VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF ADVANCED SCIENCES

DEPARTMENT OF CHEMISTRY

Integrated M.Sc. in Chemistry

Curriculum & Syllabi

(2021–2022 Admitted Students)

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VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

- **World class Education**: Excellence in education, grounded in ethics and critical thinking, for improvement of life.
- **Cutting edge Research**: An innovation ecosystem to extend knowledge and solve critical problems.
- **Impactful People**: Happy, accountable, caring and effective workforce and students.
- **Rewarding Co-creations**: Active collaboration with national & international industries & universities for productivity and economic development.
- **Service to Society**: Service to the region and world through knowledge and compassion.

VISION STATEMENT OF SCHOOL OF ADVANCED SCIENCES

To be an internationally renowned science school in research and innovation by imparting futuristic education relevant to the society.

MISSION STATEMENT OF SCHOOL OF ADVANCED SCIENCES

- To nurture students from India and abroad by providing quality education and training to become scientists, technologists, entrepreneurs and global leaders with ethical values for a sustainable future.

- To enrich knowledge through innovative research in niche areas.

- To ignite passion for science and provide solutions for national and global challenges.

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Integrated M.Sc. in Chemistry

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO_01: Graduates will be practitioners and leaders in their chosen field.

PEO_02: Graduates will function in their profession with social awareness and responsibility.

PEO_03: Graduates will interact with their peers in other disciplines in their work place and society and contribute to the economic growth of the country.

PEO_04: Graduates will be successful in pursuing higher studies in their chosen field.

PEO_05: Graduates will pursue career paths in teaching or research.

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Integrated M.Sc. in Chemistry

PROGRAMME OUTCOMES (POs)

PO_01: Having a clear understanding of the subject related concepts and of contemporary issues.

PO_02: Having an ability to design and conduct experiments, as well as to analyse and interpret data.

PO_03: Having an ability to use techniques, skills and modern tools necessary for solving scientific problems.

PO_04: Having problem solving ability- solving social issues and societal problems Having cross cultural competency exhibited by working in teams.

PO_05: Having adaptive thinking and adaptability.

PO_06: Having a clear understanding of professional and ethical responsibility.

PO_07: Having cross cultural competency exhibited by working in teams.

PO_08: Having a good working knowledge of communicating in English.

PO_09: Having a good cognitive load management [discriminate and filter the available data] skills.

PO_10: Having interest in lifelong learning.

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Integrated M.Sc. in Chemistry

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion Integrated M.Sc. Chemistry (5yr.) Programme, graduates will be able to

PSO_1: Interpreting the various spheres of study in chemistry domains and thereby implementing the essence of each foundational aspect in practical situations

PSO_2: Developing an extensive comprehension on the basis of the elementary groundwork of pure and applied chemistry which can be extendable to other interdisciplinary fields and constructing distinctive ideas on the same

PSO_3: Practically administering principle concepts of chemistry through accordingly curated experiments, compiling observations, composing inferences, subsequently articulating well-substantiated conclusions and further data interpretation

PSO_4: Conducting individual exploration and appropriate reconnaissance on real world complications to perform thorough research, through industrial visits and be a part of solution to the societal problems.

Category Credit Detail			
Sl.No.	**Description**	**Credit**	**Maximum Credit**
1	FC - Foundation Core	50	50
2	DC - Discipline Core	68	68
3	DE - Discipline Elective	45	45
4	PI - Projects and Internship	14	14
5	OE - Open Elective	6	6
6	AE - Ability Enhancement	9	9
7	SE - Skill Enhancement	8	8
Total Credits		200	

Foundation Core									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credit**
1	TBIT101L	Biological Science	Theory Only	1.0	3	0	0	0	3.0
2	TBIT101P	Biological Science Lab	Lab Only	1.0	0	0	2	0	1.0
3	TCHY102L	Inorganic and Organic Chemistry	Theory Only	1.0	3	0	0	0	3.0
4	TCHY102P	Inorganic and Organic Chemistry Lab	Lab Only	1.0	0	0	2	0	1.0
5	TCHY103L	Physical and Analytical Chemistry	Theory Only	1.0	3	0	0	0	3.0
6	TCHY103P	Physical and Analytical Chemistry Lab	Lab Only	1.0	0	0	2	0	1.0
7	TCSE103L	Programming in Python	Theory Only	1.0	2	0	0	0	2.0
8	TCSE103P	Programming in Python Lab	Lab Only	1.0	0	0	4	0	2.0
9	TCSE104L	Structured and Object Oriented Programming	Theory Only	1.0	2	0	0	0	2.0
10	TCSE104P	Structured and Object Oriented Programming Lab	Lab Only	1.0	0	0	4	0	2.0
11	TFLE200L	M.Sc. (5 Year Integrated Programme) - Foreign Language - 2021	Basket	1.0	0	0	0	0	2.0
12	THUM101L	Ethics and Values	Theory Only	1.0	2	0	0	0	2.0
13	TMAT103L	Calculus and Analytical Geometry	Theory Only	1.0	3	0	0	0	3.0
14	TMAT103P	Calculus and Analytical Geometry Lab	Lab Only	1.0	0	0	2	0	1.0
15	TMAT104L	Ordinary and Partial Differential Equations	Theory Only	1.0	3	1	0	0	4.0
16	TMGT401L	Principles of Management	Theory Only	1.0	3	0	0	0	3.0
17	TPHY102L	Physics of Waves	Theory Only	1.0	3	0	0	0	3.0
18	TPHY102P	Physics of Waves Lab	Lab Only	1.0	0	0	2	0	1.0
19	TPHY103L	Modern Physics	Theory Only	1.0	3	0	0	0	3.0
20	TPHY103P	Modern Physics Lab	Lab Only	1.0	0	0	2	0	1.0
21	TRES101L	Research Methodology	Theory Only	1.0	3	0	0	0	3.0
22	TSSC201L	Critical Thinking	Theory Only	1.0	2	0	0	0	2.0
23	TSSC202L	Intra and Interpersonal Skills	Theory Only	1.0	2	0	0	0	2.0

Discipline Core									
sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credit
1	TCHY203L	Organic Chemistry	Theory Only	1.0	4	0	0	0	4.0
2	TCHY204P	Systematic Qualitative and Quantitative Analysis of Simple Organic Molecules	Lab Only	1.0	0	0	4	0	2.0
3	TCHY401L	Advanced Organic Chemistry	Theory Only	1.0	3	0	0	0	3.0
4	TCHY401P	Advanced Organic Chemistry Lab	Lab Only	1.0	0	0	4	0	2.0
5	TCHY402L	Advanced Inorganic Chemistry	Theory Only	1.0	3	0	0	0	3.0
6	TCHY403L	Quantum Chemistry and Spectroscopy	Theory Only	1.0	3	1	0	0	4.0
7	TCHY404L	Modern Methods in Organic Synthesis	Theory Only	1.0	3	0	0	0	3.0
8	TCHY405L	Materials Chemistry	Theory Only	1.0	3	0	0	0	3.0
9	TCHY406P	Inorganic Materials Lab	Lab Only	1.0	0	0	4	0	2.0
10	TCHY407L	Electro and Surface Analytical Techniques	Theory Only	1.0	3	0	0	0	3.0
11	TCHY407P	Electro and Surface Analytical Techniques Lab	Lab Only	1.0	0	0	4	0	2.0

Discipline Elective									
sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credit
1	TCHY206L	Green Chemistry	Theory Only	1.0	3	0	0	0	3.0
2	TCHY210L	Stereochemistry and Spectroscopy	Theory Only	1.0	3	1	0	0	4.0
3	TCHY307L	States of Matter and Colloids	Theory Only	1.0	3	1	0	0	4.0
4	TCHY308L	Coordination and Organometallic Chemistry	Theory Only	1.0	3	1	0	0	4.0
5	TCHY309L	Industrial Organic Chemistry	Theory Only	1.0	3	0	0	0	3.0
6	TCHY310L	Energy Storage Devices	Theory Only	1.0	3	0	0	0	3.0
7	TCHY311L	Separation Techniques	Theory Only	1.0	3	0	0	0	3.0
8	TCHY312L	Food Chemistry	Theory Only	1.0	3	0	0	0	3.0
9	TCHY315L	Materials of Industrial Importance	Theory Only	1.0	3	0	0	0	3.0
10	TCHY390J	Study Project	Project	1.0	0	0	0	0	3.0
11	TCHY392J	Design Project	Project	1.0	0	0	0	0	3.0
12	TCHY393J	Laboratory Project	Project	1.0	0	0	0	0	3.0
13	TCHY397J	Special Project	Project	1.0	0	0	0	0	3.0
14	TCHY408L	Computational Chemistry	Theory Only	1.0	3	0	0	0	3.0
15	TCHY409L	Group Theory for Chemists	Theory Only	1.0	3	0	0	0	3.0
16	TCHY411L	Bioinorganic Chemistry	Theory Only	1.0	3	0	0	0	3.0
17	TCHY412L	Asymmetric Synthesis	Theory Only	1.0	3	0	0	0	3.0
18	TCHY413L	Advanced Spectroscopy	Theory Only	1.0	3	0	0	0	3.0
19	TCHY414L	Biophysical Chemistry	Theory Only	1.0	3	0	0	0	3.0
20	TCHY416L	Medicinal Chemistry	Theory Only	1.0	3	0	0	0	3.0
21	TCHY417L	Quality Control and Quality Assurance	Theory Only	1.0	3	0	0	0	3.0
22	TCHY418L	Inorganic Photochemistry and Spectroscopy	Theory Only	1.0	3	0	0	0	3.0
23	TCHY419L	Organic Photochemistry	Theory Only	1.0	3	0	0	0	3.0

Discipline Elective									
24	TCHY420L	Industrial Catalysis	Theory Only	1.0	3	0	0	0	3.0

Projects and Internship									
sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credit
1	TCHY497J	Project	Project	1.0	0	0	0	0	2.0
2	TCHY498J	Research Project I	Project	1.0	0	0	0	0	4.0
3	TCHY499J	Research Project II / Internship	Project	1.0	0	0	0	0	8.0

Open Elective									
sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credit
1	TCHY313L	Nanomaterials	Theory Only	1.0	3	0	0	0	3.0
2	TCHY314L	Dyes and Pigments	Theory Only	1.0	3	0	0	0	3.0
3	TCHY421L	Surface Analytical Techniques	Theory Only	1.0	3	0	0	0	3.0
4	TCHY422L	Pharmaceutical Technology	Theory Only	1.0	3	0	0	0	3.0
5	TCHY423L	Drug Design	Theory Only	1.0	3	0	0	0	3.0
6	TCHY424L	Biophysics	Theory Only	1.0	3	0	0	0	3.0
7	TCHY425L	Organic Electronics and Sensors	Theory Only	1.0	3	0	0	0	3.0
8	TCHY426L	Phytochemistry	Theory Only	1.0	3	0	0	0	3.0
9	TCHY427L	Bioinformatics	Theory Only	1.0	3	0	0	0	3.0
10	TCHY428L	Bioanalytical and Forensic Analysis	Theory Only	1.0	3	0	0	0	3.0
11	TCHY429L	Intellectual Property Rights	Theory Only	1.0	3	0	0	0	3.0
12	TCHY430L	Inorganic Materials of Industrial Importance	Theory Only	1.0	3	0	0	0	3.0
13	TCHY431L	Bioorganic Chemistry	Theory Only	1.0	3	0	0	0	3.0

Ability Enhancement									
sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credit
1	TCHY140L	Environmental Studies	Theory Only	1.0	3	0	0	0	3.0
2	TCHY410L	Polymer Chemistry	Theory Only	1.0	3	0	0	0	3.0
3	TENG101L	Effective English Communication	Theory Only	1.0	2	0	0	0	2.0
4	TENG102L	Technical English Communication	Theory Only	1.0	2	0	0	0	2.0
5	TENG102P	Technical English Communication Lab	Lab Only	1.0	0	0	2	0	1.0
6	TENG103P	Technical Report Writing	Lab Only	1.0	0	0	2	0	1.0

Skill Enhancement									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credit**
1	TCHY201P	Analytical Instrumentation	Lab Only	1.0	0	0	4	0	2.0
2	TCHY202P	Sophisticated Analytical Instrumentation	Lab Only	1.0	0	0	4	0	2.0
3	TCSE201E	Programming in Java	Embedded Theory and Lab	1.0	3	0	2	0	4.0

Integrated Master of Science in Chemistry

School of Advanced Sciences

	B.Sc.	B.Sc.(Hons)	B.Sc.(Research)	M.Sc.
Foundation Core Courses	47	47	47	50
Discipline Core Courses	43	55	55	68
Discipline Elective Courses	21	33	33	45
Ability Enhancement Compulsory Courses	09	09	09	09
Skill Enhancement Elective Courses	04	04	04	08
Open Elective Courses	00	06	00	06
Project and Internship	00	06	12	14
Total Graded Credit Requirement	124	160	160	200

Programme Credit Structure	**Credits**
Foundation Core Courses	50
Discipline Core Courses	68
Discipline Elective Courses	45
Ability Enhancement Compulsory Courses	09
Skill Enhancement Elective Courses	08
Open Elective Courses	06
Project and Internship	14
Total Graded Credit Requirement	200

Foundation Core Courses **50**

		L	T	P	C
TMAT103L	Calculus and Analytical Geometry	3	0	0	3
TMAT103P	Calculus and Analytical Geometry Lab	0	0	2	1
TPHY102L	Physics of Waves	3	0	0	3
TPHY102P	Physics of Waves Lab	0	0	2	1
TCHY102L	Inorganic and Organic Chemistry	3	0	0	3
TCHY102P	Inorganic and Organic Chemistry Lab	0	0	2	1
TCSE103L	Programming in Python	2	0	0	2
TCSE103P	Programming in Python Lab	0	0	4	2
THUM101L	Ethics and Values	2	0	0	2
TMAT104L	Ordinary and Partial Differential Equations	3	1	0	4
TPHY103L	Modern Physics	3	0	0	3
TPHY103P	Modern Physics Lab	0	0	2	1
TBIT101L	Biological Sciences	3	0	0	3
TBIT101P	Biological Sciences Lab	0	0	2	1
TCHY103L	Physical and Analytical Chemistry	3	0	0	3
TCHY103P	Physical and Analytical Chemistry Lab	0	0	2	1
TCSE104L	Structured and Object Oriented Programming	2	0	0	2
TCSE104P	Structured and Object Oriented Programming Lab	0	0	4	2
TSSC201L	Critical Thinking	2	0	0	2
TSSC202L	Intra and Interpersonal Skills	2	0	0	2
TRES101L	Research Methodology	3	0	0	3
TMGT401L	Principles of Management	3	0	0	3
TFLE200L	Foreign Language	2	0	0	2

Discipline Core Courses **68**

TCHY203L	Organic Chemistry	4	0	0	4
TCHY204P	Systematic Qualitative and Quantitative Analysis of Simple Organic Molecules	0	0	4	2
TCHY205E	Lab Safety Training	1	0	2	2
TCHY207L	Physical Chemistry	4	0	0	4
TCHY207P	Physical Chemistry Lab	0	0	4	2
TCHY208L	Inorganic Chemistry	4	0	0	4
TCHY209P	Inorganic Quantitative Analysis Lab	0	0	4	2
TCHY301L	Transition and Inner Transition Elements	4	0	0	4
TCHY302L	Chemistry of Heterocyclic and Natural Products	4	0	0	4
TCHY303L	Instrumental Methods in Chemical Analysis	3	0	0	3
TCHY303P	Instrumental Methods of Analysis Lab	0	0	4	2
TCHY304P	Organic Compounds Synthesis and Extraction Lab	0	0	4	2
TCHY305L	Chemical Kinetics, Catalysis and Surface Chemistry	4	0	0	4
TCHY305P	Kinetics and Catalysis Lab	0	0	4	2
TCHY306P	Inorganic Synthesis Lab	0	0	4	2
TCHY401L	Advanced Organic Chemistry	3	0	0	3
TCHY401P	Advanced Organic Chemistry Lab	0	0	4	2
TCHY402L	Advanced Inorganic Chemistry	3	0	0	3
TCHY403L	Quantum Chemistry and Spectroscopy	3	1	0	4

TCHY404L	Modern Methods in Organic Synthesis	3	0	0	3
TCHY405L	Materials Chemistry	3	0	0	3
TCHY406P	Inorganic Materials Lab	0	0	4	2
TCHY407L	Electro and Surface Analytical Techniques	3	0	0	3
TCHY407P	Electro and Surface Analytical Techniques Lab	0	0	4	2

Discipline Elective Courses **45**

TCHY206L	Green Chemistry	3	0	0	3
TCHY210L	Stereochemistry and Spectroscopy	3	1	0	4
TCHY307L	States of Matter and Colloids	3	1	0	4
TCHY308L	Coordination and Organometallic Chemistry	3	1	0	4
TCHY309L	Industrial Organic Chemistry	3	0	0	3
TCHY310L	Energy Storage Devices	3	0	0	3
TCHY311L	Separation Techniques	3	0	0	3
TCHY312L	Food Chemistry	3	0	0	3
TCHY315L	Materials of Industrial Importance	3	0	0	3
TCHY408L	Computational Chemistry	3	0	0	3
TCHY409L	Group Theory for Chemists	3	0	0	3
TCHY410L	Polymer Chemistry	3	0	0	3
TCHY411L	Bioinorganic Chemistry	3	0	0	3
TCHY412L	Asymmetric Synthesis	3	0	0	3
TCHY413L	Advanced Spectroscopy	3	0	0	3
TCHY414L	Biophysical Chemistry	3	0	0	3
TCHY415L	Contemporary Chemistry	3	0	0	3
TCHY416L	Medicinal Chemistry	3	0	0	3
TCHY417L	Quality Control and Quality Assurance	3	0	0	3
TCHY418L	Inorganic Photochemistry and Spectroscopy	3	0	0	3
TCHY419L	Organic Photochemistry	3	0	0	3
TCHY420L	Industrial Catalysis	3	0	0	3
TCHY390J	Study Project				3
TCHY392J	Design Project				3
TCHY393J	Laboratory Project				3
TCHY395J	Computer Project				3
TCHY397J	Special Project				3

Ability Enhancement Compulsory Courses **9**

TENG101L	Effective English Communication	2	0	0	2
TENG102L	Technical English Communication	2	0	0	2
TENG102P	Technical English Communication Lab	0	0	2	1
TENG103P	Technical Report Writing	0	0	2	1
TCHY140L	Environmental Studies	3	0	0	3

Skill Enhancement Elective Courses **8**

TCSE201E	Programming in Java	3	0	2	4
TCHY201P	Analytical Instrumentation	0	0	4	2
TCHY202P	Sophisticated Analytical Instrumentation	0	0	4	2

Open Elective Courses **9**

TCHY313L	Nanomaterials	3	0	0	3
TCHY314L	Dyes and pigments	3	0	0	3
TCHY421L	Surface Analytical Techniques	3	0	0	3
TCHY422L	Pharmaceutical Technology	3	0	0	3
TCHY423L	Drug Design	3	0	0	3
TCHY424L	Biophysics	3	0	0	3
TCHY425L	Organic Electronics and sensors	3	0	0	3
TCHY426L	Phytochemistry	3	0	0	3
TCHY427L	Bioinformatics	3	0	0	3
TCHY428L	Bioanalytical and Forensic analysis	3	0	0	3
TCHY429L	Intellectual Property Rights	3	0	0	3
TCHY430L	Inorganic Materials of Industrial Importance	3	0	0	3
TCHY431L	Bioorganic Chemistry	3	0	0	3

Project and Internship **14**

TCHY497J	Project	2
TCHY498J	Research Project I	4
TCHY499J	Research Project II / Internship	8

