a classical system, phase space, ergodicity and mixing in phase space. Theory of ensembles. Classical fluids. Phase transitions and relaxation phenomena. Monte Carlo, molecular dynamics and Brownian dynamics computer simulations. Brownian motion, Langevin equation. Elucidation of structural, dynamic and thermodynamic properties of complex fluids and soft matter.

15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours (not exceeding 5h per topic)
1.	Introduction to Fortran90 and Scripting	5
2.	Micro- and Macroscopic State of a System, Phase Space, Ergodicity and Mixing in Phase Space	3
3.	Connection of Statistical Mechanics with Classical Mechanics: Newtonian, Lagrangian and Hamiltonian Dynamics	3
4.	Ensembles and Postulates, Key Example: Ideal Gas, Fluids, Microcanonical (NVE), Canonical (NVT), Isothermal-isobaric (NPT) and Grand Canonical (μVT) ensembles.	5
5.	Intermolecular Forces and Potential Energy Models: (a) Rare Gases (b) Alkanes (c) Ionic melts and Room-Temperature Ionic Liquids (d) Water (e) Metals and Metalloids (f) Biomolecules	5

6.	Molecular Dynamics (MD):Equations of motion, Integration algorithms, Constraint dynamics, Periodic Boundary Condition and Minimum Image Convention, Structural and Dynamical Properties from MD	5
7.	Monte Carlo (MC): Markov Chains, Metropolis Algorithm, Structural Properties from MC, Central Limit Theorem	4
8.	Brownian Dynamics (BD): Brownian Motion, Langevin Equation, Mean Square displacement, Diffusion Constant and Velocity auto-correlations	5
9.	Scattering Experiments: The Pair Correlation Function	3
10.	Advance Topics: (a) Linear Response Theory: Green-Kubo relations, Computing Dynamical Properties, Complex Fluids and Soft Matter	4
Total Lecture hours (14 times 'L')		**42**

16. 2. Brief description of tutorial activities:

Module no.	Description	No. of hours
Total Tutorial hours (14 times 'T')		

17. 3. Brief description of Practical / Practice activities

Module no.	Description	No. of hours
Total Practical / Practice hours (14 times 'P')		

18. 4. Brief description of module-wise activities pertaining to self-learning component (Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not include assignments / term papers etc.)

Module no.	Description

(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)

19. 5. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. D. Chandler, Introduction to Modern Statistical Mechanics, First Edition, Oxford University Press, 1987.
2. D. A. McQuarrie, Statistical Mechanics, Second Edition, University Science Books, 2008.
3. M. P. Allen and D. J. Tildesley, Computer Simulation of Liquids, Oxford University Press, 1987.
4. D. Frenkel and B. Smit, Understanding Molecular Simulations: From Algorithms to Applications, Second Edition, Academic Press, 2002.
5. M. E. Tuckerman, Statistical Mechanics: Theory and Molecular Simulations, Oxford University Press, 2010.
6. D. L. Goodstein, States of Matter, Dover Publications, 2002.
7. K. A. Dill and S. Bromberg, Molecular Driving Forces: Statistical Thermodynamics in Chemistry and Biology, Garland Science, 2010.

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	Public domain softwares.
20.2	Hardware	Access to Computer Service Centre facilities.
20.3	Teaching aids (videos, etc.)	Description, Source , etc.
20.4	Laboratory	Type of facility required, number of students etc.
20.5	Equipment	Type of equipment required, number of access points, etc.
20.6	Classroom infrastructure	Overhead projection/Internet connectivity
20.7	Site visits	Type of Industry/ Site, typical number of visits, number of students etc.
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	Eg. 25% of student time of practical / practice hours: sample Circuit Design exercises from industry
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date: (Signature of the Head of the Department/ Centre / School)

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1.	**Department/Centre/School proposing the course**	Chemistry		
2.	**Course Title**	**6.** APPLIED BIOCATALYSIS		
3.	**L-T-P structure**	3-0-0		
4.	**Credits**	3	**Non-graded Units**	None
5.	**Course number**	CML695		
6.	**Course Status** (Course Category for Program)	**Elective**		