Integrated M.Sc. Chemistry Semester wise Curriculum

First Year							
Semester-I				**Semester-II**			
Course Code	**Course**	**L-T-P**	**C**	**Course Code**	**Course**	**L-T-P**	**C**
TENG101L	Effective English Communication	0-0-4	2	TENG102L	Technical English Communication	2-0-0	2
				TENG102P	Technical English Communication laboratory	0-0-2	1
TCHY140L	Environmental Studies	3-0-0	3				
TCSE103L	Programming in Python	2-0-0	2	TCSE104L	Structured and Object Oriented Programming	2-0-0	2
TCSE103P	Programming in Python lab	0-0-4	2				
TMAT103L	Calculus and Analytical Geometry	3-0-0	3	TCSE104P	Structured and Object Oriented Programming Lab	0-0-4	2
TMAT103P	Calculus and Analytical Geometry lab	0-0-2	1	TMAT104L	Ordinary and Partial Differential equations	3-1-0	4
TPHY102L	Physics of Waves	3-0-0	3	TPHY103L	Modern Physics	3-0-0	3
TPHY102P	Physics of Waves Lab	0-0-2	1	TPHY103P	Modern Physics laboratory	0-0-2	1
TCHY102L	Inorganic and Organic Chemistry	3-0-0	3	TBIT101L	Biological Sciences	3-0-0	3
				TBIT101P	Biological Sciences Laboratory	0-0-2	1
TCHY102P	Inorganic and Organic Chemistry lab	0-0-2	1	TCHY103L	Physical and Analytical Chemistry	3-0-0	3
				TCHY103P	Physical and Analytical Chemistry Lab	0-0-2	1
TCHY101N	Introduction to Science (NGC)	2-0-0	2				
Total Credits			**21**	**Total Credits**			**23**
Second Year							
Semester-III				**Semester-IV**			
Course Code	**Course**	**L-T-P**	**C**	**Course Code**	**Course**	**L-T-P**	**C**
TSSC201L	Critical thinking	2-0-0	2	TSSC202L	Intra and interpersonal skills	2-0-0	2
TENG103P	Technical Report Writing laboratory	0-0-2	1	TFRE101L	Foreign Language (French 1)	2-0-0	2
				TCHY208L	Inorganic Chemistry	4-0-0	4
TCSE201E	Programming in Java	3-0-0	3	TCHY207L	Physical Chemistry	4-0-0	4
TCSE201E	Programming in Java lab	0-0-2	1	TCHY210L	Stereochemistry and Spectroscopy (D.Elective-I)	3-1-0	4
TRES101L	Research Methodology	3-0-0	3				
TCHY203L	Organic Chemistry	4-0-0	4	TCHY209P	Inorganic Quantitative Analysis Laboratory	0-0-4	2
TCHY204P	Systematic Qualitative and Quantitative Analysis of Simple Organic Molecules (lab)	0-0-4	2	TCHY207P	Physical Chemistry Laboratory	0-0-4	2
				THUM101L	Ethics and Values	2-0-0	2
TCHY205E	Lab Safety Training (Theory)	1-0-0	1				
TCHY205E	Lab Safety Training (Lab)	0-0-2	1				
Total Credits			**18**	**Total Credits**			**22**
Third Year							
Semester-V				**Semester-VI**			
Course Code	**Course**	**L-T-P**	**C**	**Course Code**	**Course**	**L-T-P**	**C**
TCHY307L	States of Matter and Colloids (D.Elective-II)	3-1-0	4				
				TCHY39XJ	Discipline Elective-IV (Project)		3
TCHY301L	Transition and Inner transition elements	4-0-0	4	TCHY308L	Coordination and Organometallic Chemistry (D.Elective-V)	3-1-0	4
TCHY302L	Chemistry of Heterocyclic and Natural Products	4-0-0	4	TCHY305L	Chemical Kinetics, Catalysis and Surface Chemistry	4-0-0	4
TCHY303L	Instrumental Methods of Chemical analysis	3-0-0	3	TCHY305P	Kinetics and Catalysis Laboratory	0-0-4	2
				TCHY306P	Inorganic Synthesis Laboratory	0-0-4	2
TCHY303P	Instrumental methods of Analysis Laboratory	0-0-4	2		Discipline Elective - VI	3-0-0	3
TCHY304P	Organic Compounds Synthesis and Extraction laboratory	0-0-4	2				
TCHY311L	Separation Techniques (D.Elective-III)	3-0-0	3				
Total Credits			**22**	**Total Credits**			**18**
B.Sc. Chemistry Exit Option with 124 credits							

Fourth Year							
Semester-VII				**Semester-VIII**			
Course Code	**Course**	**L-T-P**	**C**	**Course Code**	**Course**	**L-T-P**	**C**
				TCHY497J	Project II	0-0-0	2
				TCHY404L	Modern Methods in Organic Synthesis	3-0-0	3
TCHY401L	Advanced Organic Chemistry	3-0-0	3				
TCHY401P	Advanced Organic Chemistry Lab	0-0-4	2	TCHY405L	Materials Chemistry	3-0-0	3
				TCHY406P	Inorganic Materials Laboratory	0-0-4	2
TCHY402L	Advanced Inorganic Chemistry	3-0-0	3	TCHY407L	Electro and Surface Analytical techniques	3-0-0	3
TCHY403L	Quantum Chemistry and Spectroscopy	3-1-0	4				
	Discipline Elective-VII	3-0-0	3	TCHY407P	Electro and Surface Analytical techniques Laboratory	0-0-4	2
	Discipline Elective-VIII	3-0-0	3		Discipline Elective-XI	3-0-0	3
	Discipline Elective-IX	3-0-0	3		Open Elective I	3-0-0	3
	Discipline Elective-X	3-0-0	3		Open Elective II	3-0-0	3
					Project for Honors		6
					Project for Research		12
Total Credits			**24**	**Total Credits**			**24**
B.Sc. Hons Exit Option with 160 credits (124 + 24 (7th sem) + 6 (OE 8th Sem) + 6 (project)) **B.Sc. Research Exit Option with 160 credits (124 + 24 (7th sem) + 12 (project))**							
Fifth Year							
Semester-IX				**Semester-X**			
Course Code	**Course**	**L-T-P**	**C**	**Course Code**	**Course**	**L-T-P**	**C**
TCHY498J	Project - Stage 1	0-0-0	4				
	Discipline Elective-XII	3-0-0	3				
	Discipline Elective-XIII	3-0-0	3				
	Discipline Elective-XIV	3-0-0	3	TCHY499J	Project – Stage-2	0-0-0	8
TCHY201P	Analytical Instrumentation	0-0-4	2				
TCHY202P	Sophisticated Analytical Instrumentation	0-0-4	2				
TMGT401L	Principles of Management	3-0-0	3				
Total Credits			**20**	**Total Credits**			**8**
M.Sc. Chemistry with 200 credits							

VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF ADVANCED SCIENCES

DEPARTMENT OF CHEMISTRY

Integrated M.Sc. in Chemistry

Foundation Core Courses

TMAT103L	Calculus and Analytical Geometry	L	T	P	C
		3	0	0	3
Pre-requisite	**Nil**	**Syllabus version**			
		1. 0			

Course Objectives

1. To reinforces calculus to give a better understanding of the mathematical concepts underlying them and to prepare students for more advanced mathematics.
2. To Learn to analyze and solve problems relating analytical geometry and vector calculus.
3. To consider problems that could be solved by applying appropriate theories, principles and concepts relevant to functions, continuity, derivatives, analytic geometry and vectors.

Course Outcome

At the end of this course the students should be able to

1. To Apply single variable differentiation and integration to solve applied problems in engineering and find the maxima and minima of functions.
2. Evaluate partial derivatives, limits, total differentials, Jacobians, Taylor series and optimization problems involving several variables with or without constraints.
3. Apply integrals to find area and volume and to find masses, moments, force, work and energy.
4. Study the equations of lines, planes and spheres and the role of direction cosines and direction ratio.
5. Evaluate the line, surface and volume integral of a scalar and vector fields and apply Green's, Gauss' and Stoke's theorems.

Module:1	**Differential calculus and its geometrical applications**	**7 hours**

Review of continuity and differentiability, Successive differentiation, Leibnitz's rule, Taylor's and Maclaurin's expansions, Indeterminate forms, Tangent and Normal, Curvature, Evolutes and envelopes

Module:2	**Functions of several variables**	**6 hours**

Limit and continuity, Partial Differentiation-Euler's Theorem, Chain rule, Total differentiation, Differentiation of implicit functions, Taylor's series expansion, Jacobians-Change of variables, Maxima and minima, Lagrange multiplier method

Module:3	**Integral calculus**	**6 hours**

Integration-Definite integral, Average value, Length of a plane curve, Areas, Volumes-washer method, disk method, Area of a surface of revolution, Fundamental theorem of Calculus and its consequences, Improper integral, Differentiation under Integral sign-Leibnitz rule

Module:4	**Multiple integrals and their applications**	**5 hours**

Double and triple integrals, Change of order of integration, Change of variables, Areas and volumes, Masses, moments, Force, Work and energy

Module:5	**Analytical solid geometry**	**7 hours**

Coordinate systems and their interrelation, Direction cosines and direction ratios, Projection on a straight line, Angle between straight lines, Equation of plane, Shortest distance between the skew-lines, length of perpendicular from a given point to a given plane, Bisectors of the angles between two planes, Orthogonal projection on a plane, Sphere.

Module:6	**Vector differentiation**	**6 hours**

Scalar, vector fields and level Surfaces, Differentiation-Gradient, Tangent plane and normal, Directional derivative, Divergence and curl

Module:7	**Vector integration**	**6 hours**

Vector Integration, Line integrals, Surface integrals, Green's theorem in plane, Stokes's theorem, volume integrals, Divergence theorem			
Module:8	**Contemporary issues**		**2 hours**
Guest Lecture from industry and R&D organisations			
	Total Lecture hours:		**45 hours**
Text Book(s)			
1. George B. Thomas, Joel Hass, Christopher Heil, Maurice D. Weir, Thomas' Calculus, 2018, 14th edition, Pearson, India 2. Shanti Narayan, P. K. Mittal, Analytical Solid Geometry, 2007, 17th edition, S. Chand & Co., India			
Reference Books:			
1. Karl J. Smith, Monty J. Strauss, Magdalena D. Toda, Calculus, 2017, 7th edition, Kendall Hunt Publishing Company, USA 2. Saturnino L. Salas, Garret J. Etgen, Einar Hille, Calculus One and Several Variables, 2021, 10th edition, Wiley, India			
Mode of Evaluation: CAT, Written assignment , Quiz , FAT			
Recommended by Board of Studies	24.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TMAT103P	Calculus and Analytical Geometry Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives

1. To familiarize with the basic syntax, semantics and library functions of MATLAB which serves as a tool not only in calculus but also many courses in engineering and sciences.
2. To visualize mathematical functions and its related properties.
3. To evaluate single and multiple integrals and understand it graphically.

Course Outcome

At the end of the course the student should be able to:

1. Demonstrate MATLAB code for challenging problems in engineering
2. Using plots/displays, interpret and illustrate elementary mathematical functions and procedures.

Indicative Experiments (Any 10 experiments to be performed)

1.	To plot and visualize curves and surfaces in MATLAB – Symbolic computations using MATLAB
2.	To evaluate limits and Derivatives of functions
3.	To investigate applications of differentiation and study maxima and minima of a function of single variable
4.	To analyze maxima and minima of a function of two variables
5.	To write Taylor's and Maclaurin's series up to finite terms
6.	To evaluate integrals and find area, volume of solid of revolution
7.	To calculate double and triple integrals
8.	To find equation of line and angle between two planes
9.	To study divergence, curl and gradient and visualize vector fields
10.	To evaluate line integral and work done
	Total Laboratory Hours **30 hours**

Text Book(s)

1. Cesar Lopez, MATLAB Differential and Integral Calculus, 2014, 1st Edition, Apress
2. Ronald L. Lipsman, Jonathan M. Rosenberg, Multivariable Calculus with MATLAB: With Applications to Geometry and Physics, 2018, 1st edition Springer

Mode of assessment: Continuous assessments, Oral, FAT

Recommended by Board of Studies	24.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TPHY102L	Physics of Waves	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To develop deeper insights to cut through various fields of Physics.
2. To provide expertise for solving the differential equations which arise in simple mathematical models for oscillations and waves.
3. To hone the foundation of various Physics courses such as pre-quantum theory, optics, acoustics etc.

Course Outcome

At the end of the course the student will be able to

1. Comprehend the simple harmonic motion in various physical systems.
2. Explain the damped as well as forced oscillations in realistic physical systems.
3. Recall the theoretical ideas of complex vibrations using Fourier series.
4. Understand the ideas of transverse, longitudinal and standing waves in various physical systems.
5. Apply the knowledge of various types of oscillations and vibrations for designing simple machines.

Module:1	**Simple harmonic motion**	**5 hours**
Oscillations in physical systems, Spring-mass system- Time period and frequency, Harmonic oscillator in one-dimension and its solutions, Superposition of simple harmonic oscillations, Lissajous figures.		
Module:2	**Damped oscillations**	**6 hours**
Damped harmonic oscillator, solution of the differential equation of damped oscillator. Energy considerations, relaxation time, quality factor		
Module:3	**Forced oscillations**	**6 hours**
Differential equation of forced oscillator and its solution, amplitude resonance and velocity resonance.		
Module:4	**Complex vibrations**	**8 hours**
Fourier theorem and evaluation of the Fourier coefficients, analysis of periodic wave functions-square wave, triangular wave, saw tooth wave.		
Module:5	**Transverse waves: Vibrating strings**	**6 hours**
Transverse wave propagation along a stretched string, general solution of wave equation and its significance, modes of vibration of stretched string clamped at ends, overtones, energy transport and transverse impedance. Hertz's experiment.		
Module:6	**Longitudinal waves: Vibration of bars**	**6 hours**
Longitudinal vibrations in bars-wave equation and its general solution. Special cases i) bar fixed at both ends ii) bar fixed at the mid point iii) bar free at both ends iv) bar fixed at one end. Tuning fork.		
Module:7	**Standing waves**	**6 hours**
Standing waves, Reflection and transmission of waves at a boundary, Impedance matching, Wave packet, Phase velocity and group velocity. Tuning fork (revisited).		
Module:8	**Contemporary issues**	**2 hours**
Guest lectures by industry and R & D organizations		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	H. J. Pain, The Physics of Vibrations and Waves, Sixth Edition, 2013, Wiley Publications, USA.

Reference Books			
1. 2. 3. 4	N. Bajaj, The Physics of Waves and Oscillations, 2017, Tata McGraw Hill, India. Walter Fox Smith, Waves and Oscillations, 2010, Oxford University Press, New York, USA. Arnt Inge Vistnes, Physics of Oscillations and Waves-with use of MATLAB and PYTHON, 2016, Springer, Switzerland. Howard Georgi, The Physics of Waves, 2015, Prentice Hall, New Jersey, USA.		
	Authors, book title, year of publication, edition number, press, place		
Mode of Evaluation: CAT, Written assignment, Quiz and FAT			
Recommended by Board of Studies	26.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TPHY102P	Physics of Waves Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To gain hands on experience with spring-mass system for understanding various types of motions.
2. To learn the basics of waves by doing various types of experiments in different fields of Physics such as quantum theory, optics, acoustics etc.

Course Outcome

At the end of the course the student will be able to
1. Comprehend the various types of motions/oscillations and the behaviour of waves in ideal and real physical systems.
2. Apply the knowledge of various types of oscillations and vibrations for performing experiments in different fields of Physics such as quantum theory, optics, acoustics etc.
3. Analyze the theoretical modelling of harmonic oscillation experiments using software packages.

Indicative List of Experiments	
1.	To demonstrate the simple harmonic motion –spring mass system
2.	To demonstrate the standing waves on a string
3.	To demonstrate the Lissajous figures using CRO
4.	To determine the frequency of the alternating current using a sonometer
5.	To determine the frequency and velocity of ultrasonic wave
6.	To generate electromagnetic wave using Hertz's experiment
7.	To determine the wavelength of sodium light using Newton's ring method
8.	To determine the wavelength of a He-Ne laser source using an optical grating
9.	To determine the refractive index of a given prism
10.	To determine the frequency of the alternating current using a sonometer
	Total Laboratory Hours **30 hours**

Mode of assessment: Continuous assessment, Oral examination and FAT			
Recommended by Board of Studies	26.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TCHY102L	Inorganic and Organic Chemistry	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at

1. Imparting the knowledge on the structure, bonding and reaction mechanisms of inorganic and organic compounds.
2. Making the students to understand stereochemistry and conformational aspects in molecular level with three dimensional perspective which enables to understand reaction mechanism

Course Outcome:

At the end of the course, the students should be able to

1. Understand the basics of atomic structure and the periodic properties.
2. Discuss bonding characteristics of inorganic compounds.
3. Analyse various theories to understand bonding in inorganic compounds.
4. Examine the electronic effects of organic compounds.
5. Relate the concepts of bonding isomerism and stereochemistry.
6. Utilize the concepts of hybridization in different hydrocarbons.

Module:1	**Atomic Structure and periodic properties**	**6 hours**

Electronic configuration - filling of orbitals - stability of filled and semi filled orbitals - shapes and energy of atomic orbitals. Quantum numbers - Bohr's model of atom-Heisenberg uncertainty principle-Pauli's exclusion principle, Hund's rules maximum multiplicity- Aufbau principle. Periodic Properties-Atomic radii, ionic radii, covalent radii-ionisation potential-electronegativity and electron affinity.

Module:2	**Chemical Bonding**	**6 hours**

Types of bonding, Ionic Bond-conditions for bond formation-energetics of NaCl formation-Born-Haber cycle, hydration and lattice energies, Fajan's rule. Covalent bond-Conditions for bond formation-bond polarity-overlap of orbitals-bond length and energies-hybridisation-sigma and pi bond- coordinate – covalent bond.

Module:3	**Bonding in Inorganic Molecules**	**8 hours**

VSEPR theory - $BeCl_2$, BF_3, XeF_4, PCl_5, SF_6 and IF_7. Sidgwick's Theory - EAN rule - Theory of Bonding - Valence Bond Theory, MO theory. Relative order of Energies of molecular orbitals - MO diagram of H_2, He_2, O_2, O^{2+}, O^{2-}, N_2 and CO - Bond Order.

Module:4	**Basic Concepts of Organic Chemistry**	**6 hours**

Electronic Effects: Inductive, Inductomeric and Electromeric effects, resonance, hyperconjugation, steric effect (Hammett and Taft equation). Cleavage of bonds: homolytic and heterolytic C-C bond fission- Reaction Intermediates and their structure, stability and reactivity of intermediates: carbocations, carbanions and free radicals, carbenes and nitrenes.

Module:5	**Bonding and Hybridisation in Organic Molecules**	**6 hours**

Bonding in organic molecules-hybridisation-geometry of molecules-alkanes, alkenes, alkyne and benzene, benzyne; pKa, pKb, pH, polarity of molecules-organic acids and bases: Factors affecting the strength of acids and bases.

Module:6	**Stereochemistry**	**6 hours**

Concept of Isomerism, Classification of Stereoisomers- configurational (cis, trans or E, Z-alkenes, cycloalkanes) Wedge formula, Fischer projection, Newman projection and its interconversion. Application of Newman Projection to understand reaction mechanism.

Optical isomerism, Chirality & elements of symmetry- Chiral, achiral, prochiral, enantiomers, meso form, diastereoisomerism, akamp isomerism and atropisomerism.		
Module:7	**Alkanes, Alkenes and Alkynes**	**5 hours**
Alkanes, Alkenes and Alkynes: Synthesis (any three methods), Physical, Chemical properties and industrially important molecules and its applications.		
Module:8	**Contemporary issues**	**2 hours**
Guest lectures by industry and R & D organizations		
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Morrison R. T., Boyd R. N. and Bhattacharjee S. K., Organic Chemistry, Seventh Edition, Pearson Prentice Hall, 2011.
2. J.D. Lee, Concise Inorganic Chemistry, Oxford University Press, 5th Edition, 2014.

Reference Books

1. Peter K., Vollhardt, C., and Schore N. E., Organic Chemistry, W. H. Freeman and Company, 2010.
2. Pine S. H., Organic Chemistry, Tata McGraw Hill, 5th edition, 2008.
3. T. Overton, F. Armstron, J. Rourke and M. Weller. Inorganic Chemistry, 6th Edition, Oxford University Press, 2015.
4. J.E. Huheey, E.A. Keiter, R.L.. Keiter and O.K. Medhi Inorganic Chemistry: Principles of Structure and Reactivity, 4th Edition, Pearson Education, 2006.

Mode of Evaluation: CAT, Quiz , Assignments, FAT

Recommended by Board of Studies	28.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TCHY102P	Inorganic and Organic Chemistry Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

The course is aimed at
1. Imparting the knowledge on qualitative analysis of inorganic and organic compounds.
2. Understanding the principles of quantitative chemical analysis and synthetic methods of simple organic compounds.

Course Outcome

At the end of the course, the student should be able to
1. Understand the concepts of qualitative and quantitative analyses.
2. Estimate different components in given analytes.
3. Develop synthetic and experimental skills for real time sample analysis

Indicative Experiments	
1	Acid-base titration: Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture
2	Redox titration: Estimation of Fe(II) and oxalic acid using standardized KMnO4 solution.
3	Redox titration: Estimation of ferrous and ferric ions in a mixture
4	Iodometry – Estimation of copper
5	Precipitation Titration: Determination of chloride
6	Acid-Base titrations: Estimation of free alkali present in different soaps/detergents
7	Systematic Qualitative organic analysis -1
8	Systematic Qualitative organic analysis -2
9	Determination of optical rotation for the hydrolysis of sucrose into glucose and fructose using Polari meter
10	Synthesis of *tert.* butyl chloride from *tert.* Butanol
11.	Single step synthesis : Synthesis of benzoic acid from benzaldehyde by oxidation method

Total Laboratory Hours	**30 hours**
Mode of assessment: Lab assessments, Viva-Voce, FAT	
Recommended by Board of Studies	28.06.2021
Approved by Academic Council	No. 63 Date 23.09.2021

TCSE103L	Programming in Python	L	T	P	C
		2	0	0	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. To introduce core programming basics required for science using Python language
2. To read and write simple Python programs
3. To develop Python programs with conditionals and loops
4. To use Python data structures – lists, tuples, dictionaries
5. To introduce the important science modules SymPy, NumPy, SciPy, Pandas and Matplotlib
6. To introduce the input/output with files in Python and statistical processing of a data

Course Outcome:

At the end of the course students will be able to:

1. Read, write, execute simple Python programs
2. Decompose a Python program into functions
3. Manipulate with 1-d,2-d and multidimensional data using Python
4. Data Visualization using Python
5. Read and write data from/to files in Python programs
6. Develop algorithmic solutions to science related problems

Module:1	**Algorithmic Problem Solving**	**3 hours**

Algorithms, building blocks of algorithms (statements, state, control flow, functions); algorithmic problem solving; iteration, recursion. Illustrative problems: flow chart, finding minimum in a list, factorial of a number.

Module:2	**Data, Expressions, Statements in Python**	**4 hours**

Python Strengths and Weakness; Installing Python; IDLE - Spyder – Jupyter; Mutable and Immutable Data Types, Naming Conventions; String Values; String Operations; String Slices; String Operators; String functions. Numeric Data Types; Arithmetic Operators and Expressions; Comments in the Program;

Module:3	**Data Collection and Language Component of Python**	**4 hours**

List; Tuples; Sets; Dictionaries; Operations on List, Tuple , Set, Dictionary; Control Flow and Syntax; Indenting; The if statement; Relational Operators; Logical Operators; Bit-wise Operators; The while Loop – break and continue statements; The for Loop; List Comprehension

Module:4	**Functions in Python**	**4 hours**

Functions - Introduction; Defining your own functions; parameters; local and global scope; passing collections to a function; variable number of arguments; passing functions to a function; Lambda function; map; filter.

Module:5	**Modules for Science**	**3 hours**

Modules: Introduction; Standard Modules – sys, math, time, sympy, random.

Module:6	**Handling Scientific Data in Python**	**5 hours**

NumPy arrays – 1-d, multidimensional arrays and matrices; Mathematical operations with arrays; Slicing and addressing arrays; Boolean masks; Difference between lists and arrays SciPy – Scientific Computing library of Python – Introduction, Basic functions, Special functions, scipy.integrate, scipy.optimize, scipy.interpolate

Module:7	**Data Visualization and Analysis of Data in Python**	**5 hours**

Python Plotting: PyPlot – Basic Plotting; Logarithmic Plots; Plots with multiple axes; Matplotlib – interactive functions 3d plotting; Pandas – Introduction, Data Frame, Reading

and writing CSV, XLS files, Working with missing data, categorical data, data visualization with pandas		
Module:8	**Contemporary issues: (**Industry Expert Lecture**)**	**2 hours**
Research and Development problems related to Scientific Domains		
Total Lecture Hours		**30 hours**

Text Book(s)	
1.	David J. Pine, Introduction to Python for Science and Engineering, CRC Press, 2019.
2.	Robert Johansson, Numerical Python – Scientific Computing and Data Science Applications with NumPy, SciPy and Matplotlib, Apress, 2019
Reference Book(s)	
1.	Robert Sedgewick, Kevin Wayne, Robert Dondero, Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016
2.	Nelli, F., Python Data Analytics: with Pandas, NumPy and Matplotlib, Apress, 2018.
3.	Jake vander Plas, Python Data Science Handbook – Essential Tools for Working with Data, O'Really Media, 2017

Mode of Evaluation: CAT, Quiz, Digital Assignment and FAT.			
Recommended by Board of Studies	12-07-2021		
Approved by Academic Council	63	Date	23.09.2021

TCSE103P	Programming in Python Lab	L	T	P	C
		0	0	4	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. To introduce core programming basics required for data science using Python language
2. To read and write simple Python programs
3. To develop Python programs with conditionals and loops
4. To use Python data structures – lists, tuples, dictionaries
5. To introduce the important science modules SymPy, NumPy, SciPy, Pandas and Matplotlib
6. To introduce the input/output with files in Python and statistical processing of a data

Course Outcome:

At the end of the course students will be able to:

1. Read, write, execute simple Python programs
2. Decompose a Python program into functions
3. Manipulate with 1-d,2-d and multidimensional data using Python
4. Read and write data from/to files in Python programs
5. Develop algorithmic solutions to science related problems

List of Challenging Experiments (Indicative)

1. *First Basic Experiment(s):* (i) "Hello World!" Program in IDLE, Jupyter, Spyder Environments. (ii) Program(s) to demonstrate the Python data types
2. Python Operators, Expressions and Flow Controls
3. Python Lists, Tuples, Dictionaries & Sets
4. Python Functions, Modules and Packages
5. Python Symbolic Computation and Random Number generation
6. Array and Matrix Manipulation in Python
7. Data Manipulation – SciPy Module
8. Data Visualization in Python – PyPlot Module
9. Data Manipulation using Pandas
10. Descriptive Statistical Analysis – Evaluation, Plotting and Interpretation
11. Evaluation of Probability using various Distributions Functions
12. Linear and Nonlinear Regression in Python

	Total Laboratory Hours	**60 hours**	
Mode of assessment: CAT / Written Assignment / Quiz / FAT / Project.			
Recommended by Board of Studies	12-07-2021		
Approved by Academic Council	No. 63	Date	23.09.2021

THUM101L	Ethics and Values	L	T	P	C
		2	0	0	2
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives:

1. To understand and appreciate the ethical issues faced by an individual in profession, society and polity.
2. To understand the negative health impacts of certain unhealthy behavior.
3. To appreciate the need and importance of physical, emotional health and social health.

Course Outcomes:

Students will be able to:

1. Follow sound morals and ethical values scrupulously to prove as good citizens.
2. Understand various social problems and learn to act ethically.
3. Understand the concept of addiction and how it will affect the physical and mental health.
4. Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects.
5. Identify the main typologies, characteristics, activities, actors and forms of cybercrime.

Module:1	**Being Good and Responsible**	**5 hours**
Gandhian values such as truth and non-violence – Comparative analysis on leaders of past and present – Society's interests versus self-interests - Personal Social Responsibility: Helping the needy, charity and serving the society.		
Module:2	**Social Issues 1**	**4 hours**
Harassment – Types - Prevention of harassment, Violence and Terrorism.		
Module:3	**Social Issues 2**	**4 hours**
Corruption: Ethical values, causes, impact, laws, prevention – Electoral malpractices; White collar crimes - Tax evasions – Unfair trade practices.		
Module:4	**Addiction and Health**	**5 hours**
Peer pressure - Alcoholism: Ethical values, causes, impact, laws, prevention – Ill effects of smoking - Prevention of Suicides; Sexual Health: Prevention and impact of pre-marital pregnancy and Sexually Transmitted Diseases.		
Module:5	**Drug Abuse**	**3 hours**
Abuse of different types of legal and illegal drugs: Ethical values, causes, impact, laws and prevention.		
Module:6	**Personal and Professional Ethics**	**4 hours**
Dishonesty - Stealing - Malpractices in Examinations – Plagiarism.		
Module:7	**Abuse of Technologies**	**3 hours**
Hacking and other cyber crimes, Addiction to mobile phone usage, Video games and Social networking websites.		
Module 8	**Contemporary Issues**	**2 hours**
	Total Lecture Hours:	**30 hours**

Text Books :

1. R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Values and Professional Ethics", 2019, 2nd Revised Edition, Excel Books, New Delhi.

2.	Hartmann, N., "Moral Values" , 2017, United Kingdom: Taylor & Francis.
Reference Books :	
1.	Rachels, James & Stuart Rachels, "The Elements of Moral Philosophy", 9th edition, 2019, New York: McGraw-Hill Education.
2.	Blackburn, S. "Ethics: A Very Short Introduction", 2001, Oxford University Press.
3.	Dhaliwal, K.K , "Gandhian Philosophy of Ethics: A Study of Relationship between his Presupposition and Precepts", 2016, Writers Choice, New Delhi, India.
4	Ministry of Social Justice and Empowerment, "Magnitude of Substance Use in India", 2019, Government of India.
5.	Ministry of Home Affairs, "Accidental Deaths and Suicides in India", 2019, Government of India.
6.	Ministry of Home Affairs, "A Handbook for Adolescents/ Students on Cyber Safety", 2018, Government of India.
Mode of Evaluation: Poster making, Quiz, Assignment, CAT and Term End Examination	

Recommended by Board of Studies	27-10-2021		
Approved by Academic Council	No. 64	Date	16-12-2011

TPHY103L	Modern Physics	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To understand the dual nature of matter and radiation.
2. To apply Schrödinger equations to solve finite and infinite potential problems and apply quantum ideas at the nanoscale.
3. To model the atomic and nuclear structure.

Course Outcomes

At the end of the course the student will be able to

1. Compare and contrast the properties of waves and particles.
2. Apply uncertainty principle to estimate position and energy.
3. Model matter waves using tools of quantum mechanics.
4. Apply Schrödinger equation to confined particles and predict tunnelling probability.
5. Demonstrate knowledge on atomic and nuclear structure and appreciate nuclear reactions.

Module:1	**Particle properties of waves**	**7 hours**
Blackbody radiation, Planck's quantum theory of light, idea of quantization (Planck and Einstein), Photoelectric effect, Compton scattering.		
Module:2	**Wave properties of particle**	**7 hours**
Double slit experiment with electrons, de Broglie waves, Davisson Germer experiment, wave function and probability interpretation, construction of wave packets (phase velocity and group velocity).		
Module:3	**Measurement of position and energy**	**6 hours**
Heisenberg uncertainty principle, Heisenberg's microscope (Gedanken experiment), application to virtual particles and range of an interaction.		
Module:4	**Wave mechanics**	**5 hours**
Linear superposition principle, probability and normalization, operators, expectation values: position, momentum, energy, Schrödinger equation for non-relativistic particles.		
Module:5	**Application of wave mechanics**	**6 hours**
Eigenvalues and eigenfunction of particle confined in one- dimensional box - 3 dimensional box (qualitative), quantum confinement and quantum dots.		
Module:6	**Atomic structure**	**6 hours**
Bohr atom model, energy levels and spectra, optical spectra, special terms and notations, selection rule, fine structure of sodium D lines, Zeeman effect- theory and experiment, Stark effect.		
Module:7	**Nuclear structure**	**6 hours**
Nuclear composition, stable nuclei, Liquid drop model (qualitative), Shell model (qualitative), radioactive decay, half-life, alpha, beta, gamma decay, nuclear fission and fusion.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. A. Beiser, S. Mahajan, S. R. Choudhury, Concepts of Modern Physics, 7th edition, 2017, McGraw- Hill., India.
2. H. D. Young and R. A. Freedman, University Physics with Modern Physics, 15th edition, 2019, Pearson, UK.

Reference Books			
1.	K. Krane, Modern Physics, 4th Edition, 2016, Wiley Indian Edition.		
2.	D. J. Griffiths, D. F. Schroeter, Introduction to Quantum Mechanics, 3rd Edition, 2019, Cambridge University Press, UK.		
3.	B. R. Martin, G. Shaw, Nuclear and Particle Physics: An Introduction, 3rd Edition, 2019, Wiley, USA.		
Mode of Evaluation: CAT, Written assignment, Quiz and FAT			
Recommended by Board of Studies	26-06-2021		
Approved by Academic Council	No. 64	Date	16-12-2011

TPHY103P	Modern Physics Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To apply theoretical knowledge gained in the theory course and get hands-on experience of the topics.

Course Outcomes

At the end of the course the student will be able to:

1. Comprehend the dual nature of radiation and matter by means of experiments.
2. Get hands-on experience on the topics of quantum mechanical ideas in the laboratory.
3. Apply quantum mechanical ideas to atomic physics experiment.

Indicative Experiments

1.	Determination of Planck's constant using LED.
2.	Determination of work function of a metal using Photoelectric effect.
3.	Demonstration of Black body spectrum of light intensity for a given light source.
4.	Determination of phase velocity and group velocity of EM waves.
5.	Demonstration of wave nature of electrons through electron diffraction.
6.	Demonstration of tunnelling effect in tunnel diode using I-V characteristics.
7	Demonstration of Heisenberg Uncertainty Principle.
8	Determination of wavelength of Sodium D1 and D2 lines.
9	Determination of the ionization potential of mercury.
10	Numerical solutions of Schrödinger equation (e.g., particle in a box problem).

Total Laboratory Hours	**30 hours**

Mode of assessment: Continuous assessment, FAT and Oral examination

Recommended by Board of Studies	26-06-2021		
Approved by Academic Council	No. 64	Date	16-12-2011

TBIT101L	Biological Science	L	T	P	C
		3	0	0	3
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives

1. Recall the understanding of origin and diversity of biological beings
2. Contrast the fundamental concepts of organization and principles of living systems
3. Illustrate the basic concepts of heredity

Course Outcomes

1. Relate the basic concepts of biology including diversity, evolution and ecology
2. Demonstrate the structural and functional organization of the cell
3. Analyze the biological flow of information at the molecular level
4. Outline the metabolic pathways governing cellular function
5. Distinguish the organismal complexities in animals and plants
6. Interpret the genetic basis of hereditary traits and diseases

Module:1	**Origin and Diversity of Living Systems**	**7 hours**

Basis of life – diversification of life including viruses, Chemical basis of life – early origin of life experiments, Concept of evolution and natural selection, Levels of ecological study, Biotic and abiotic factors in ecosystem

Module:2	**The Cellular System**	**6 hours**

Cell as fundamental unit of life, Structure of a prokaryotic cell, Structure of a eukaryotic cell, Cell division – mitosis and meiosis

Module:3	**Molecules of Life**	**6 hours**

Structures and functions of biomolecules – carbohydrates, lipids, nucleic acids, and proteins

Module:4	**Metabolic Systems**	**6 hours**

Redox reactions, ATP energy coupling, Glycolysis, TCA cycle, Electron transport chain and ATP-synthesis

Module:5	**Molecular Information**	**6 hours**

Central dogma of molecular biology, DNA and genetic code, Replication, Transcription, Translation

Module:6	**Overview of Plant and Animal Systems**	**6 hours**

Plant forms and functions, Plant cells and tissue systems, Animal forms and functions, Animal tissues, organs, and systems, Animal homeostasis

Module:7	**Genetics and Heredity**	**6 hours**

Mendel's experiment – monohybrid cross and dihybrid cross, Linkage and crossing over, Mendel's laws of inheritance, Genetics of human diseases

Module:8	**Contemporary issues**	**2 hours**

Lecture by Industry Experts

	Total Lecture hours:	**45 hours**

Text Book

1. Freeman S, Quillin K, Allison L, Black M, Taylor E, Biological Science, 2017, 6th edition Prentice Hall, USA

Reference Books

1. Urry LA, Cain ML, Wasserman SA, Minorsky PV, Orr R, Campbell Biology, 2021, 12th edition,. Pearson Publisher, USA
2. Enger ED, Ross FC, Bailey DB, Concepts in Biology, 2017, 14th edition, Tata McGraw-Hill Publishing Co Ltd, India

Mode of Evaluation: CAT, Assignment, Quiz, and FAT

Recommended by Board of Studies	30-06-2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TBIT101P	Biological Science Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives

1. To develop a basic understanding and practical knowledge of biological beings, their constituents and their functionalities.

Course Outcome

1. Able to interprete the structure-function relationships in biological beings and their constituents.

Indicative Experiments

1.	Principles and handling of microscope and studying the diversity of cells using permanent slides (morphology of bacteria, fungi and algae)	2-4 hours each experiments
2.	Identifying bacteria through Gram's staining	--do--
3.	Study of mitotic stages in onion roots	--do--
4.	Extraction of eukaryotic DNA	--do--
5.	Quantitative estimation of protein	--do--
6	Qualitative assay of salivary amylase	--do--
7	Rate of photosynthesis in plant	--do--
8	Tissue and organ structures in animal and plant from permanent slides	--do--
9	Testing Mendelian ratio by Chi square test	--do--
10	Human genetic variation study in facial feature in the class group	--do--
	Total Laboratory Hours	**30**

Mode of assessment: Continuous assessment, FAT and Oral examination

Recommended by Board of Studies	30-06-2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TCHY103L	Physical and Analytical Chemistry	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The Course is aimed at

1. To make the student understand the concepts of equilibrium, Thermodynamics, chemical Kinetics and surface chemistry.
2. To impart knowledge on analysis of errors and evaluation of determinate and indeterminate errors which can be applied in volumetric methods of analysis and acid-base, redox systems concepts.

Course Outcomes

1. Apply the concepts in chemical equilibrium reaction calculations.
2. Analyse the thermodynamics of chemical reactions.
3. Evaluate the rate of chemical reactions and factors influencing them.
4. Utilise adsorption isotherms for understanding surface reactions.
5. Introduce concepts of errors and deviations in volumetric analysis.
6. Use electrochemical concepts in study of redox reactions by conductivity and EMF measurements.

Module:1	**Chemical and Ionic Equilibria**	**6 hours**

Chemical equilibrium: law of mass action; Kp, Kc and Kx; LeChatelier's principle, solubility product; Concepts of a strong, weak acids and bases; pH scale; Henderson-Hasselbach equations;

Buffer solutions: Acid-base indicators; Ionic equilibrium: monoprotic, diprotic, and triprotic acids; pH, pOH: measurements and significance, solubility products.

Module:2	**Thermodynamics**	**6 hours**

Thermodynamic processes – Cyclic, Reversible, Irreversible, Isothermal, Isobaric, Adiabatic; Exact and Inexact Differentials - Heat and Work - Zeroth Law of Thermodynamics. Zeroth law of thermodynamics, First law of Thermodynamics - Cp and Cv Relationship - calculation of w, q, ΔE and ΔH for expansion of Ideal Gases under reversible, Isothermal and adiabatic Conditions.

Module:3	**Chemical Kinetics**	**7 hours**

Rate of a chemical reaction. Order and molecularity of chemical reactions, Factors influencing rates of chemical reactions; Rate equations for zero-, first- and second-order reactions - equal and unequal concentrations of reactants. Half-life period; Determination of order of reaction- differential method, method of integration, half-life period method, isolation method.

Module:4	**Surface Chemistry**	**6 hours**

Difference between adsorption and absorption. Physical and chemical adsorption--desorption. Adsorption isotherms: Gibbs, Langmuir, BET, other isotherms - measurement of surface area using adsorption isotherms, Freundlich adsorption isotherm and its experimental verification. Adsorption indicators.

Module:5	**Errors in Chemical Analysis**	**7 hours**

Classification of analytical methods- classical and instrumental, basis of their classification with examples. Classification - systematic or Determinate errors – additive, proportional; Types – instrumental, operative, errors of method; Random errors – Gaussian distribution; Accuracy-absolute error and relative error; Precision – uncertainty; Propagation of systematic and random errors. Standard deviation, relative standard deviation- related numerical.

Module:6	**Acid -Base concept and redox systems**	**6 hours**

Arrhenius concept, Brønsted-Lowry acids and bases, Lewis acids and bases, Acid and base

strength. Theory of electron transfer- redox reactions-electrochemical concepts in the study of redox systems – study of acid base and redox reactions by pH,conductivity and emf measurements		
Module:7	**Volumetric analysis**	**5 hours**
Principles of Volumetric analysis-molarity-molality-normality-mole fraction-calculations-primary and secondary standards-equivalent weight of acid, base, salt, oxidising agent and reducing agents. Theories of Acid-Base, redox, precipitation, complexometric, iodometric and iodimetric titrations-Theories of indicators-acid base, redox.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Skoog and West Fundamentals of Analytical Chemistry by F. James Holler, Donald M. West, Stanley R. Crouch. Cengage Learning EMEA; 9th edition (2013)
2.	Atkins Physical Chemistry,11th Edition By Peter Atkins, Julio De Paula, James Keeler, Oxford University press, 2018.
Reference Books	
1.	Analytical Chemistry, Gary Christian, 6th Edition, John Wiley & Sons, New York, 2004.
2.	Chemical Kinetics, Keith James Laidler, J. Keith, Professor Emeritus of Chemistry Keith J Laidler Harper & Row, 1987.
3.	Principles Of Physical Chemistry, by B.R. Puri, L.R. Sharma, M.S. Pathania. 47th edition (2016), Vishal Publishing Co, India.
4.	Vogel's Text book of Quantitative Chemical Analysis, G. H. Jeffery j. Bassett J. Mendham R C. Denney, 5th Edition, Longman Scientific and Technical and John Wiley & Sons, New York, 1989.
Mode of Evaluation: CAT, Quiz, Assignments, FAT	

Recommended by Board of Studies	28-06-2021		
Approved by Academic Council	No. 64	Date	16-12-2011

TCHY103P	Physical and Analytical Chemistry Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at

1. Understand the principles and methods of Conductivity, monitoring redox reactions using electrochemical methods.
2. Impart the concepts of monitoring the kinetics of chemical reactions.