Institute Core for all UG programs	(Yes / No)
Programme Linked Core for:	
Departmental Core for:	
Departmental Elective for:	
Minor Area / Interdisciplinary Specialization Core for:	
Minor Area / Interdisciplinary Specialization Elective for:	
Programme Core for:	M.Sc Chemistry
Programme Elective for:	
Open category Elective for all other programs (No if Institute	(Yes)

7.	**Pre-requisite(s)**	NIL

8.	**Status vis-à-vis other courses**		
8.1	List of courses precluded by taking this course (significant overlap)		1.
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School	
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	
8.2	Supersedes any existing course		

9.	**Not allowed for**	

10.	**1. Frequency of offering** (check one box)	☐Every semester ☐I sem ☐II sem ☒ Either semester

11.	**Faculty who will teach the course** (Minimum 2 names for core courses / 1 name for electives) 1. Prof S K Khare 2. Dr Tanmay Dutta

12.	**Will the course require any visiting faculty?**	(No)

13.	**Course objectives** (about 50 words. "On successful completion of this course, a student should be able to…")**:** This course aims at educating the students about enzymes and biocatalysis with their applications in various industrial processes.

14.	**Course contents** (about 100 words; Topics to appear as course contents in the Courses of Study booklet) (Include Practical / Practice activities)**:** Introduction to enzymes and enzyme catalysed reactions. Classification and mechanism of reaction. Purification and characterization of enzymes. Michelis Menten kinetics, Industrial enzymes. Applications of enzymes in diagnostics, analysis, biosensors and other industrial processes and bio-transformations.Enzyme structure determination, stability and stabilisation. Enzyme immobilization and concept of enzyme engineering. Nanobiocatalysis.

15. Lecture Outline(with topics and number of lectures)

Module no.	**Topic**	**No. of hours** (not exceeding 5h per topic)
1.	Introduction to enzymes	3
2.	Enzyme catalysed reactions	4
3.	Classification and mechanism of reaction	3
4.	Purification and characterisation of enzymes	3
5.	Michaelis menten kinetics	3
6.	Industrial enzymes	3
7.	Applications of enzymes in diagnostics, analysis, biosensors and other industrial processes.	5

8	Bio-transformations	3
9.	Enzyme structure determination	4
10.	Stability and stabilization	3
11.	Enzyme immobilization and the concept of enzyme engineering	4
12.	Nanobiocatalysis	4
Total Lecture hours (14 times 'L')		**42**

16. 2. Brief description of tutorial activities:

Module no.	**Description**	**No. of hours**
	None	
Total Tutorial hours (14 times 'T')		

17. 3. Brief description of Practical / Practice activities

Module no.	**Description**	**No. of hours**
	None	
Total Practical / Practice hours (14 times 'P')		

18. 4. **Brief description of module-wise activities pertaining to self-learning component** (Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	**Description**
	Not applicable

(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)

19. 5. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Price and Stevens, Fundamentals of enzymology, Oxford University Press 2. Buchholz, Kasche and Bornscheuer, Biocatalysts and Enzyme Technology, Wiley 3. Polaina and MacCabe, Industrial Enzymes: Structure, Function and Applications, Springer

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	Enzo
20.2	Hardware	
20.3	Teaching aids (videos, etc.)	LCD projector
20.4	Laboratory	
20.5	Equipment	
20.6	Classroom infrastructure	Standard classroom
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	Eg. 25% of student time of practical / practice hours: sample Circuit Design exercises from industry
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date: (Signature of the Head of the Department/ Centre / School)

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1.	**Department/Centre/School proposing the course**	Chemistry		
2.	**Course Title**	**7.** Microbial Biochemistry		
3.	**L-T-P structure**	3-0-0		
4.	**Credits**	3	**Non-graded Units**	None
5.	**Course number**	CML 697		
6.	**Course Status** (Course Category for Program)	**Elective**		

Institute Core for all UG programs	(Yes / No)
Programme Linked Core for:	
Departmental Core for:	
Departmental Elective for:	
Minor Area / Interdisciplinary Specialization Core for:	
Minor Area / Interdisciplinary Specialization Elective for:	
Programme Core for:	M.Sc Chemistry
Programme Elective for:	
Open category Elective for all other programs (No if Institute	(Yes)