Course Outcomes

1. Apply the concepts of electrochemical measurements in redox titrations.
2. Design experiments for monitoring rates of chemical reactions including surface reactions.
3. Evaluate the dissociation constant and partition coefficient of chemical reactions.

Indicative Experiments	
1.	Estimation of Chloride by Conductometry
2.	Determination of concentration of an acid using pH measurement method
3	Thermodynamics functions from EMF measurements : Zinc – silver chloride system
4	Determination of partition coefficient of iodine in CCl_4 and water
5.	Adsorption of acetic acid on charcoal
6.	Estimation of Ferrous ion by potassium permanganate using potentiometry
7.	Acid catalyzed hydrolysis of an ester- Determination of rate constant
8.	Ionization constant of a weak acid
9.	Kinetics of persulphate and iodide second order reaction
10.	Dissociation constant of methyl red

Total Laboratory Hours	30 hours
Mode of assessment: Lab assessment, Viva-Voce and FAT	

Recommended by Board of Studies	28-06-2021		
Approved by Academic Council	No. 64	Date	16-12-2011

TCSE104L	Structured and Object Oriented Programming	L	T	P	C
		2	0	0	2

Pre-requisite	NIL	Syllabus version
		1.0

Course Objectives

1. To impart the basic constructs in structured programming and object-oriented programming paradigms.
2. To inculcate the insights and benefits in accessing memory locations by implementing real world problems.
3. To help solving real world problems through appropriate programming paradigms.

Course Outcome

At the end of the course, students should be able to:

1. Understand different programming language constructs and decision-making statements; manipulate data as a group.
2. Recognize the application of modular programming approach; create user defined data types and idealize the role of pointers.
3. Comprehend various elements of object-oriented programing paradigm; propose solutions through inheritance and polymorphism; identify the appropriate data structure for the given problem and devise solution using generic programming techniques.

Module:1	C Programming Fundamentals	3 hours

Variables - Reserved words – Data Types – Operators – Operator Precedence - Expressions - Type Conversions - I/O statements - Branching and Looping: if, if-else, nested if, if-else ladder, switch statement, goto statement - Loops: for, while and do…while – break and continue statements.

Module:2	Arrays, Functions	4 hours

Arrays: One Dimensional array - Two-Dimensional Array – Strings and its operations. User Defined Functions: Declaration – Definition – call by value and call by reference - Types of Functions - Recursive functions - Storage Classes - Scope, Visibility and Lifetime of Variables.

Module:3	Pointers	4 hours

Declaration and Access of Pointer Variables, Pointer arithmetic – Dynamic memory allocation – Pointers and arrays - Pointers and functions.

Module:4	Structure and Union	3 hours

Declaration, Initialization, Access of Structure Variables - Arrays of Structure - Arrays within Structure - Structure within Structures - Structures and Functions – Pointers to Structure – Union – Linked list

Module:5	Overview of Object-Oriented Programming	4 hours

Features of OOP - Classes and Objects - “this” pointer - Constructors and Destructors - Static Data Members, Static Member Functions and Objects - Inline Functions – Call by reference - Functions with default Arguments - Functions with Objects as Arguments - Friend Class and Friend Functions

Module:6	Inheritance	4 hours

Inheritance - Types of Inheritance: Single inheritance, Multiple Inheritance, Multi-level Inheritance, Hierarchical Inheritance - Multipath Inheritance - Inheritance and constructors.

Module:7	**Polymorphism and Generic Programming**	**6 hours**
Function Overloading - Operator Overloading – Dynamic Polymorphism - Virtual Functions - Pure virtual Functions - Abstract Classes - Function templates and class templates, Standard Template Library		
Module:8	**Contemporary issues**: (Industry Expert Lecture)	**2 hours**
Research and Development problems related to Scientific Domains		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Herbert Schildt, C: The Complete Reference, 4th Edition, McGraw Hill Education, 2017
2.	Herbert Schildt, C++: The Complete Reference, 4th Edition, McGraw Hill Education, 2017.
Reference Books	
1.	Yashavant Kanetkar, Let Us C: 17th Edition, BPB Publicaitons, 2020.
2.	Stanley Lippman and Josee Lajoie, C++ Primer, 5th Edition, Addison-Wesley publishers, 2012.

Mode of Evaluation: CAT / Written Assignment / Quiz / FAT / Project.			
Recommended by Board of Studies	12-07-2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TCSE104P	Structured and Object Oriented Programming Lab	L	T	P	C
		0	0	4	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To impart the basic constructs in structured programming and object-oriented programming paradigms.
2. To inculcate the insights and benefits in accessing memory locations by implementing real world problems.
3. To solve real world problems through appropriate programming paradigms.

Course Outcome

At the end of the course, students should be able to:

1. Understand different programming language constructs and decision-making statements; manipulate data as a group.
2. Recognize the application of modular programming approach; create user defined data types and idealize the role of pointers.
3. Comprehend various elements of object-oriented programing paradigm; propose solutions through inheritance and polymorphism; identify the appropriate data structure for the given problem and devise solution using generic programming techniques.

	Indicative Experiments
1.	Programs using basic control structures, branching and looping
2.	Experiment the use of 1-D, 2-D arrays and strings and Functions
3.	Demonstrate the application of pointers
4.	Experiment structures and unions
5.	Programs on basic Object-Oriented Programming constructs.
6.	Demonstrate various categories of inheritance
7.	Program to apply kinds of polymorphism.
8.	Develop generic templates and Standard Template Libraries.
	Total Laboratory Hours | **60 hours**

Mode of assessment: CAT / Written Assignment / Quiz / FAT / Project.			
Recommended by Board of Studies	12-07-2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TSSC201L	Critical Thinking	L	T	P	C
		2	0	0	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. To understand the importance of critical thinking.
2. To diagnose need analysis as well as to identify ways of improving them.
3. To describe and apply the nuances of decision making and problem-solving.

Course Outcomes:

1. Execute the basic tools of critical and lateral thinking in solving real life issues.
2. Develop coherent and critical thinking required for academic and corporate environments.
3. Integrate leadership, decision making and motivational strategies for the professional milieu.
4. Apply informal logical concepts to contemporary scenarios.

Module:1	**Introduction to Critical Thinking in Academic Contexts**	**4 hours**
History of Critical Thinking- - Basic Tools for Critical thinking - Strategies to be adopted for lateral thinking.		
Module:2	**Critical Thinking in Reading and Argumentation**	**4 hours**
Finding and evaluating the line of reasoning in a text - Identifying false premises and flawed reasoning - Recognizing good and bad arguments.		
Module:3	**Skills & Procedure**	**4 hours**
Socratic questioning in a professional environment - Differentiating between different types of statements - Grammar for Critical Thinking.		
Module:4	**Purpose of adopting Critical Thinking**	**4 hours**
Necessity - Professional Excellence - Personality Development - Qualities of a Critical Thinker.		
Module:5	**Decision-Making Skills**	**4 hours**
Cost-Benefit - Narrow Down the Options - Evaluate Significance –Prioritisation.		
Module:6	**Critical Thinking in Corporate Contexts**	**4 hours**
Importance of Critical Thinking in the Workplace - Critical Thinking and Leadership Skills - Critical Thinking for Evaluating Information - Critical thinking skill development & Motivational strategies.		
Module:7	**Informal Fallacies**	**4 hours**
Ad Hominem - Appeal to the Emotions - Bandwagon fallacy - False Dilemma - Appeal to Unqualified Authority - Begging the question - Appeal to tradition - Strawman Fallacy.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Galen A. Foresman, Peter S. Fosl, and Jamie Carlin Watson (2017), *The Critical Thinking Toolkit.* New Sussex: Wiley Blackwell
2. Caroselli, M. (2011). *The Critical Thinking Toolkit: Spark Your Team's Creativity with 35 Problem Solving Activities*. AMACOM

Reference Books

1. Nevid, J. S., &Rathus, S.A. (2009). *Psychology and the challenges of life* (11th edition). New York: John Wiley & Sons.

2	Hanscomb, S. (2017). Critical thinking: The basics. Taylor & Francis.
3	https://courses.lumenlearning.com/austincc-learningframeworks/chapter/chapter-7-critical-thinking-and-evaluating-information/.
4.	Cottrell, Stella (2017). *Critical Thinking Skills: Effective Analysis, Argument and Reflection*. London: Palgrave Macmillan.
5.	Manika Ghosh (2013) Positivity – A way of life: Orient Blackswan Private Limited - New Delhi.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Case Study / Seminar			
Recommended by Board of Studies	28-06-2021		
Approved by Academic Council	No. 65	Date	17-03-2022

TSSC202L	Intra and Interpersonal Skills	L	T	P	C
		2	0	0	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To understand the core concepts of interpersonal and intrapersonal skills.
2. To enrich expertise to evaluate oneself, one's sentiments and to ascertain means of sharing opinions constructively.
3. To classify one's talents and imperfections and improve aptitudes to accomplish constructive relationships.

Course Outcome

1. Exemplify the concepts of interpersonal and intrapersonal skills in all scenarios.
2. Describe the concepts of self, emotions and communication in relationships.
3. Assess features of healthy relationships and develop skills to handle and respond to criticism.
4. Translate what is learned into strategies for use in educational and professional settings.

Module:1	**Introduction to Intrapersonal and Interpersonal Skills**	**4 hours**
Nature and Process - Interpersonal Communication – Models - Perception and communication		
Module:2	**Knowing and valuing Yourself**	**4 hours**
Concept of self, Self-Awareness, Self-Esteem - Attachment styles: Dismissive-Avoidant, Fearful-Avoidant, Anxious Attachment and Secure Attachment - Self-presentation and Self-disclosure		
Module:3	**Understanding yourself throughout your life span**	**4 hours**
Influences on personality - Personality types and development - The Myers Brigg personality test. Genetics and personality: Gender and personality & Culture and Personality		
Module:4	**Exploring values and making wise choices**	**4 hours**
Understanding values and choices - Define wellness and ways of promoting wellness - Exploring and prioritizing - Cultivate skills to make prudent decisions		
Module:5	**Experiencing and expressing emotion**	**4 hours**
Emotional Behaviour - Understanding emotions& adoption of ways to express emotions - Developing effective listening - Positive listening		
Module:6	**Communication in Constructive Criticism**	**4 hours**
Need of criticism - Making constructive criticism - Handling negative comments & Responding to criticism - Giving and receiving criticism		
Module:7	**Building Positive Relationships**	**4 hours**
Ways of achieving happiness and satisfaction - Types of relationships - Define conflict styles and conflict management		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	Wood, J. T. (2015). *Interpersonal communication: Everyday encounters*. Cengage Learning. UK
Reference Books	
1.	DeVito, J. A. (2019). The interpersonal communication. *Instructor*, *1*, 18. Pearson Education India; 13th edition
2.	Ury, W. (2007). *Getting past no: Negotiating in difficult situations*. Bantam Books. US
3.	Corey, G., & Corey, M. S. (2017). *I never knew I had a choice: Explorations in personal growth*. Cengage Learning. US.
4.	Pavord, E., & Donnelly, E. (2015). *Communication and interpersonal skills*. Lantern Publishing. UK
5.	Adler, R. B., & Proctor II, R. F. (2016). *Looking out, looking in*. Cengage Learning. US
6.	Goldsmith, D. J. (2008). Politeness theory. *Engaging theories in interpersonal communication: Multiple perspectives*, 255-267. Thousand Oaks. Sage Publishers. CA
7.	Diener, E., Lucas, R. E., &Oishi, S. (2021). Subjective well-being: The science of happiness and life satisfaction. *Handbook of positive psychology*, *2*, 63-73. Oxford University Press. USA
8.	Gibson, T. (2020). *Attachment theory: A guide to strengthening the relationships in your life*. Bottom of Form. Rockridge Press. US
Mode of Evaluation: CAT / written assignment / Quiz / FAT / group discussion/Case Study	

Recommended by Board of Studies	28-06-2021		
Approved by Academic Council	No. 65	Date	17-03-2022

TRES101L	Research Methodology	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students to

1. Identify the societal lead hypothesis and ability to design the research framework.
2. Understand the value of Research ethics.
3. Scrutinize the raw data and derive to the conclusion.
4. Compose and present the research investigation report.

Course Outcomes:

At the end of the course the students will be able to

1. Understand the basic concepts of research and values of research ethics.
2. Sketch out the research problems and carryout the literature review.
3. Articulate the research design and execute the sampling method.
4. Fetch, Organize, Investigate and Interpret the data.
5. Perform the statistical analysis and identify the significance of research.
6. Use of search engines and various research tools judiciously for research purposes.

Module:1	**Introduction to Research**	**5 hours**

Research- Definition, objectives, motivation and its importance. Concepts of theory: empiricism, deductive and inductive theory. Scientific method- definition, characteristics. The language of research- definition-theory, hypothesis, conceptualization, variables- dependent and independent variables, sample, population, validity, reliability, data.

Module:2	**Identification and Formulation of Research Problem**	**5 hours**

Research Problem- Need, definition, components, characteristics and formulating the research problem. Literature review- research articles, review articles, case studies and their importance. Hypothesis- null and alternative.

Module:3	**Research Ethics and Intellectual Property Rights**	**7 hours**

Introduction to research ethics, moral issues in research. Different types of animal models and human model used in research, basics to animal ethical guidelines. Introduction to Intellectual Property Rights (IPR), basics of patent rights, copy right, trademark. Common authorship issues in publications.

Module:4	**Research Design and Sampling**	**7 hours**

Research Design- Importance, features and their concepts. The research process basics. Types of Research Design- Historical, descriptive, exploratory and experimental design. Sampling methods- types, advantages and disadvantages. Criteria to determine the sample method and size.

Module:5	**Data Collection and Statistical Analysis**	**7 hours**

Introduction to primary data and secondary data, importance of data collection, open sources reliability. Statistical analysis- basics, univariate, bivariate, and multivariate analysis. Error analysis.

Module:6	**Report and Proposal Writing**	**6 hours**

Report Writing- Importance, types of report, precautions. Layout of research report. Interpreting the research results, infographic interpretation and its report writing. Oral presentations. Proposal writing.

Module:7	**Use of Encyclopaedias, Tools/Techniques for Research**	**6 hours**

Introduction to research, guides and handbooks. Academic databases for chemistry and biological science discipline. Software for detection of plagiarism. Software used for paper formatting and reference management.

Module:8	**Contemporary Issues**	**2 hours**

	Total Lecture hours:	**45 hours**
Text Book(s)		
1.	C. R. Kothari, 2019. Research methodology- Methods & Techniques, (Second Revision Edition), New Age International Publishers.	
2.	Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, 2017. An Introduction to Statistical Learning with Applications in R, Springer.	
Reference Books		
1.	Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.	
2.	Coley, S.M. and Scheinberg, C. A., 1990, “Proposal Writing”, Sage Publications.	
3.	Catherine Dawson, Introduction to research methods : a practical guide for anyone undertaking a research project, Oxford : How To Books, Reprint 2010	
Mode of Evaluation: Quiz/Digital Assignment/CAT/Seminar/Project		
Recommended by Board of Studies	14-02-2022	
Approved by Academic Council	No. 65	Date 17-03-2022

Course Code	Course Title	L	T	P	C
TFRE101L	French I	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

The course gives students the necessary background to:

1. Develop language competencies for effective communication in French.
2. Provide insights into the French culture and make them understand the nuances through communication activities.
3. Enable the students to communicate effectively in general and in a professional context.

Course Outcomes

The students will be able to:

1. Acquaint with the basics of the French Language.
2. Comprehend the various parts of speech and grammar concepts to frame basic sentences in French.
3. Translate and acquire knowledge on a broad range of printed materials for general, specific, and practical information.
4. Acquire and explain the culture of French people through the language studied in the class.

Module:1	Saluer et se presenter:	6 hours

Les Alphabets, Les Salutations, Les nombres (0-100000), L'heure, Les jours de la semaine, Les mois de l'année, Les Pronoms personnels sujets, La conjugaison des verbes réguliers (Les verbes ER) / irréguliers (avoir / être)

Savoir-faire et savoir-agir :

Saluer, Se présenter, Présenter quelqu'un, Donner des informations, Discuter de la classe / l'université.

Module:2	L'activitéinteractive:	6 hours

La Nationalité du Pays, Les articles définis / indéfinis, Les prépositions de lieu et l'article contracté, L'heure en français, La Couleur, La conjugaison des verbes - habiter / venir/Aller etc.

Savoir-faire et savoir-agir :

Localiser des lieux dans une ville, Exprimer l'heure en français et Échanger des informations sur un hébergement.

Module:3	Les activités quotidiennes:	4 hours

Les adjectifs possessifs, L'accord des adjectifs, Les pronoms toniques, La conjugaison du verbe 'faire' avec du, de la, de l', des. L'interrogation avec combien / comment / où etc. L'adjectif démonstratif, L'adjectif interrogatif,**La traduction simple** (français-anglais/anglais-français)

Savoir-faire et savoir-agir :

Parler de la famille, Décrire une personne, parler de nos goûts, parler de nos activités.

Module:4	S'exprimer:	4 hours

Les parties du corps. Avoir mal à + les parties du corps

La conjugaison des verbes pronominaux, La conjugaison des verbes réguliers (ir) et les autres verbes tels que -lire, écrire, pouvoir, vouloir, devoir, et sortir.

Savoir-faire et savoir-agir : Parler de nos quotidiennes, proposer une sortie, inviter, accepter et refuser une invitation.		
Module:5	**La culturefrançaise:**	**3 hours**
La gastronomie française. Les endroits. Le présent progressif, L'article partitif, Mettez les phrases au pluriel et faites des phrases avec les mots donnés, Trouvez les questions. **Savoir-faire et savoir-agir :** Décrire une journée extraordinaire, Répondre aux questions générales en français, Faire des phrases.		
Module:6	**L'activitédialogique:**	**2 hours**
La traduction avancée (français-anglais/anglais-français) **Savoir-faire et savoir-agir :** Faire des achats, Demander la direction, Réserver une chambre dans un hôtel, La compréhension écrite et orale.		
Module:7	**L'activité de loisir**	**3 hours**
La rédaction / Dialogue:Décrire / parler de: ses goûts et préférences/ une personne / une place/ à la cafeteria / la profession / l'université/ les loisirs.		
Module:8	**Faciliter des échanges académiques**	**2 hours**
	Total Lecture hours:	**30hours**

Textbook(s)	
1.	Nathalie Hirschsprung, Tony Tricot, COSMOPOLITE- 1- Méthode de français, 2017, Hachette Français Langue Étrangère, Paris.
Reference Books	
1.	Celine Braud, EDITO 1, Méthode de français, 2016, Didier,Paris.
2.	Marie-Noelle Cocton, GÉNÉRATION 1, Méthode de français, 2016, Didier,Paris.

Mode of Evaluation:CAT , Digital assignment , Quiz , FAT			
Recommended by Board of Studies	30-10-2021		
Approved by Academic Council	No. 68	Date	19-12-2022

VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF ADVANCED SCIENCES

DEPARTMENT OF CHEMISTRY

Integrated M.Sc. in Chemistry

Discipline Core Courses

TCHY203L	Organic Chemistry	L	T	P	C
		4	0	0	4
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students

1. understanding the fundamentals about the nomenclature, notations, basic concepts about organic reaction mechanisms and synthesis
2. knowing about the synthesis of various organic molecules, and how to carry out the various substitution and addition reactions along with mechanistic and stereochemical aspects

Course Outcomes

At the end of the course, the student should be able to

1. recall the fundamentals about the nomenclature, notations and variables
2. synthesise various alcohols, ethers, carbonyls and carboxylic acids
3. apply their understanding about the basic concepts of mechanisms and various multistep mechanisms
4. interpret the concepts of synthesis and to carry out substitution and addition reactions and their mechanisms

Module:1	**Nomenclature, Notations and Variables**	**7 hours**

Nomenclature - the basic system for naming simple organic compounds such as alkanes, haloalkanes, nitroalkanes, cycloalkanes, ethers, alkenes, alkynes, and benzene derivatives; naming of compounds with functional groups - alcohols, amines, ketones, aldehydes, carboxylic acids and their derivatives. The arrow notation in mechanisms. Basic terminology: reactants and reagents, product selectivity- regioselectivity, stereo-selectivity, stereo-specificity, reaction rates, and aromaticity.

Module:2	**Functional organic molecules**	**6 hours**

Preparation, properties, identification, and synthetic utility of alcohols, phenols, ethers, carbonyls, carboxylic acids.

Module:3	**Introduction to Reaction Mechanisms**	**7 hours**

An introduction to mechanisms, thermodynamics, and charge stability- an overview of the most common elementary steps in proton transfer reactions. Methods of determination of reaction mechanism: kinetics and non-kinetic methods - kinetic and thermodynamic control of chemical reaction- principles of microscopic reversibility- energy profile diagram- Hammond postulate.

Module:4	**Substitution and Elimination Reactions**	**12 hours**

Nucleophilic substitution and elimination reactions and their mechanisms - nucleophilic substitution vs elimination. Electrophilic addition to nonpolar π bonds - addition of a Brønsted acid. Electrophilic addition to nonpolar π bonds - reactions involving cyclic transition states.

Module:5	**Addition Reactions**	**11 hours**

Nucleophilic addition to polar π bonds - addition of strong nucleophiles. nucleophilic addition to polar π bonds- weak nucleophiles and acid and base catalysis.

Organic synthesis - intermediate topics in synthesis design, and useful redox and carbon–carbon bond formation reactions. Nucleophilic addition–elimination reactions - the general mechanism involving strong nucleophiles. Nucleophilic addition–elimination reactions - weak nucleophiles. The Diels–Alder reaction and other pericyclic reactions and reactions involving free radicals.

Module:6	**Aromatic substitution Reactions**	**9 hours**

Mechanism of aromatic electrophilic substitution reactions – *pi* and *sigma* complexes – nitration, halogenation, sulfonation, Friedel Crafts alkylation and acylation reactions, Reimer Tiemann reaction – orientation and reactivity - partial rate factors -aromatic nucleophilic

substitution reactions – S_NAr, S_N1 and benzyne mechanisms – Chichibabin reaction - linear free energy relationship – Hammett equation – significance of *sigma* and *rho* – Taft equation.		
Module:7	**Addition to carbon-hetero atom multiple bonds**	**6 hours**
Aldol and Knoevenagel reactions and its stereoselectivity (syn- & anti-), reactions of enamine, Mannich reaction, Perkin reaction, addition of Grignard reagent, and Stobbe reaction, Claisen ester condensation, Benzoin condensation, Darzens glycidic ester condensation, Reformatsky reaction, McMurry coupling, Michael addition and Robinson annulation.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**60 hours**

Text Book(s)	
1.	Morrison R. T., Boyd R. N. and Bhattacharjee S. K., Organic Chemistry, Seventh Edition, Pearson Prentice Hall, 2011.
2.	Finar I.L., Organic Chemistry, Volume 1, 6th edition, Pearson education India, 2011.
Reference Books	
1	Peter K., Vollhardt, C., and Schore N. E., Organic Chemistry, W. H. Freeman and Company, 2010.
2	Carey, F.A., and Sundberg R.J., Advanced Organic Chemistry, Part A: Structure and Mechanisms, 5th edition, 2007.
3	Pine S. H., Organic Chemistry, Tata McGraw Hill, 5th edition, 2008.
4	Jagdamba singh and L. D S. Yadav, Advanced Organic Chemistry, 2016.
5	Narain, Rp, mechanisms in Advanced Organic Chemistry 1st Edition, New age International (P) Ltd Publishers, 2017.
6	March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, Michael B. Smith, Jerry March John Wiley & Sons, 6th edition, 2007.
7	Martin Silberberg and Patricia Amateis, Chemistry: The Molecular Nature of Matter and Change (WCB CHEMISTRY), 2017.

Mode of Evaluation: CAT / written assignment / Quiz / FAT			
Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY204P	Systematic qualitative and quantitative analysis of simple organic molecules	L	T	P	C
		0	0	4	2

Pre-requisite	NIL	Syllabus version
		1.0

Course Objectives

The course is aimed at students
1. distinguishing methods of separation of binary organic mixtures by systematic qualitative analysis
2. estimating different organic compounds in the sample through characteristic reactions and titrimetry

Course Outcomes

At the end of the course, the student should be able to
1. separate and purify binary organic mixtures, identify the individual compounds
2. estimate organic compounds in the given sample

Indicative Experiments		
1.	Separation and Systematic qualitative analysis of binary mixture -I	6 hours
2	Separation and Systematic qualitative analysis of binary mixture –II	6 hours
3.	Separation and Systematic qualitative analysis of binary mixture –III	6 hours
4.	Separation and Systematic qualitative analysis of binary mixture –IV	6 hours
5.	Separation and Systematic qualitative analysis of binary mixture -V	6 hours
6.	Estimation of Phenol	6 hours
7.	Estimation of Aniline	6 hours
8.	Estimation of Glucose	6 hours
9.	Estimation of Methyl Ketone (Acetone)	6 hours
10.	Estimation of carbonyl group (percentage purity of carbonyl compound.)	6 hours
	Total Laboratory Hours	60 hours

Mode of assessment: Continuous assessment / FAT / Oral examination

Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY205E	Lab Safety Training	L	T	P	C
		1	0	2	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students to
1. acquire fundamental understanding of laboratory safety
2. practice basic lab safety protocols
3. develop analytical ability and experimental skills

Course Outcome

At the end of the course the student will be able to
1. adhere to laboratory safety standards
2. adopt best laboratory practices
3. employ emergency procedures when required
4. devise material handling strategies in the laboratory
5. categorise waste and dispose appropriately

Module:1	**Occupational Health Safety (OHS) and Lab Hygiene**	**2 hours**

Introduction to OHS and lab hygiene - Definitions and common terms, overview of occupational and environmental diseases. Routes of exposure and its control, national OHS policy. Factories act and factory rules, medical surveillance, chemical interaction, toxicology, occupational exposure limits (OELs)/standards/assessment.

Module:2	**Accident and Emergency Management**	**2 hours**

Incident Management - definition, near-miss incidents, unsafe conditions, accident causation theories - Heinrich's Domino theory, reporting of incident and investigation, financial cost of incidents, root cause of analysis. Emergency Management - definition and types of emergency, regulatory requirements of emergency, onsite and off-site emergency plan, role of emergency response team, disaster mitigation and response.

Module:3	**Personal Protective Equipment (PPE)**	**2 hours**

Importance and types of PPE, Eye protection, respiratory protection, body protection, hand and leg protection, emergency shower and eye wash fountain.

Module:4	**Electrical and Gas Cylinder Safety**	**2 hours**

Electrical Safety- dangers from electricity, safe limits of amperages and voltages, earthing standards, insulation and continuity test, protection against overvoltage, flame proof electrical equipment, static charge and its control. Gas cylinder safety- rules, color coding and storage requirement of cylinders.

Module:5	**Fire prevention, Protection and Laboratory Design**	**2 hours**

Fire prevention- definition and its classifications, fire tetrahedron, lower and upper explosive limits, flash point, reducing dual-use hazardous materials, fire extinguishing types and techniques, do's and don'ts during firefighting, prevention of fire, general lab designs including ventilation, entry and exit pathways.

Module:6	**Material Safety Data Sheet (MSDS) and Globally Harmonized labelling System (GHS Label)**	**1 hour**

Importance of MSDS and interpretation of MSDS data, requirements of GHS labeling and its components.

Module:7	**Storage, Risk Assessment and Ergonomics**	**3 hours**

Safe storage of chemicals- manual handling and storage of chemicals, maximum loads that may be carried, lifting and carrying of objects of different shapes, size and weight, safe use of accessories for manual handling, storage requirements as per National Fire Protection

Association (NFPA-45) codes. Risk assessment- Definition and importance of risk assessment, hazard and risk assessment methods, elements of process safety. Ergonomics- Introduction and objectives of ergonomics, anthropometry, applying ergonomics, lab ergonomics, classification of body movement, postures and positions.		
Module:8	**Contemporary topics**	**1 hour**
	Total Lecture hours:	**15 hours**

Laboratory Safety Training Experiments	
Various types of fire extinguisher and their safe handling during fire emergency situations.	
Protective methods and first aid treatment against electrical shocks in the laboratory.	
Handling and disposal of acidic reagents.	
Handling and disposal of alkaline reagents and lab wastes.	
Quenching and safe disposal of hazardous organic laboratory reagents (Chlorinated solvents, organo mercaptans, etc.)	
Handling of typical laboratory glassware (distillation, schlenk line setup etc.) and sharp objects.	
Handling of common laboratory equipments.	
Quenching of hazardous inorganic reagents (Eg. HF, Derivatives of perchlorates, Na metal etc.)	
Quenching of hazardous organometallic reagents (Eg. Organo Hg, Sn, Pb, etc.)	
Handling and disposal of common heavy metals salts of Cr, Mn, Hg, etc.	
Total Laboratory Hours	**30 hours**

Text Book(s)	
1.	Howson, E.M., Safety in Academic Chemistry, Laboratories, best practices for First- and second-year University students. ACS, 8th Ed., 2017.
2.	Haldar, S.K., Industrial and Occupational Health, CBS Publishers, 2017.
Reference Books	
1.	Occupational Health and Safety Management Systems – Specification, BIS–OHSAS
2.	18001.
3.	Guidelines on occupational Safety and Health Management Systems, ILO-OSH, 2001.
4.	Personal Protective Equipment Pocket Guide, Genium Publishing Corp., ISBN: 0-931690-73-0, 1995.
5.	NFPA – 45 Standard on fire protection for laboratories using chemicals
6.	Friend, M.A. and Kohn, J.P., Fundamentals of Occupation Health and Safety – 4th Ed., ISBN-13: 978-1598889826, 2018.
7.	American Conference of Governmental Industrial Hygienists (2021): Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. Cincinnati, Ohio, USA. Brauer, R.L., Safety and Health for Engineers, Wiley, 2016.

Mode of Evaluation:, Written assignment, Quiz and FAT/group discussion/seminar			
Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY205E	Lab Safety Training	L	T	P	C
		1	0	2	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students to
1. acquire fundamental understanding of laboratory safety
2. practice basic lab safety protocols
3. develop analytical ability and experimental skills

Course Outcome

At the end of the course the student will be able to
1. adhere to laboratory safety standards
2. adopt best laboratory practices
3. employ emergency procedures when required
4. devise material handling strategies in the laboratory
5. categorise waste and dispose appropriately

Module:1	**Occupational Health Safety (OHS) and Lab Hygiene**	**2 hours**

Introduction to OHS and lab hygiene - Definitions and common terms, overview of occupational and environmental diseases. Routes of exposure and its control, national OHS policy. Factories act and factory rules, medical surveillance, chemical interaction, toxicology, occupational exposure limits (OELs)/standards/assessment.

Module:2	**Accident and Emergency Management**	**2 hours**

Incident Management - definition, near-miss incidents, unsafe conditions, accident causation theories - Heinrich's Domino theory, reporting of incident and investigation, financial cost of incidents, root cause of analysis. Emergency Management - definition and types of emergency, regulatory requirements of emergency, onsite and off-site emergency plan, role of emergency response team, disaster mitigation and response.

Module:3	**Personal Protective Equipment (PPE)**	**2 hours**

Importance and types of PPE, Eye protection, respiratory protection, body protection, hand and leg protection, emergency shower and eye wash fountain.

Module:4	**Electrical and Gas Cylinder Safety**	**2 hours**

Electrical Safety- dangers from electricity, safe limits of amperages and voltages, earthing standards, insulation and continuity test, protection against overvoltage, flame proof electrical equipment, static charge and its control. Gas cylinder safety- rules, color coding and storage requirement of cylinders.

Module:5	**Fire prevention, Protection and Laboratory Design**	**2 hours**

Fire prevention- definition and its classifications, fire tetrahedron, lower and upper explosive limits, flash point, reducing dual-use hazardous materials, fire extinguishing types and techniques, do's and don'ts during firefighting, prevention of fire, general lab designs including ventilation, entry and exit pathways.

Module:6	**Material Safety Data Sheet (MSDS) and Globally Harmonized labelling System (GHS Label)**	**1 hour**

Importance of MSDS and interpretation of MSDS data, requirements of GHS labeling and its components.

Module:7	**Storage, Risk Assessment and Ergonomics**	**3 hours**

Safe storage of chemicals- manual handling and storage of chemicals, maximum loads that may be carried, lifting and carrying of objects of different shapes, size and weight, safe use of accessories for manual handling, storage requirements as per National Fire Protection

Association (NFPA-45) codes. Risk assessment- Definition and importance of risk assessment, hazard and risk assessment methods, elements of process safety. Ergonomics- Introduction and objectives of ergonomics, anthropometry, applying ergonomics, lab ergonomics, classification of body movement, postures and positions.		
Module:8	**Contemporary topics**	**1 hour**
	Total Lecture hours:	**15 hours**

Laboratory Safety Training Experiments	
Various types of fire extinguisher and their safe handling during fire emergency situations.	
Protective methods and first aid treatment against electrical shocks in the laboratory.	
Handling and disposal of acidic reagents.	
Handling and disposal of alkaline reagents and lab wastes.	
Quenching and safe disposal of hazardous organic laboratory reagents (Chlorinated solvents, organo mercaptans, etc.)	
Handling of typical laboratory glassware (distillation, schlenk line setup etc.) and sharp objects.	
Handling of common laboratory equipments.	
Quenching of hazardous inorganic reagents (Eg. HF, Derivatives of perchlorates, Na metal etc.)	
Quenching of hazardous organometallic reagents (Eg. Organo Hg, Sn, Pb, etc.)	
Handling and disposal of common heavy metals salts of Cr, Mn, Hg, etc.	
Total Laboratory Hours	**30 hours**

Text Book(s)	
1.	Howson, E.M., Safety in Academic Chemistry, Laboratories, best practices for First- and second-year University students. ACS, 8th Ed., 2017.
2.	Haldar, S.K., Industrial and Occupational Health, CBS Publishers, 2017.
Reference Books	
1.	Occupational Health and Safety Management Systems – Specification, BIS–OHSAS
2.	18001.
3.	Guidelines on occupational Safety and Health Management Systems, ILO-OSH, 2001.
4.	Personal Protective Equipment Pocket Guide, Genium Publishing Corp., ISBN: 0-931690-73-0, 1995.
5.	NFPA – 45 Standard on fire protection for laboratories using chemicals
6.	Friend, M.A. and Kohn, J.P., Fundamentals of Occupation Health and Safety – 4th Ed., ISBN-13: 978-1598889826, 2018.
7.	American Conference of Governmental Industrial Hygienists (2021): Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. Cincinnati, Ohio, USA. Brauer, R.L., Safety and Health for Engineers, Wiley, 2016.

Mode of Evaluation:, Written assignment, Quiz and FAT/group discussion/seminar			
Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY207L	Physical Chemistry	L	T	P	C
		4	0	0	4
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students
1. recall the laws of thermodynamics, concepts of dilute solutions and osmosis.
2. define distribution laws and phase diagrams of one and two-component systems.
3. examine concepts of electrolysis and electrochemical systems

Course Outcomes

At the end of the course, students will be able to
1. apply the laws of thermodynamics
2. analyse the properties of dilute solutions and applications of osmosis
3. recall concepts of distribution laws and liquid-liquid and partition chromatography
4. review phase rule concepts and apply them to one and two-component systems
5. experiment on electrolysis and conductance for various applications
6. relate ion transport for application in conductometric titrations
7. correlate electromotive force and half-cell and single-cell construction

Module:1	**Second and Third Laws of Thermodynamics**	**9 hours**

Spontaneous Processes, Entropy – units, standard entropy of formation, physical significance; Entropy changes for irreversible and reversible processes, Carnot Cycle, Gibbs Helmholtz Equation, Clausius-Clapeyron equation, van'T Hoff Isotherm, Fugacity and Activity; Third law of thermodynamics.

Module:2	**Theory of Dilute Solutions and Osmosis**	**9 hours**

Colligative Properties- Lowering of vapour pressure, Raoult's Law – derivation; measurement of lowering of vapour pressure -barometric method; boiling point elevation - determination of molecular mass from elevation of boiling Point; depression of freezing point- determination of molecular mass from depression of freezing point,
Osmosis – semipermeable membranes, osmotic pressure-osmometer; reverse osmosis-desalination of sea water

Module:3	**Distribution Law**	**8 hours**

Nernst's distribution law–explanation and limitations, Henry's Law, determination of equilibrium constant from distribution coefficient; Liquid-liquid chromatography, solvent extraction, partition chromatography, Parke's process (desilverization of lead).

Module:4	**Phase Rule**	**8 hours**

Definitions, derivation of Gibbs phase Rule, phase Diagrams-one-component system (phase diagram of water), two-component system (eutectic mixture, systems with congruent melting point), KI-water system.

Module:5	**Electrolysis**	**8 hours**

Faraday's first and second laws, conductance of electrolytes–specific and equivalent conductance; determination of cell constant; strong and weak electrolytes- measurement of electrolytic conductance,
Debye-Huckel limiting law, electrolysis – mechanism.

Module:6	**Electrolytic Dissociation**	**8 hours**

Arrhenius theory of ionisation, migration of ions, transport number, determination of transport number – Hittorf's and Moving boundary methods, Kohlrausch's Law and its applications, conductometric titrations.

Module:7	**Electromotive Force**	**8 hours**

Electrochemical cells, cell potential – calculation and measurement, relation between EMF and free energy, EMF of half cells – determination, the Nernst equation – calculation of cell potential, electrodes – Calomel, Quinhydrone and Hydrogen electrodes; Determination of pH of a solution; Potentiometric titrations

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**60 hours**

Text Book(s)	
1.	Atkins Physical Chemistry, 11th Edition By Peter Atkins, Julio De Paula, James Keeler, Oxford University press, 2018.
2.	Principles Of Physical Chemistry, by B.R. Puri, L.R. Sharma, M.S. Pathania. 47th edition, Vishal Publishing Co, India, 2016.

Reference Books	
1.	Hofmann Andreas, Physical Chemistry Essentials, Springer International Publishing AG, 2018
2.	Nag, Physical Chemistry, Vol.1, McGraw Hill Education, 2017.
3.	Glasstone Samuel and David Lewis, Elements of Physical Chemistry, D. Van Nostrand Co., 1963.

Mode of Evaluation: CAT, Quiz, Assignments, FAT			
Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY207P	Physical Chemistry Lab	L	T	P	C
		0	0	4	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

The course is aimed at students to
1. understand thermodynamic concepts by determining molecular weight, enthalpy change, etc
2. describe the principles and methods of conductivity, potentiometry by exploring electrochemical properties of systems

Course Outcomes

At the end of the course the students will be able to
1. perform experiments for determining thermodynamic properties of matter
2. apply the concepts of electrochemical measurements using potentiometric and conductometric methods
3. calculate the dissociation constants of an acid in various solvents
4. evaluate acid mixtures through conductometric and potentiometric titrations

	Indicative Experiments	Duration
1	Determination of molecular weight by depression of freezing point methods a) Rast method and b) Transition temperature method	6 hours
2	Determination of solubility of benzoic acid at different temperature and to determine enthalpy change of dissolution process	6 hours
3	Construction of phase diagram of a simple eutectic system (KI-Water system)	6 hours
4	Determination of the dissociation constant of acetic acid	6 hours
5	Determination of Viscosity of liquid by Oswald viscometer.	6 hours
6	Measurement of conductance - distinguishing strong electrolyte, weak electrolyte and non-electrolyte using conductivity measurement.	6 hours
7	Determination of cell constant, specific conductance and equivalent conductance.	6 hours
8	Conductometric titration of ammonium chloride vs NaOH and sodium acetate vs HCl	6 hours
9	Determination of activity and activity coefficient of an electrolyte by potentiometry.	6 hours
10	Estimation of chloride in ORS by potentiometry	6 hours
	Total Laboratory Hours	60 hours

Text Book(s)

1. Renu Gupta, Practical Physical Chemistry 1 Edition (English, Paperback, Renu Gupta), New Age International, ISBN: 9789386418098, 9386418096, Edition: 1, 2017.

Reference Books

1. A.I. Vogel's Text book of Quantitative Chemical Analysis, G H Jeffery, J Bassett, J Mendham, R C Denney, Longman Scientific and Technical, 5th Edition, 1989.

Mode of assessment: Lab assessment, Viva-Voce and FAT

Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY208L	Inorganic Chemistry	L	T	P	C
		4	0	0	4
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students to

1. get introduced to the basic inorganic chemistry concepts and properties of alkali and alkaline earth metals
2. distinguish preparation, properties and structure of Boron, Carbon, Nitrogen, Oxygen family compounds
3. differentiate the properties of halogens and noble gases

Course Outcomes

At the end of the course, the students will be able to

1. state the periodic properties of alkali and alkaline earth metals
2. explain the preparation, properties and structure of compounds of boron, carbon
3. analyse the properties and structures of prepared pnictogen and chalcogen group compounds
4. relate the properties of various elements with respect to their position in the periodic table
5. compare the properties of halogen compounds and noble gases

Module:1	**Alkali and Alkaline earth metals**	**8 hours**

Alkali and Alkaline earth metals - electronic configuration, periodic properties, diagonal relationship, compounds of alkali and alkaline earth metals, comparative features of alkaline earth metals with alkali metals.

Module:2	**Boron group**	**8 hours**

B, Al, Ga, In and Tl - electronic configuration, periodic properties. Anomalous behaviour of boron , boron and silicon diagonal relationship, boron trihalides, electron deficiency and electron acceptor behaviour of bonding in diborane (hydrogen bridge structure), borazine, $NaBH_4$, $LiAlH_4$ and boron nitride - preparation, properties and uses.

Module:3	**Carbon group**	**8 hours**

C, Si, Ge, Sn and Pb – electronic configuration, periodic properties, structure and allotrophy of the elements. Inert pair effect, carbon materials - Fullerene, CNT, Graphene, compounds of carbon family.