7.	**Pre-requisite(s)**	

8.	**Status vis-à-vis other courses**		
8.1	List of courses precluded by taking this course (significant overlap)		1.
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School	
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	>10%
8.2	Supersedes any existing course		

9.	**Not allowed for**	

10.	**1. Frequency of offering** (check one box)	☐Every semester ☐I sem ☐II sem ☒ Either semester

11.	**Faculty who will teach the course** (Minimum 2 names for core courses / 1 name for electives) 1. Prof S K Khare 2. Dr Tanmay Dutta

12.	**Will the course require any visiting faculty?**	(No)

13.	**Course objectives** (about 50 words. "On successful completion of this course, a student should be able to…")**:** To understand the biochemical principles and biochemistry of living systems through microbial cells as simplest model

14.	**Course contents** (about 100 words; Topics to appear as course contents in the Courses of Study booklet) (Include Practical / Practice activities)**:** Microscopic examination of microorganisms; classification; morphology and fine structure of microbial cells; cultivation, reproduction and growth; pure culture techniques; Basic microbial metabolisms; concepts of their genetics-transformation, transduction and conjugation, Important microorganisms and enzymes

15. Lecture Outline(with topics and number of lectures)

Module no.	**Topic**	**No. of hours** (not exceeding 5h per topic)
1.	Microscopic examination of microorganisms: simple, Gram and differential staining; principles of microscopy, SEM and TEM	3
2.	Classification, Nomenclature, and Identification of microorganisms	5
3.	Morphology and fine structure of microbial cells; morphological, biochemical and , cultural, metabolic characteristics; Cell wall and its associated structures (External and internal both); cellular organelles	5
4.	Cultivation and nutritional requirements, reproduction and growth cycle and its quantitative measurements	5
5.	Pure culture techniques	4
6.	Microbial metabolisms: energy production and utilization biosynthesis, aerobes and anaerobes	5

7.	Microbial genetics -transformation, transduction and conjugation Recombination and mutation	5
8	Important microorganisms- food, environment and biomedical related	5
9.	Microbial enzymes of industrial relevance	5
Total Lecture hours (14 times 'L')		**42**

16. 2. Brief description of tutorial activities:

Module no.	**Description**	**No. of hours**
	None	
Total Tutorial hours (14 times 'T')		

17. 3. Brief description of Practical / Practice activities

Module no.	**Description**	**No. of hours**
	None	
Total Practical / Practice hours (14 times 'P')		

18. 4. **Brief description of module-wise activities pertaining to self-learning component** (Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	**Description**
	Not applicable
(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)	

19. 5. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Microbial Biochemistry , 2010, Georges N. Cohen, Springer Prescott's Microbiology, 2013 Joanne Willey, Linda Sherwood, Christopher J. Woolverton, MacGraw Hill General Microbiology, 1987, Roger Y. Stanier, Macmillan Press Microbiology, 2010, Michael J Pelczar, ECS Chan, Noel R Krieg, Tata McGraw-Hill

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	
20.2	Hardware	
20.3	Teaching aids (videos, etc.)	LCD projector
20.4	Laboratory	
20.5	Equipment	
20.6	Classroom infrastructure	Standard classroom
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	Eg. 25% of student time of practical / practice hours: sample Circuit Design exercises from industry
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date: (Signature of the Head of the Department/ Centre / School)

Date of Approval of Template by Senate	

The information on this template is as on the date of its approval, and is likely to evolve with time.

COURSE TEMPLATE

(Please avoid changing the number of tables, rows and columns or text in dark black, but fill only the columns relevant to the template by editing the columns in grey letters or blank columns: this would help in automating the processing of template information for curricular use)

1.	**Department/Centre/School proposing the course**	**Chemistry**		
2.	**Course Title**	**8. Food Chemistry and Biochemistry**		
3.	**L-T-P structure**	**3-0-0**		
4.	**Credits**	**3.0**	**Non-graded Units**	Please fill appropriate details in S. No. 21
5.	**Course number**	**CML698**		
6.	**Course Status** (Course Category for Program) **Elective**			