Module:4	**Pnictogens**	**8 hours**

Periodic properties of the elements, hydrides, oxides, hydroxides and halides of N and P, Oxy acids of N and P - structure and acidic strength only. Anomalous properties of nitrogen - preparation, properties and uses of ammonia and nitric acid.

Module:5	**Chalcogens**	**10 hours**

Periodic properties of the elements, hydrides , oxides, hydroxides and oxyacids of S, Se and Te. Anomalous properties of oxygen, preparation, properties, structure and uses of ozone, hydrogen peroxide and sulphuric acid, role of selenium in xerography.

Module:6	**Halogens**	**8 hours**

Comparative properties of halogens, oxides and oxyacids, geometry of interhalogen compounds, pseudohalogens, astatine, comparison of pseudohalogens and halogens.

Module:7	**Noble gases**	**8 hours**

Electronic Configuration, general properties, chemical inertness, compounds of Xenon - hybridization and geometry of XeF_2, XeF_4, XeF_6 and $XeOF_4$. Clathrate compounds of noble gases.

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**60 hours**

Text Book(s)

1.	A. J. Elias; The Chemistry of p-Block Elements: Synthesis, Reactions, and Applications, 2ed, Universities Press, 2019			
2.	J. D. Lee, Concise Inorganic Chemistry, Oxford University Press, 5th Edition, 2014.			
Reference Books				
1.	Overton, T., Armstrong, F., Rourke, J. and Weller, M. Inorganic Chemistry, 6th Edn., (Oxford University Press, 2015.			
2	J. E. House; Inorganic Chemistry, 3rd edition, Academic Press**,** 2019			
3.	Douglas, B., McDaniel, D. and Alexander, J., Concepts and Models of Inorganic Chemistry, 3rd Edition, John Wiley & Sons, 2010.			
4.	Housecraft, C. E. and Sharpe, A. G., Inorganic Chemistry, 4th edition, Pearson, 2012.			
5.	Cotton, F. A., Wilkinson, G., Murillo, C. A. and Bochmann, M.; Advanced Inorganic Chemistry, 6th Edition, John Wiley & Sons, 2008.			
Mode of Evaluation: CAT, written assignment, Quiz and FAT.				
Recommended by Board of Studies		14-02-2022		
Approved by Academic Council		No. 65	Date	17-03-2022

TCHY209P	Inorganic Quantitative Analysis lab	L	T	P	C
		0	0	4	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. Imparting the knowledge on quantitative analysis lab of inorganic compounds.
2. Understanding the principles of quantitative chemical analysis of inorganic compounds.
3. Apply volumetric principles to carry out acid-base titrations, complexometric titrations, precipitation titrations and redox titrations and iodometric titrations.
4. Quantitatively estimate cations using gravimetric analysis.

Course Outcome

1. Understand the concepts of quantitative analyses.
2. Develop experimental skills for real time sample analysis
3. Gain knowledge on the choice of precipitating methods, reagents, crucibles and filtration.
4. Identify the common errors in gravimetric analysis
5. Understand the importance and hands-on experience on analysis of metal ions by means of experiments.

Indicative Experiments

1.	Estimation of temporary and permanent hardness of water.	6 hours
2	The Winkler approach for quantitative assessment of dissolved oxygen	6 hours
3.	Estimation of magnesium using EDTA	6 hours
4.	Estimation of alkalinity of water sample.	6 hours
5.	Complexometric estimation of Fe(III)+Al(III) in a mixture	6 hours
6.	Estimation of amount of chloride in water using $AgNO_3$ (Mohr's method).	6 hours
7.	Determination of percentage of Manganese dioxide in Pyrolusite	6 hours
8.	Gravimetric estimation of Zinc using 8-hydroxy quinoline	6 hours
9.	Gravimetric estimation of barium as barium sulphate	6 hours
10.	Estimation of Ni and Cu in an alloy by gravimetry	6 hours
	Total Laboratory Hours	60 hours

Mode of assessment: Continuous assessment / FAT / Oral examination			
Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY301L	Transition and Inner Transition Elements	L	T	P	C
		4	0	0	4
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

The course is aimed at students
1. understanding the general periodic properties of transition and inner transition elements
2. applying the concepts learnt towards the formation of different types of compounds and their significance
3. imparting basic knowledge on nuclear chemistry and solid state chemistry

Course Outcomes:

At the end of the course, the students will be able to
1. compare the periodic trends and properties of 3d, 4d and 5d elements
2. examine the various compounds, their characteristic properties and their potential applications
3. recall the occurrence of Lanthanides and Actinides in nature and their uses
4. justify the implications of nuclear energy in the modern world
5. relate the structural aspects and the properties of solids

Module:1	**General trends**	**9 hours**

Atomic and ionic radii, electronic configuration, oxidation states – stable and unusual oxidation states. ionization energies, melting and boiling points, metallic character – comparison between 3d and 4d elements.

Module:2	**Colour and magnetism**	**8 hours**

Incompletely filled d shell, colors of aqua species of transition metal ions, reducing properties, catalytic properties, non-stoichiometric compounds, and complex formation, magnetic properties- orbital and spin momentum, spin only formula, measurement of magnetic moment.

Module:3	**Compounds of transition metals**	**8 hours**

Preparation, properties and uses - $KMnO_4$ and $K_2Cr_2O_7$; Oxides, halides and sulphides of Cu, Zn, Fe, Ti, V, Cr, W, Mo; Interstitial compounds – carbides and nitrides of Ti, V, Cr, W and their industrial uses.

Module:4	**Lanthanides**	**9 hours**

Lanthanide series, abundance and natural isotopes, electronic configuration, Lanthanide contraction and its consequences, oxidation states, chemical properties of Ln(III) cations, magnetic properties, color and electronic spectra of Ln^{3+} ions. Lanthanide shift reagents, separation of lanthanides.

Module:5	**Actinides**	**9 hours**

Actinide series, abundance and natural isotopes, electronic configuration, oxidation states, general properties. Uranium – occurrence, extraction, chemical properties of hydrides, oxides and halides. Comparison of lanthanides and actinides.

Module:6	**Nuclear Chemistry**	**7 hours**

Isotopes, stability of nucleus, n / p ratio, Binding energy, Nuclear energy, U isotopes – enrichment and separation, nuclear reactions - alpha, beta and gamma emission, Radioactive decay, carbon dating, neutron activation analysis and applications.

Module:7	**Basic solid state chemistry**	**8 hours**

Introduction on solids: classification – based on physical form crystalline and amorphous, based on bonding (covalent, ionic, metals), based on property (conductors, semi, insulators, superconductors)- types of radii- structure and symmetry : close packing- unit cell, crystal system, miller indices - atoms per unit cell, Bravais lattices- point groups- space groups.

Module:8	**Contemporary Issues**	**2 hours**

	Total Lecture hours:			**60 hours**
Text Book(s)				
1.	Overton Weller, Armstrong, Rourke, Inorganic Chemistry, 2015, 6th Edition, Oxford University Press ,UK.			
2.	Dennis Close, Inorganic Chemistry, 2018, Willford Press, USA.			
Reference Books				
1.	Ram Charitra Maurya, Inorganic Chemistry: Molecular Facets, 2021, De Gruyter, UK.			
2.	Huheey / Medhi, Inorganic Chemistry: Principles of Structure and Reactivity, 2006, 4th Edition, Pearson Education, India.			
3.	Mark Weller, Tina Overton, Jonathan Rourke, Fraser Armstrong, Inorganic Chemistry, 2018, 7th International Edition, Oxford university press, UK.			
4.	G.K. Rustagi & Yahpal Singh, Inorganic Chemistry, 2020, CBH Publications, India.			
Mode of Evaluation: CAT / written assignment / Quiz / FAT				
Recommended by Board of Studies		14-02-2022		
Approved by Academic Council		No. 65	Date	17-03-2022

TCHY302L	Chemistry of Heterocyclic and Natural Products	L	T	P	C
		4	0	0	4
Pre-requisite	NIL	**Syllabus version**			
		1.0			

Course Objectives:

The course is aimed at students

1. imparting knowledge in the theory and applications of various heterocyclic compounds and their physical and chemical behavior in order to synthesize them, this can be further put to medicinal use.
2. learning and understanding the principles behind physical and chemical nature of heterocyclic compounds and their reaction mechanisms
3. to develop thorough knowledge of natural products such as alkaloids, terpenoids relating with its synthesis, properties, medicinal applications and their metabolic activities and biological functions. Become familiar with steroids and its functions with special reference to its biological functions.

Course Outcome

At the end of the course, students will be able to

1. recall the significance of fundamental aspects of heterocyclic compounds
2. describe the concepts related to the nomenclature, structural aspects, synthesis, reaction mechanisms and the functions of various reagents or catalysts
3. correlate organic and heterocyclic reactions to industrial significance
4. categorize heterocyclic reactions based on the influence of the substituents on substrate molecules and nature of solvent and the parametric conditions
5. create new heterocyclic reactions in order to achieve the required product(s)
6. classify natural products such as alkaloids, terpenoids and steroids based on properties, And their structural elucidation.
7. synthesis of natural products like steroids, alkaloids, terpenoids and flavonoids

Module:1	**Nomenclature and general synthesis of Heterocycles**	**5 hours**

Replacement and systematic nomenclature (Hantzsch-Widman system) for monocyclic, fused and bridged heterocycles. General principles of heterocyclic synthesis involving cyclization reactions and cycloaddition reactions with reference to small ring heterocycles like three, four, five and six membered heterocycles.

Module:2	**Small ring heterocycles**	**12 hours**

Small Ring: Three-membered and four-membered heterocycles - synthesis and reactions of aziridines, oxiranes, thiiranes, azetidines, oxetanes and thietanes.
Five-Membered: Synthesis and reactions of pyrrole, thiophene, furan, pyrazoles, oxazoles and Imidazoles.
Six-Membered: Synthesis and reactions of diazines, triazines, tetrazines and thiazines.

Module:3	**Large ring Heterocycles**	**7 hours**

Synthesis and reactions of azepines, oxepines, thiepines, diazepines (1,2 and 1,4), thiazepines, azocines.

Module:4	**Fused Heterocycles**	**10 hours**

i) Synthesis and reactions of benzopyrroles, benzofurans and benzothiophenes, Indoles and Benzotriazoles. ii) Synthesis and reactions of quinolines and isoquinolines, coumarins and chromones.

Module:5	**Terpenoids**	**8 hours**

Classification, mevalonic lactose, structural elucidation and synthesis of bisabolene, longifolene and caryophyllene.

Module:6	**Steroids**	**8 hours**

Introduction, structure, chemistry of steroids, synthesis, structural elucidation and conformational analysis of cholesterol. Other examples with reference to synthesis and structural elucidation of oestrone, androsterone, testosterone and progesterone.

Module:7	**Alkaloids**	**8 hours**

Classification, general structural elucidation and identification tests, structural elucidation and chemistry of quinine, morphine and reserpine.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**60 hours**
Text Book(s)		
1.	John A. Joule (Author), Keith Mills ,Heterocyclic Chemistry At A Glance ,Wiley-Blackwell ;2nd Revised edition, 2012.	
2.	Natural Products in the Chemical Industry. By Bernd Schaefer. Springer: New York, 2014, 2nd ed., p. 1-831, ISBN 978-3-642-54461-3.	
Reference Books		
1.	F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry, Part-A and B, Fifth Edition, Springer, Revised 2008.	
2.	Eicher, T.; and Hauptmann, S.; The Chemistry of Heterocycles, Wiley-VCH, Weinheim, 3rd Ed, 2012	
3.	I. L. Finar, Organic Chemistry, Vol II, Stereochemistry and the Chemistry of Natural Products Fifth Edition, Pearson 2009.	
4.	Gilchrist, T. L., Heterocyclic Chemistry, Prentice Hall, 3rd Edition, 2005.	
5.	Heterocyclic chemistry, R. K. Bansal, New Age International Private Limited; Fifth edition, 2017.	
Recommended by Board of Studies	14-02-2022	
Approved by Academic Council	No. 65	Date 17-03-2022

TCHY303L	Instrumental Methods of Chemical Analysis	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students

1. select appropriate instrumental methods for the identification and quantitative analysis of chemical substances
2. acquire working knowledge of analytical instrumentation typically employed in chemical and biochemical research laboratories

Course Outcome

At the end of the course, students will be able to

1. list the principles of spectroscopy, conductometry, potentiometry, thermoanalytical and diffraction techniques
2. analyse instrumental techniques to solve real life problems
3. apply instrumental skills in designing solutions for problem rectification
4. select appropriate characterization method based on instrumental skills
5. choose characterization technique for new compounds and materials
6. perform laboratory experiments based on instrumental methods

Module:1	**Atomic Absorption spectroscopy (AAS)**	**6 hours**

Flame atomization: types of flames, flame structure, flame absorption profiles, flame atomizers; Electrothermal atomization; atomic absorption instrumentation-Interference in atomic absorption spectroscopy-spectral and chemical Interference; procedures for trace metal analysis in different matrices.

Module:2	**Atomic Emission Spectroscopy (AES)**	**5 hours**

Atomic emission spectroscopy based on plasma sources-introduction, instrumentation and applications; miscellaneous sources for optical emission spectroscopy; Flame emission-glow discharge and laser based atomic emission systems; Procedures for alkali metal estimation.

Module:3	**Fluorescence Spectroscopy**	**6 hours**

Introduction to electronic spectroscopy and Jablonski diagram, Instrumentation, fluorophores, spectral and time-resolved fluorescence, solvent and environmental effects on fluorescence, fluorescence quenching; dynamics of solvent and spectral relaxation; fluorescence anisotropy, fluorescence imaging methods, applications of fluorescence spectroscopy.

Module:4	**Conductometry, Potentiometry and Nephelo-Turbidimetry**	**6 hours**

Conductometry: Electrolyte theory and principle; Conductivity cell – construction, care and measurement technique, applications in neutralization titrations, advantages & limitations of conductometric titrations.

Potentiometry: Principles, different electrodes, potentiometric titrations-acid-base, redox and precipitation.

Nephelo-Turbidimetry: Principle, instrumentation and applications

Module:5	**Plasma based spectroscopy**	**6 hours**

Concept of Inductively coupled plasma-principle of basic instrumental components of ICP-OES and ICP-MS-sample introduction, plasma source, ion lenses, collision/reaction cell; Mass-analyzer-quadrupole MS, detector, spectral interferences, standard preparation and sampling techniques, methods of quantitation and applications.

Module:6	**Thermal Analysis**	**7 hours**

Introduction to thermal analysis; Thermogravimetric analysis-principle, instrumentation and applications, Differential thermal analysis-principle, instrumentation, principle and applications including enthalpy calculations, Differential scanning calorimetry-iInstrumentation, principle and applications; introduction of microthermal analysis.

Module:7	**X-ray Diffraction**	**7 hours**

Interaction of X-rays with matter, unit cells and crystal structure, Miller indices, Bragg's

equation, instrumentation, structural analysis of crystals, powder diffraction, indexing diffraction patterns, NaCl & KCl crystal structures, numerical/problems, scopes of XRD.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Douglas A. Skoog, F. James Holler, Stanley R. Crouch; Principles of Instrumental Analysis; 2017, 7th Edition, Cengage, Boston USA.
2.	Principles of Physical Chemistry, by B.R. Puri, L.R. Sharma, M.S. Pathania. 47th edition (2016), Vishal Publishing Co, India

Reference Books

1.	Peter Atkins, Julio De Paula, James Keeler, Atkins Physical Chemistry, 11th Edition, Oxford University press, 2018.
2.	Vogel's Text book of Quantitative Chemical Analysis, G. H. Jeffery j. Bassett J. Mendham R C. Denney, 5th Edition, Longman Scientific and Technical and John Wiley & Sons, New York, 1989.
	Fluorescence Spectroscopy, by J. R. Lakowicz, Springer, 2006.
3.	Analytical Chemistry, Gary Christian, 6th Edition, John Wiley & Sons, New York, 2004.
4.	Elements of X-Ray Diffraction by B.D. Cullity and S.R. Stock, Third Edition, Pearson, 1994
5.	Inductively Coupled Plasma-Mass Spectrometry: Practices and Techniques by Howard E. Taylor and Howard M Taylor, Academic Press, 2001

Mode of Evaluation: CAT, Quiz, Assignments, FAT			
Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY303P	Instrumental Methods of Analysis Lab	L	T	P	C
		0	0	4	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students

1. make the students familiar with different instrumental methods for the identification and quantitative analysis of chemical substances.
2. afford students a working knowledge of analytical instrumentation typically employed in chemical and biochemical research laboratories.

Course Outcomes

At the end of the course, students will be

1. apply the principles of spectroscopy, conductometry, potentiometry, thermoanalytical and diffraction techniques for conducting different experiments
2. evaluate the scope of different instrumental techniques in solving related problems
3. design solution for problem rectification choosing appropriate instrumental skills
4. select characterization methods based on the studied instrumental skills
5. devise characterization technique for new compounds and materials
6. perform laboratory experiments based on instrumental methods

Indicative Experiments		**Duration**
1.	Determination of concentration of potassium and sodium ions by flame photometry.	6 hours
2.	Determination of sulphate ion by Nephelo-Turbidimetry	6 hours
3.	Determination of concentration of lead in highway dusts by AAS	6 hours
4.	Determination of quinine sulphate by Fluorimetry	6 hours
4.	Stability testing of a composite using TGA	6 hours
6.	Synthesis of a polymer and determination of the glass transition temperature (Tg), the crystallisation temperature (Tc) and the melting temperature (Tm) of polymer by using DSC analysis	6 hours
7	Determination of the strength of strong and weak acids in a given mixture by conductometry	6 hours
8	Determination of the strength of strong and weak acids in a given mixture by potentiometry.	6 hours
9	Determination of solubility product by potentiometry – concentration cell method	6 hours
10	Synthesis and characterization of ZnO nanoparticles using p-XRD and determination of its lattice constant and crystallite size.	6 hours
	Total Laboratory Hours	60 hours

Text Book(s)

1. Renu Gupta, Practical Physical Chemistry 1 Edition (English, Paperback, Renu Gupta), New Age International, ISBN: 9789386418098, 9386418096, Edition: 1, 2017.

Reference Books

1. A.I. Vogel's Text book of Quantitative Chemical Analysis, G H Jeffery, J Bassett, J Mendham, R C Denney, Longman Scientific and Technical, 5th Edition, 1989.

Mode of assessment: Lab assessment, Viva-Voce and FAT

Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY304P	Organic Compounds Synthesis and Extraction Lab	L	T	P	C
		0	0	4	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

The course is aimed at students

1. preparations of various organic compounds employing different reactions.
2. one step and two step reactions followed by characterization using UV, IR , GCMS and NMR technique.
3. extraction of various organic compounds

Course Outcomes:

At the end of the course the students will be able to

1. carry out organic synthesis by single or two step process followed by characterization by different instrumental techniques such as IR, UV-Vis, GCMS, NMR
2. design extraction of different organic compounds in a given sample

List of Experiments

1.	Separation of binary mixture by TLC and column chromatography - non-polar and polar samples	6 hours
2.	Synthesis, characterization of phenytoin from benzoin- two step reactions	6 hours
3.	Synthesis, characterization of 2,3-diphenyl quinoxaline (from benzil)	6 hours
4.	Synthesis characterization of 2-phenylindole from acetophenone –two step reactions	6 hours
5.	Synthesis, characterization of tetrahydrocarbazole from cyclohexanone-(Fischer Indolization)	6 hours
6.	Synthesis, characterization of methyl cinnamate from malonic acid through cinnamic acid two step reactions	6 hours
7.	Synthesis, characterization of methyl salicylate from salicylic acid: one-step	6 hours
8	Friedlander synthesis: 2-aminobenzophenone to 2-methyl-3-aceylquinoline	6 hours
9.	Extraction and characterization of Caffeine from Tea leaves	6 hours
10.	Extraction and characterization of Piperine from Black pepper	6 hours
11.	Extraction and characterization of Lycopene from Tomatoes	
	Total Laboratory Hours (any 10 experiments)	**60 hours**

Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY305L	Chemical Kinetics, Catalysis and Surface Chemistry	L	T	P	C
		4	0	0	4
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students
1. understanding the concepts of chemical kinetics, catalysis, and surface chemistry
2. imparting knowledge on theory of rate processes; applications of kinetics to the study of reaction mechanisms, homogenous and heterogeneous catalysis, and surface reactions

Course Outcomes:

At the end of the course the students will be able to
1. analyse the reaction mechanisms of kinetics of the reactions
2. apply the concepts of complex reaction mechanisms
3. evaluate the rate of fast reactions
4. correlate the concepts of homogeneous and heterogeneous catalysis
5. derive the Michaelis-Menten parameters in enzyme catalysis
6. compare various surface characterization techniques in study of surfaces

Module:1	**Theories of reaction rates and mechanisms**	**8 hours**

Effect of temperature and catalyst on reaction rates – Arrhenius equation; collision theory of bimolecular gaseous reactions, activated complex theory of bimolecular reactions; enthalpy, entropy and free energy of activation; potential energy surfaces, reaction coordinates, factors determining reaction rates in solution, solvent dielectric constant and ionic strength.