Institute Core for all UG programs	(Yes / No)
Programme Linked Core for:	
Departmental Core for:	
Departmental Elective for:	
Minor Area / Interdisciplinary Specialization Core for:	
Minor Area / Interdisciplinary Specialization Elective for:	
Programme Core for:	M.Sc. Chemistry
Programme Elective for:	
Open category Elective for all other programs (No if Institute Core)	(Yes / No)

7.	**Pre-requisite(s)**	**NIL**

8.	**Status vis-à-vis other courses**		
8.1	List of courses precluded by taking this course (significant overlap)		1.
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School	
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	>10%
8.2	Supersedes any existing course		

9.	**Not allowed for**	**NIL**

10.	**1. Frequency of offering** (check one box)	☐ Every semester ☐ I sem ☐ II sem ☒ Either semester

11.	**Faculty who will teach the course** **Dr. S. K. Khare; Dr. Tanmay Dutta, Dr. N.G. Ramesh and Dr. R. P. Singh**

12.	**Will the course require any visiting faculty?**	**NO**

13.	**Course objectives** (about 50 words. "On successful completion of this course, a student should be able to…")**:** The students will develop an understanding of the properties of food constituents, and the interactions between these constituents. They will develop an understanding of the relationship between form and functionality of constituents. Students will gain an appreciation of the relationship between chemical composition and properties of macro constituents (like carbohydrates, proteins, lipids) and micro constituents (Vitamins, minerals, antioxidants, flavor and anti nutritional chemicals) and their functions in plant and animal based food. On completing this unit, students will be able to describe the chemical and biochemical properties of major food constituents.

14.	**Course contents** (about 100 words; Topics to appear as course contents in the Courses of Study booklet) (Include Practical / Practice activities)**:** Carbohydrates: Structure and functional properties of mono-oligo-polysaccharides including starch, cellulose, pectic substances and dietary fibers; Essential amino acids, Proteins and lipids in food and their impact on in functional properties; vitamins and minerals; Food flavours; Terpenes, esters, ketones and quinines; Food additives; Bioactive constituents in food: isoflavones, phenol and glycosides; Enzymes: Enzymatic and non-enzymatic browning, Enzymes in food processing, Oxidative enzymes; Food biochemistry: Balanced diet, PER, Antinutrients and toxins, nutrition deficiency diseases

15. Lecture Outline(with topics and number of lectures)

Module no.	**Topic**	**No. of hours** (not exceeding 5h per topic)
1.	Carbohydrates:L Structure and functional properties of mono-oligo-polysaccharides including starch, cellulose, pectic substances and dietary fibre	5
2.	Essential amino acids and fatty acids	4
3.	Proteins and lipids in food and their impact on functional properties	5
4.	Vitamins and minerals	4
5.	Food additives	3
6.	Food flavours; Terpenes, esters, Ketones and qyuinones	3
7.	Bioactive constituents in food: Isoflavones, phenols and glycosides	4
8.	Enzymes: Enzymatic and non-enzymatic browning; enzymes in food processing; oxidative enzymes	5

9.	Food biochemistry: Balanced diet, PER, Antinutrients and toxins	5
10.	Nutrition deficiency diseases	4
Total Lecture hours (14 times 'L')		**42**

16. 2. Brief description of tutorial activities: NOT APPLICABLE

Module no.	Description	No. of hours
Total Tutorial hours (14 times 'T')		

17. 3. Brief description of Practical / Practice activities

Module no.	Description	No. of hours
Total Practical / Practice hours (14 times 'P')		

18. 4. Brief description of module-wise activities pertaining to self-learning component (Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	Description
(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)	

19. 5. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

- H.D. Belitz et.al., Food Chemistry, 4th revised and extended ed., Springer, 2009
- Damodaran et.al., Fennema's Food Chemistry, 3rd edition, CRC Press, 2007

- Eskin and Shahidi, Biochemistry of Foods, 3rd edition, Academic Press, 2012
- B. Simpson et.al., Food Biochemistry and Food Processing, 2nd Edition, Jhon Wiley and Sons Inc., 2012

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	
20.2	Hardware	
20.3	Teaching aids (videos, etc.)	LCD Projector
20.4	Laboratory	
20.5	Equipment	
20.6	Classroom infrastructure	Standard Classroom
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	Eg. 25% of student time of practical / practice hours: sample Circuit Design exercises from industry
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

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