Module:2	**Kinetics of complex reactions**	**8 hours**

Mechanisms of complex reactions – steady-state and equilibrium approximations; Kinetics of opposing or reversible reactions, consecutive reactions, and chain reactions

Module:3	**Kinetics of fast reactions**	**7 hours**

Study of kinetics of fast reactions - stopped flow technique, relaxation method, process instrumentation, methodologies, and applications.

Module:4	**Surface Chemistry**	**9 hours**

Different types of surfaces, thermodynamics of surfaces, Gibbs adsorption equation and its verification; Surfactants and micelles, critical micellar concentration, surface pressure and surface potential and their measurements and interpretation; kinetics of surface reactions involving adsorbed species - Langmuir-Hinshelwood mechanism; surface films-Langmuir-Blodgett films; self-assembled monolayers.

Module:5	**Introduction to Surface Characterization techniques**	**8 hours**

Basic aspects and applications of a) Surface-enhanced Raman scattering (SERS), low energy electron diffraction and photoelectron spectroscopy, electron spectroscopy for chemical analysis (ESCA), Auger electron spectroscopy, scanning probe microscopy, ion scattering, SEM.

Module:6	**Homogeneous and heterogeneous Catalysis**	**9 hours**

Homogeneous catalysis-Acid-base catalysis; specific and general catalysis, Skrabal diagram, Bronsted catalysis law, prototropic and protolytic mechanism with examples, acidity function. Heterogeneous catalysis mechanism - unimolecular and bimolecular surface reactions, porous solids, catalysis by metals, semiconductors and solid acids supported metal catalysts - catalyst preparation - deactivation and regeneration, model catalysts-ammonia synthesis, hydrogenation of carbon monoxide; selective catalytic reduction – polymerization; Autocatalysis and oscillators.

Module:7	**Enzyme Catalysis and Photocatalysis**	**9 hours**

Enzyme catalysis - Michaelis-Menten equation. Rates of enzyme catalyzed reactions - effect of substrate concentration, pH, and temperature. Determination of Michaelis-Menten parameters, Lineweaver-Burk plot, effect of inhibitors, competitive, non-competitive and uncompetitive reactions.

Porphyrins -phthalocyanines and semiconductor as photocatalysts in photolysis reactions - generation of hydrogen by photocatalysts		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**60 Hours**

Text Book(s)

1. Atkins Physical Chemistry, 11th Edition By Peter Atkins, Julio De Paula, James Keeler, Oxford University press, 2018.
2. Principles Of Physical Chemistry, by B.R. Puri, L.R. Sharma, M.S. Pathania. 47th edition, Vishal Publishing Co, India, 2016.

Reference Books

1. Chemical Kinetics, Keith James Laidler, J. Keith, Professor Emeritus of Chemistry Keith J Laidler, Harper & Row, 1987.
2. P.H. Emmet, Catalysis (Vol I and II), Reinhold, New York, 1954.
3. B. Viswanathan, S. Kannan, R.C. Deka, Catalysts and Surfaces: Characterization Techniques, Narosa, New Delhi, 2010.

Mode of Evaluation: CAT, Quiz, Assignments, FAT			
Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY305P	Kinetics and Catalysis Lab	L	T	P	C
		0	0	4	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students
1. imparting the concepts to follow kinetics of chemical reactions
2. understanding the principles of conductivity and electrochemical methods

Course Outcomes:

At the end of the course the students will be able to
1. investigate the rates of chemical reactions including surface reactions using various methods
2. apply the concepts of electrochemical measurements in redox titrations

Indicative Experiments		
1.	Determination of Arrhenius parameters in the kinetic study of acid catalysed hydrolysis of ester	6 hours
2.	Study of salt effect on the reaction between acetone and iodine	6 hours
3.	Primary salt effect on second-order kinetics of persulphate – iodide reaction	6 hours
4.	Kinetics of iodination of acetone	6 hours
5.	Decomposition of diacetone alcohol-dilatometry method.	6 hours
6.	Study of complex formation by spectrophotometry using Job's method	6 hours
7.	Determination of distribution coefficient of iodine between organic and inorganic layer	6 hours
8.	Verification of Ostwald's Dilution law for a weak electrolyte.	6 hours
9.	Study the kinetics of decomposition of the complex formed between sodium nitroprusside and sodium sulphide spectrophotometrically and find the order and rate constant of the reaction	6 hours
10	Verify the Freundlich and Langmuir isotherms for the adsorption of oxalic acid on activated carbon	6 hours
	Total Laboratory Hours	**60 hours**

Text Book(s)

1.	Renu Gupta, Practical Physical Chemistry 1 Edition (English, Paperback, Renu Gupta), New Age International, ISBN: 9789386418098, 9386418096, Edition: 1, 2017.

Reference Books

1.	A.I. Vogel's Text book of Quantitative Chemical Analysis, G H Jeffery, J Bassett, J Mendham, R C Denney, Longman Scientific and Technical, 5th Edition, 1989.

Mode of assessment: Lab assessment, Viva-Voce and FAT

Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY306P	Inorganic Synthesis Lab	L	T	P	C
		0	0	4	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students to
1.perform the synthesis of inorganic complexes
2.select appropriate instrumental methods for characterization of metal complexes

Course Outcomes :

At the end of the course students will be able to
1. synthesize and purify different inorganic complexes
2. apply UV-Vis and IR spectroscopic techniques for metal complexes characterization
3. differentiate physical and chemical properties of metal complexes
4. evaluate structure property relationship of inorganic complexes

	Synthesis and characterization (by IR,UV-VIS and NMR spectroscopic techniques) of inorganic complexes	**Duration**
1	Werner's complex $[Co(NH_3)_5Cl]Cl_2$	6 hours
2	Tris(ethylenediamine)cobalt(III)chloride $[Co(en)_3]Cl_3$	6 hours
3	*cis* and *trans*-dichlorobis-(ethylenediamine)cobalt(III) chloride $[CoCl_2(en)_2]Cl$	6 hours
4	Potassium trisoxalatoferrate(III) trihydrate $K_3[Fe(C_2O_4)_3]$	6 hours
5	Vanadyl acetylacetonate $[VO(acac)_2]$	6 hours
6	Bis-(salicylaldimine)-Cu(II)	6 hours
7	Zinc (tris) thiourea sulphate, $Zn(SC(NH_2)_2)_3SO_4$	6 hours
8	Ferrocene $(\eta^5\text{-}C_5H_5)_2Fe$	6 hours
9	Al^{III}(8-hydroxyquinolinolato)$_3$ (Alq_3)	6 hours
10	Nickel(II) salt of ethylenediamine-tetraacetate [Ni(EDTA). H_2O.Na] Tris(ethylenediamine)-nickel(II) chloride dehydrate$[Ni(en)_3Cl_2.2H_2O]$ Hexa ammine nickel(II) chloride $[Ni(NH_3)_6Cl_2]$, CFSE calculation.	6 hours
	Total Laboratory Hours	**60 hours**

Mode of Evaluation: Continuous Assessment in lab, Viva-Voce & FAT

Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

Course Code	Course Title	L	T	P	C
TCHY401L	Advanced Organic Chemistry	3	0	0	3
Pre-requisite	TCHY203L, TCHY210L	Syllabus version			
		1.0			

Course Objectives

The course is aimed at:

1. Summarizing the basic concepts about synthesis and reaction mechanisms of various organic reactions with respect to the configuration, asymmetry and various stereo-chemical, mechanistic and conformational aspects.
2. Discussing the theory and applications of various spectroscopic techniques for material characterization in different domains.

Course Outcomes

At the end of the course, students should be able to

1. Distinguish aromatic, non-aromatic, anti-aromatic, homo-aromatic compounds.
2. Explain the various rearrangements, mechanisms, functions of various reagents and catalysts.
3. Identify reaction intermediates and propose suitable mechanisms for the organic reactions.
4. Classify the different conformational analysis, the conformations and reactivity.
5. Comprehend the principles, concepts of asymmetric synthesis and the reactivity of enolates and enamines and their significance in organic synthesis.

Module:1	Aromaticity	5 hours

Huckel's rule of aromaticity, benzenes, fused benzenes-anthracenes, phenanthrenes, pyrenes, chrysenes, corannulenes, coronenes, helicenes- other aromatics - cycloheptatrienes, azulenes, heteroaromatics, annulenes, aromatic ions-cyclopentadienyl anion, tropylium ion, antiaromaticity-cyclooctatraene, pentalenes, homoaromaticity (more examples). NMR and Aromaticity-Diamagnetic and paramagnetic anisotropy, NMR of aromatic and anti-aromatic compounds.

Module 2	Reactive intermediates	4 hours

Synthesis, structure, stability and reactivity of carbocations (including non-classical carbocations), carbanions. free radicals, carbenes and nitrenes.

Module:3	Cationic and anionic rearrangements	9 hours

Cationic rearrangements:

Pinacol-pinacolone, Demjanov, Wagner Meerwin, Schmidt, Hoffmann, Lossen, Curtius, Neber, Wolff, Baeyer-Villiger Oxidative Rearrangements, Stieglitz Rearrangement, Beckmann Rearrangement.

Anionic rearrangements:

Benzil-Benzilic acid, Brook, Wittig, Stevens, Sommelet-Hauser, Favorskii, Barton deoxygenation and decarboxylation, McMurry coupling.

Module: 4	Methods of determining reaction mechanisms	6 hours

Hammond Microscopic reversibility - kinetics, isotopic labeling, cross over experiments, trapping - structure and reactivity - Hammett and Taft equations.

Module 5	Conformation and reactivity of cyclic molecules	8 hours

Mono, di and tri substituted cyclohexane, cyclohexanone and cyclohexene; conformations and reactivity of cyclohexanol (acylation and oxidation); Neighbouring group participation, Reduction of cyclohexanone, esterification and hydrolysis of cyclohexane carboxylic acid derivatives. Cis-, trans-decalins.

Module:6	Chemistry of enolates and enamines	7 hours

Kinetic and thermodynamic enolates, Lithium and boron enolates in aldol and Michael reactions, Alkylation, acylation and stereoselectivity of enolates, synthesis of enamines		
Module:7	**Asymmetric Synthesis and Enantioselective reactions**	**4 hours**
Importance, classification and principle; modes of asymmetric induction, methods of asymmetric induction – kinetic control and thermodynamic control, auxiliary control, substrate control, reagent control, and solvent control; kinetic resolution and dynamic resolution, chiral discrimination; desymmetrization (chemical and enzymatic). Determination of optical purity using NMR, Polarimeter, GC and HPLC techniques.		
Module:8	**Contemporary Issues**	
	Industry Expert Lecture	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry Part A and Part B: Reaction and Synthesis, Springer, 5th Edition, 2010.
2. J. March and M. B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 6th Edition, Wiley, 2013.

Reference Books

1. I. L. Finar, Organic Chemistry Vol. I & Vol. II, Longman (Cambridge), 2011.
2. W. Carruthares, Iain coldham, Modern Methods of Organic Synthesis South Asia Edition, Cambridge University Press, Fourth Edition, 2015.
3. R.M. Silverstein, G. C. Bassler, T. C. Morril, Spectrometric identification of Organic Compounds, John Wiley & Sons, Inc, 2010.
4.Peter K., Vollhardt, C., and Schore N. E., Organic Chemistry, W. H. Freeman and Company, 2010.
5. Pine S. H., Organic Chemistry, Tata McGraw Hill, 5th edition, 2008.
6. R. Chang, Chemistry, 1st Indian Edition, Tata-McGraw Hill, 2007.
7. Guidebook to Mechanism in Organic Chemistry (6th Edition), Peter Sykes, Longman Scientific & Technical, 2018.
8. Grossman, R. B. The Art of Writing Reasonable Organic Reaction Mechanisms, 2nd edition, Springer, 2019.
9. L. Kuerti and B. Czako, Strategic Applications of named Reactions in Organic Synthesis, Elsevier Academic Press, 2019.
10. Noyori, Asymmetric Catalysis in Organic Synthesis, John Wiley & Sons, 1994.
11. Ernest L. Eliel and Samuel H. Wilen, Stereochemistry of Organic Compounds, Wiley; 1st edition, 2020.
12. D Nasipuri, Stereochemistry of Organic Compounds Principles and Applications, New Age International Publishers, 2023.

Mode of Evaluation : Written Examinations, Quiz and Assignments			
Recommended by Board of Studies	19-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course title	L	T	P	C
TCHY401P	Advanced Organic Chemistry Lab	0	0	4	2
Pre-requisite	TCHY203L, TCHY210L	Syllabus version			
		1.0			

Course Objectives

1. Summarize the preparations and characterizations of various organic compounds through IR, NMR and MS techniques.
2. Choose a specific isolation and purification technique of different organic compounds through single or two-step syntheses.

Course Outcome

1. Perform experiments to synthesize, separate and purify the organic compounds.
2. Choose appropriate characterization techniques to confirm the organic compounds.

	EXPERIMENTS	Hours
1.	Synthesis and characterization of methyl salicylate from salicylic acid / (Zn Acetic acid acetylation. (IR, NMR).	6 hours
2.	Synthesis and characterization of Diels Alder adduct using anthracene and Maleic anhydride – (IR, NMR).	6 hours
3.	Synthesis and characterization of Neroline from β-Napthol (IR, NMR).	6 hours
4.	Synthesis and characterization of barbituric acid (IR, NMR).	6 hours
5.	Synthesis and characterization of flavone (IR, NMR).	6 hours
6.	Synthesis and characterization of trimethylquinoline from p-toluidene- two step (IR, NMR).	6 hours
7.	Synthesis and characterization of benzocain (IR, NMR).	6 hours
8.	Synthesis and characterization of 7-hydroxy-4-methylcoumarin (IR, NMR).	6 hours
9.	Synthesis and characterization of methyl red from anthranillic acid: two-step process (IR, NMR, ESI-MS).	6 hours
10.	Synthesis and characterization of α, β -Unsaturated acid from anisaldehyde –two step Knoevenagel condensation/hydrolysis (ESI-MS) (separation by column).	6 hours
	Total Laboratory Hours	**60 hours**

Text Book(s)

1. B.S. Furniss, A.J. Hannaford, P.W.G. Smith and A.R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, Pearson India; 5th edition, 2003.

Reference Books

1. R.K. Bansal, Laboratory Manual of Organic Chemistry, New Age International Private Limited, 2008.
2. V.K. Ahluwalia and R. Aggarwal, Comprehensive practical organic chemistry, University press, 2000.
3. https://doi.org/10.1016/j.molstruc.2023.137373.

Mode of assessment: Internal assessment / FAT / Oral examination and others

Recommended by Board of Studies	19-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY402L	Advanced Inorganic Chemistry	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

The course is aimed at:

1. Applying the knowledge of structure, bonding and reactivity of transition metals, rare metals, organometallics, bio-inorganic and inorganic photochemistry.
2. Analyzing real time problems and provide solutions.

Course Outcomes

At the end of the course, students should be able to

1. Know the concepts of bonding, electronic spectroscopy and photochemistry in metal complexes.
2. Relate the structural properties of inorganic clusters and polyacids.
3. Develop catalytic pathways leading to desired products.
4. Describe the role of transition metal coordination complexes in biological systems and medicinal applications.
5. Illustrate the principles, photochemical properties, and applications of inorganic complexes.

Module:1	Bonding in coordination complexes	6 hours

Theories of bonding – VBT, CFT and their limitations. JT – distorted octahedral, square pyramidal, trigonal bipyramidal and tetrahedral complexes; CFSE for d1 to d10 systems, pairing energy, low spin and high spin complexes and magnetic properties; LFT, and molecular orbital theory of selected octahedral and tetrahedral complexes.

Module:2	Electronic spectroscopy	8 hours

Term, term symbols, microstates, term symbols for atoms and ions, energy levels of d^1 – d^{10} ions in octahedral, tetrahedral and square planar fields. Intensity of absorption bands, dipole moment integral. Oscillator strength, selection rules, spin-orbit and vibronic coupling contributions to intensity. Weak and strong field complexes - Raccah parameter, Orgel diagram, Tanabe Sugano diagram - effects of distortion and spin – orbit coupling on spectra – applications to simple coordination complexes (Co(III) and Ni(II)), charge transfer spectra of halide, cyanide based complexes – electronic spectrum of $Ru(bpy)_3^{2+}$.

Module:3	Inorganic – clusters, cages and polyacids	7 hours

Clusters - polynuclear carbonyls - synthesis, reactivity, molecular structure, stereochemical non-rigidity and polyhedral skeletal electron-pair theory (PSPET). Cages: B-N, P-N and S-N compounds.

Polyacids- isopoly and heteropoly acids. Boron systems styx rule, boranes, metallo and carboranes, heteroboranes, identification of closo nido arachno hypo structures for $B_nH_{2n}^{2-}$ and zintl structures.

Module:4	Organometallic catalysis	6 hours

Reaction of organometallic complexes - substitution, oxidative addition, reductive elimination, insertion, and deinsertion. Hydrogenation of olefins - hydroformylation of olefins – Monsanto process, Wacker process, Fischer - Tropsch process - Ziegler–Natta catalyst. Metallocenes - nonmetallocene catalysts - olefin metathesis.		
Module:5	**Bioinorganic systems**	**7 hours**
Porphyrin systems: dioxygen transport - hemoglobin, hemerythrin and hemocyanin. Cooperativity in O_2 binding, O_2 and CO discrimination. Inorganic model compounds. Oxygen Metabolism - Oxygen atom transfer by cytochromes-P_{450} - nitrogenases - carbonic anhydrase - carboxypeptidase - alcohol dehydrogenase – photosystem I and II.		
Module:6	**Medicinal applications**	**5 hours**
Metal complexes in medicine- cisplatin and its mode of action. Gold and lithium compounds as drugs - metal complexes as probes of nucleic acid, metal ions in genetic regulations, metal DNA and RNA interaction – potential binding sites.		
Module:7	**Inorganic photochemistry**	**6 hours**
Laws of photochemistry, photophysical mechanism of excited states, quantum yield, electronic Structure - types of excited states and electronic transitions - absorption and emission bands - Jablonski diagram, internal conversion, intersystem crossing, fluorescence, phosphorescence and delayed fluorescence, photosensitizers, chemiluminescence, bioluminescence, Photochemistry of Ru(II) and Cr(III) complexes – porphyrin-based photosensitizers for photodynamic therapy, photochemical water splitting by transition metal complexes and DSSC.		
Module:8	**Industry Expert Lecture**	**2 hours**
	Total Lecture hours	**45 hours**
Text Book(s)		
1. D. F. Shriver and P.W. Atkins, Inorganic Chemistry, Oxford University Press, 5th Edition, 2010. 2. Dieter Rehder. Bioinorganic Chemistry: An Introduction, Oxford University Press; 1st Edition, 2014. 3. J.E. Huheey, E. A. Kelter and R.L. Kelter, Inorganic Chemistry: Principles of structure and reactivity, Harper Collins College Publishers, 4th Edition, 2011. 4. K. Sridharan, Spectral Methods in Transition Metal Complexes, Elsevier, 1 st Edition, 2016. 5. F. Albert Cotton, Geofrey Wilkinson, Advanced Inorganic Chemistry, 6th Ed., 1999.		
Reference Books		
1. M.N. Hughes; The inorganic chemistry of biological processes, John Wiley and Sons, London, 1972. 2. Keith F. Purcell, John C. Kotz; Inorganic Chemistry; Saunders, 1989.		
Mode of Evaluation: Written Examinations, Quiz and Assignments		
Recommended by Board of Studies	19-01-2024	
Approved by Academic Council	No. 73	Date 14-03-2024

Course Code	Course Title	L	T	P	C
		3	1	0	4
TCHY403L	Quantum Chemistry and Spectroscopy	Syllabus Version			
Prerequisite	Nil	1.0			

Course Objectives

The course is aimed at:

1. Applying aspects of quantum chemistry, and spectroscopy in different problems of chemical interest.
2. Identifying the theories behind the interpretation of rotational, vibrational, and electronic spectra of molecules.

Course Outcomes

At the end of the course the students will be able to

1. Summarize the concepts of quantum chemistry.
2. Explore the fundamentals of quantum chemistry in molecular spectroscopy.
3. Discuss the practical implementation of quantum chemistry in spectroscopy.
4. Apply the quantum chemistry, group theory and molecular spectroscopy to solve real world problems.
5. Describe the basic principles of NMR and ESR spectroscopies.

Module 1	Quantum Chemistry I	6 hours

Basic mathematics-exponential functions, vector algebra, matrices, determinants. Wave-particle dualism, Uncertainty principle, Operators for dynamic variables– Eigen values and Eigen functions, Postulatory basis of quantum mechanics, Schrödinger wave equation.

Module 2	Quantum Chemistry II	7 hours

Free particle, Particle in a box: one and three-dimensional, quantum numbers, zero-point energy, orthogonalization and normalization, finite potential barrier – tunnelling.

Module 3	Quantum Chemistry III	7 Hours

Born-Oppenheimer Approximation, The Rigid Rotator, One Dimensional Harmonic Oscillator, Solutions to hydrogen atom, Variation theorem, Perturbation Theory, Time-dependent Schrodinger wave function. Examples of conjugated diene, Huckel MO theory

Module 4	Fundamentals of molecular spectroscopy	7 hours

Interaction of electromagnetic radiation with matter, Einstein coefficients, The basis of absorption and emission of radiation by molecular species, types of molecular spectroscopy, molecular energies, factors affecting linewidth and intensity, signal to noise ratio and resolving power, the wave properties of the light, the quantum theory of light, quantum theory of matter, Stimulated and spontaneous emission, Physical principles of Nuclear Magnetic Resonance Spectroscopy, Spin-Spin and Spin-lattice relaxation times and their measurements, Bloch equation.

Module 5	Rotational Spectroscopy	6 hours

Classical description of molecular rotation, quantum mechanics of molecular motion, rotational spectra, determination of the bond length from rotational constants, vibrational stretching and vibrational satellites, non-rigid rotor, centrifugal distortion, degeneracies and intensities, Stark effect, selection rules, rotational spectra of polyatomic molecules.

Module 6	Vibrational Spectroscopy	6 hours

The Molecular vibrations-types, Vibrating Diatomic Molecule - harmonic and anharmonic oscillators- Diatomic Vibrating Rotator - Vibrations of polyatomic molecules- Fundamentals, overtones, combination bands and Fermi resonance. Basics of Raman scattering. Examples		
Module 7	**Electronic Spectra of Molecules**	**6 hours**
Vibrational Coarse structure: Progressions, Intensity of vibrational-Electronic spectra: Franck-Condon Principle, Dissociation Energy, Dissociation Products and Predissociation		
Module 8	**Industry Expert Lecture**	**2 hours**
	Total lecture hours	**45 hours**

Text books

1.Colin N Banwell, Elaine M. McCash, *Fundamentals of Molecular Spectroscopy*, Tata McGraw – Hill, Publishing Co. Ltd., 5th Edition, 2013.

2. P. W. Atkins and Julio de Paula, *Atkins' Physical Chemistry,* 2018, International 11th Edition, Oxford University Press, United Kingdom.

3. Understanding NMR Spectroscopy, James Keeler, Wiley India Pvt Ltd; Second edition, 2013.

4. Ira N. Levine, Quantum Chemistry, Prentice Hall India Learning Private Limited, 2009.

Reference books

1. D. A. McQuarrie, *Quantum Chemistry*, 2nd Edition, University Science Books, 2008.
2. Hollas J. Michael Hollas, *Modern Spectroscopy*, John Wiley & Sons Inc. 4th Edition, 2003.
3. A.K. Chandra, *Introduction to Quantum Chemistry*, Tata Mc Graw Hill Publishing Company, New Delhi, 4th Edition, 2009.
4. P. S. Kalsi, *Spectroscopy of Organic Compounds*, 6th Edition. New Age International Publishers, 6th Edition, 2006.
5. F. Hammer, *Inorganic Spectroscopy and Related Topics*, Sarup & Sons, 1st Edition, 2008.

Mode of Evaluation	CAT / Assignment / Quiz / FAT / Project / Seminar		
Recommended by Board of Studies	19-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY404L	Modern Methods in Organic Synthesis	3	0	0	3
Pre-requisite	TCHY203L, TCHY210L	Syllabus version			
		1.0			

Course Objectives

The course is aimed at:

1. Summarizing the basic concepts about organic synthesis involving carbon-carbon single/double bond formation and reagents used in them as tools applied in the art of organic synthesis, understanding retrosynthetic approach towards organic synthesis.
2. Imparting knowledge in organic synthesis, significant exposure in multistep organic synthesis and application of the art of organic synthesis towards research and development for future development.

Course Outcomes

1. Design the retrosynthetic method for the logical dissection of complex organic molecules and devise synthetic methods.
2. Recall the fundamental principles of organic reactions, identifying the appropriate reagents and protecting groups.
3. Understand the concepts in organic synthesis involving carbon-carbon single/double bond formation and reagents, mechanisms, and the functions of various reagents or catalysts. Suggest methods to investigate the mechanism of reactions and alternative reagents and reactions for performing desired organic transformations.
4. Apply their understanding to explain in detail the outcome of organic synthesis for the application of industrial significance for the day-to-day benefit of human society by applying various reagents, oxidation, reduction and protecting groups techniques for the art of organic synthesis in a logical manner.
5. Understanding the role of oxidation – reduction techniques, role of important reagents and protecting groups in organic synthesis.

Module:1	Disconnection approach	6 hours

Retrosynthetic Analysis: Basic principles and terminology of retrosynthesis, one group and two group C-X disconnections, one group C-C and two group C-C disconnections, Reversal of polarity (Umpolung), important strategies of retrosynthesis including functional group transposition and Domino (Cascade or Tandem) reactions.

Module:2	Carbon-Carbon Single Bond Formation Reactions	5 hours

Alkylation of enolates and enamines, Conjugate addition reactions of enolates and enamines, The aldol reaction, Asymmetric methodology with enolates and enamines.

Module:3	Carbon-Carbon double Bond Formation Reactions	5 hours

Elimination reactions, Pyrolytic syn eliminations, Fragmentation reactions, Alkenes from hydrazones, 1,2-diols, alkynes, sulfones and Peterson olefination.

Module:4	Formation of Carbon-Carbon bonds using organometallic reagents	6 hours

Synthesis, mechanism, and application (selected examples) of organolithium, organomagnesium, organoboron, organocopper and organopalladium reagents.

Module:5	Oxidation techniques in organic synthesis	7 hours

Metal based and metal-free oxidations of alcohols (chromium, manganese, DMSO, and hypervalent iodine). Peracids oxidation of alkenes and carbonyls. Alkenes to diols (manganese, osmium based), alkenes to carbonyls with bond cleavage (ruthenium, and lead based, ozonolysis), and alkenes to alcohols/carbonyls without bond cleavage (hydroboration-oxidation, Wacker oxidation, and selenium based allylic oxidation).

Module:6	**Reduction techniques in organic synthesis**	**6 hours**

Catalytic homogeneous and heterogeneous hydrogenation, Wilkinson catalyst. Metal based reductions using Li/Na in liquid ammonia, sodium, magnesium, zinc, titanium, and samarium. Hydride transfer reagents: $NaBH_4$, L-selectride, K-selectride, Luche reduction, $LiAlH_4$ and DIBAL-H.

Module:7	**Reagents in Organic Synthesis and Protecting groups**	**8 hours**

Use of the following reagents in organic synthesis and functional group transformations; complex metal hydrides, lithium dimethylcuprate, lithium diisopropylamide (LDA), 1,3-dithiane (reactivity Umpoloung), tri-n-butyltin hydride, Phosphorous ylides (Wittig Reaction), Woodward and Prevost hydroxylation. Protecting groups: Protection and deprotection of hydroxy, carboxyl, carbonyl, carboxy amino groups and carbon-carbon multiple bonds; chemo- and regioselective protection and deprotection.

Module:8	**Contemporary Issues**	
	Industry Expert Lecture	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. W. Carruthers, Modern Methods of Organic Synthesis, Cambridge University Press, 2015.
2. George S. Zweifel, Michael H. Nantz and Peter Somfai, Modern Organic Synthesis, By · Wiley, 2017.
3. F. A. Cary and R. I. Sundberg, Advanced Organic Chemistry, Part A and B, 5th Edition, Springer, 2009.
4. S. Warren, Organic Synthesis, The disconnection Approach, John Wiley & Sons, 2004.

Reference Books

1. L. Kuerti and B. Czako, Strategic Applications of named Reactions in Organic Synthesis, Elsevier Academic Press, 2005.
2. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, Oxford University Press, 2001.
3. M. B. Smith, Organic Synthesis, 3rd Edition, 2011, Academic Press, USA.
4. Advanced Organic Chemistry by J. March, John Wiley & Sons, 2006.
5. Organic Chemistry by S. H. Pine, McGraw Hill, 1987.
6. E.J. Corey and Xue-Min Cheng, The Logic of Chemical Synthesis, Wiley India Pvt Ltd, 2011.
7. Peter G.M. Wuts and Theodora W. Greene, Protective Groups in Organic Synthesis, Wiley India Pvt Ltd, 2011.
8. Richard O.C. Norman, Principles of Organic Synthesis, Routledge, 2017.

Mode of Evaluation: Written Examinations, Quiz and Assignments

Recommended by Board of Studies	19-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY405L	Materials Chemistry	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

The course is aimed at:

1. Discussing the basic aspects of materials and their applications.
2. Correlating the structure and property of materials for transport, magnetic, optical and dielectric properties.

Course Outcomes

At the end of the course, students should be able to

1. Categorize materials in diverse crystal systems.
2. List different methods of materials synthesis and characterization.
3. Apply the properties of emerging materials in various domains.
4. Identify appropriate transport, magnetic, optical and dielectric properties for a given application.
5. Explain the importance of energy materials.

Module:1	Symmetry and structural aspects of solids	7 hours

Symmetry elements - point groups, space groups. Fundamentals and applications of X-ray diffraction, indexing of cubic system. AB_2 -pyrite, cuprite - A_2B_3 - Al_2O_3 (Corundum type) and rare- earth oxides, AB_3 - ReO_3, pervoskites, AB_2O_4 (Spinels), Zeolites

Module:2	Preparative strategies and characterization	7 hours

Chemistry behind solid state synthesis –co-precipitation, precursor, sol-gel, combustion, intercalation, chimie douce, ion- exchange, microwave, electrochemical, sonochemical, hydrothermal -high temperature and high-pressure synthesis. XRD, SEM and particle size analysis.

Module:3	Emerging materials	7 hours

Emerging materials: Graphene, graphene oxide, MXenes, monolayer MoS_2, boron nitride, BCN – synthesis, structural features and applications.

Module:4	Transport properties	7 hours

Defects in solids: Stoichiometric and nonstoichiometric defects - point defects - Frenkel and Schottky defects and properties- color centers. Band theory of solids - metals, semiconductors, insulators, superconductors, ionic conductors and fast ion conductors

Module:5	Magnetic materials	5 hours

Magnetic properties- dia, para, ferro, antiferro and ferri magnetism – spinels, garnets and multiferroics, magnetic moment and magnetic susceptibility measurements

Module:6	Optical and dielectric materials	5 hours

Optical properties- optical absorption and band gap – luminescence materials - lasers: principle & characteristics. Dielectric properties- ferro, anti-ferro, piezo, tribo and pyro electrics- relationship and applications.

Module:7	Energy materials	5 hours

Thermoelectric materials- intermetallics and oxides. Lithium-ion battery materials – electrode and electrolyte materials, supercapacitors, solid oxide fuel cells, photoelectrochemical cells - material aspects		
Module:8	**Industry Expert Lecture**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Anthony R. West, Solid State Chemistry and its Applications, 2nd Ed., John Wiley & Sons, 2014.
2. Patrick M. Woodward, Pavel Karen, John S. O. Evans, Thomas Vogt , Solid State Materials Chemistry, Cambridge University Press, 1st Ed. 2021.

Reference Books

1.Lesley E. Smart and Elaine A. Moore, Solid State Chemistry-An Introduction , 4th Ed., CRC Press, Taylor and Francis Group, 2012.
2. Richard J. D. Tilley, Understanding Solids: The Science of Materials, 2nd Ed., Wiley, 2013.
3. Chawla K Krishnan, Composite Materials –Science and Engineering, Springer, 2012.
4. Robert J. Young and Peter A. Lovell, Introduction to Polymers, 3rd Ed., CRC Press, 2021.

Mode of Evaluation: Written Examinations, Quiz and Assignments

Recommended by Board of Studies	19-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Name	L	T	P	C
TCHY406P	Inorganic Materials Lab	0	0	4	2
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

The course is aimed at

1. Training in synthesis of inorganic material, characterization and chemical analysis.
2. Discussing the importance of different instrumental methods in analysis of materials.

Course Outcomes

At the end of the course, the student should be able to

1. Prepare selected inorganic materials for specific applications.
2. Analyze the structural and physical properties of inorganic materials through instrumental techniques.

	Experiments	Hours
I. Preparation and characterization of materials		
1	Preparation of superconducting oxide - Yttrium Barium Copper Oxide ($YBa_2Cu_3O_7$) and ruby powder by combustion method	6 hours
2	Preparation of Barium Titanate ($BaTiO_3$) by sol-gel method	6 hours
3	Preparation and characterization of silver nanoparticles	6 hours
4	Soft chemical routes to material synthesis – hydrogen insertion, Li insertion	6 hours
II. Characterization of Materials		
5.	Preparation of $Ba_{1-x}Sr_xTiO_3$ and powder XRD analysis	6 hours
6.	(i) Phase identification (ii) lattice parameter calculation (iii) density calculation of $Ba_{1-x}Sr_xTiO_3$ using powder XRD data	6 hours
7.	Verification of Vegard's law for a given material	6 hours
III. Measurement of properties of materials		
8.	Resistivity and band gap measurement of Si – four probe method	6 hours
9.	Crystallite size calculation of the given nanomaterial using Scherrer formula	6 hours
10.	Determination of optical band gap of given metal oxide semiconductor	6 hours
	Total Laboratory Hours	**60 hours**

Text Book(s)

1. C.N.R. Rao, Kanishka Biswas; Essentials of Inorganic Materials Synthesis, 2015, John Wiley & Sons, Inc.

2. C. Suryanarayana, M. Grant Norton; X-Ray Diffraction - A Practical Approach, 2013, Springer NY.			
Reference Books			
1. A. K. Tyagi, Raghumani, S. Ningthoujam; Handbook on Synthesis Strategies for Advanced Materials, Volume-I: Techniques and Fundamentals, 2022, Springer Nature Singapore Pte. Ltd.			
Mode of Evaluation: Continuous Assessment in lab, Viva-Voce & FAT			
Recommended by Board of Studies	19-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY407L	Advanced Electrochemistry	3	0	0	3
Pre-requisite	TCHY207L, TCHY207P	Syllabus version			
		1.0			

Course Objectives

The course is aimed at:

1. Discussing ionics, electrified interface and electrodics of advanced electrochemistry.
2. Describing electrochemical processes involved in batteries, fuel cells as well as corrosion phenomenon.
3. Introducing important potentiodynamic and pulse techniques so that these methods can be employed in analyzing and estimating analytes in the given sample.
4. Applying the electrochemical concepts to advanced and applied electrochemistry such as chemically modified electrodes, biosensors, ultramicroelectrodes, etc.

Course Outcomes

At the end of the course, students should be able to

1. Understand electrochemical processes taking place at electrified interface including dynamics of ions in a solution and electrode kinetics.
2. Apply these advanced concepts in understanding the principles of batteries, fuel cells, corrosion process and its prevention.
3. Analyze and determine various analytes in the solution using potentiodynamic and pulse techniques.
4. Grasp advanced and frontline electrochemical methods and applications including chemically modified electrodes, biosensors and ultramicroelectrodes.

Module:1	Ionics and Electrified Interface	8 hours

Introduction to basic electrochemistry, Debye – Huckel theory of strong electrolytes –derivation and verification– Activity coefficient of electrolytes – ionic strength – Debye Huckel Limiting Law –derivation and verification – Determination of solute/solvent activities – Bjerrum's theory of ion association in electrolyte solution – Electrified interfaces – thermodynamic treatment – electrical capacitance. Determination of the surface excess – Structure of the electric field – Helmholtz – Perrin Model, Gouy – Chapmann diffusion model and Stern Model.

Module:2	Electrodics	8 hours

Kinetics of electrode reaction – Butler Volmer equation – Tafel equation – Diffusion over potential. Irreversible electrode process – Overvoltage. Applications – Electro deposition.

Polarography - Introduction, Dropping mercury electrode (DME) – Instrumentation – Ilkovic equation and its verification - Determination of half wave potential. Applications – Amperometric and Coulometric titrations.

Module:3	Potentiodynamic techniques	5 hours

Voltammetry- A three electrode system concept - Diffusion-controlled and adsorption-controlled electron-transfer reactions - Single sweep voltammetry.

Cyclic voltammetry - Randles-Sevcik equation - Criteria for reversible and irreversible processes -voltammograms, applications.

Module:4	Pulse techniques	6 hours

Advanced voltammetric techniques – Principle, procedure and applications: Normal pulse voltammetry, Differential pulse voltammetry (DPV), Square wave voltammetry (SWV), Staircase voltammetry and A.C. Voltammetry.
Coulometry: Basic principle, Instrumentation and applications – Potentiostatic coulometry & Chronocoulometry.

Module:5	**Modified electrodes**	**6 hours**

Chemically modified electrodes - Classification - Polymer electrodes, Inorganic films, Biological matrices, Electrochemical and bioelectrochemical sensors. Examples - ascorbic acid and glucose biosensors.
Ultramicroelectrodes: Definition- Construction, working principles and applications.

Module:6	**Batteries and Fuel Cells**	**7 hours**

Batteries: Working principle, cell reactions and cell performances of Lithium Batteries (Primary and secondary). Sodium ion batteries.
Fuel cell: Introduction, Chemistry of fuel cells - Hydrogen-oxygen fuel cells, Hydrocarbon-oxygen fuel cells, Carbon monoxide fuel cell, Methyl alcohol fuel cell; Efficiency of fuel cells - Advantages of fuel cells.

Module:7	**Corrosion**	**5 hours**

Introduction and types of corrosion, Electrochemical corrosion of metals - processes, conditions for the occurrence of corrosion process - kinetic theory of corrosion and its application to pure metals - Methods of corrosion protection - corrosion of technical metals.

Module:8	**Industry Expert Lecture**	**2 hours**
	Total lecture hours:	**45 hours**

Text Book(s)

1. Allen. J. Bard and Larry R. Faulkner, Electroanalytical Methods: Fundamentals and Applications, Second edition, Wiley, 2001.
2. John O'M. Bockris, Amulya K. N. Reddy, Modern Electrochemistry 1, 2A and 2B, Second edition, Springer, 2002.

Reference Books

1. Joseph. Wang, Analytical Electrochemistry, 3rd edition, Wiley-VCH, 2006.
2. Samuel Glasstone, An Introduction to Electrochemistry, East-West Press (Pvt) Ltd 2006.
3. Peter Atkins, Julio De Paula, James Keeler, Physical Chemistry, 12th edition, Oxford University Press, 2022.
4. Nester Perez, Electrochemistry and Corrosion Science, Kluwer Academic Publisher, 2004.
5. R.P.W.Scott, Tandem Techniques, Wiley India Pvt. Ltd. Reprint 2009.
6. D.A.Skoog, D.M. West, F.J. Holler and S.R. Crouch, Fundamentals of Analytical Chemistry, Thompson Asia Pvt Ltd., Bangalore, 2004.
7. Puri, Sharma and Pathania, Principles of Physical Chemistry, Vishal Publications, 46th Edition, 2008.

Mode of Evaluation: Written Examinations, Quiz and Assignments.

Recommended by Board of Studies	19-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY407P	Electroanalytical Techniques Lab	0	0	4	2
Pre-requisite	TCHY207L, TCHY207P	Syllabus version			
		1.0			

Course Objectives

The course is aimed at:
1. Employing potentiometric and conductometric methods of analysis of various analytes using electrochemical instruments.
2. Applying the procedures to estimate organic and inorganic materials in real samples.

Course Outcome

Students should be able to
1. Understand and apply potentiometric technique to evaluate physical constants and amounts of various inorganic and organic materials.
2. Understand and apply conductometric technique to understand theoretical concepts and determine organic compounds in real samples.
3. Evaluate reversibility of an electrochemical reaction as well as estimate an analyte in given a sample using voltammetric techniques.

	EXPERIMENTS	
1.	Determination of mixture of acids - HCl and phosphoric acid potentiometrically using glass electrode	6 hours
2.	Determination of dissociation constant (K_a) of weak electrolyte and verification of Debye-Huckel Onsager equation using strong electrolyte	6 hours
3.	Potentiometric determination of the stability constant of the silver-ammonia complex	6 hours
4.	Conductometric titration of a mixture of trichloroacetic acid, monochloroacetic acid and acetic acid with sodium hydroxide	6 hours
5.	Determination of iodide, bromide and chloride in the mixture by potentiometric titration with silver nitrate	6 hours
6.	Determination of pK values of phosphoric acid by potentiometric titration using a glass electrode	6 hours
7.	Estimation of sulphides in effluent using potentiometric titration	6 hours
8.	Determination of ascorbic acid using Differential Pulse Voltammetry	6 hours
9.	Cyclic voltammetry of ferricyanide/ferrocyanide redox system on Pt electrode – Determination of reversibility and surface area of an electrode	6 hours
10.	Estimation of extent of corrosion of iron pieces by potentiometry	6 hours
	Total Laboratory Hours	**60 hours**

Text Book:

1) Kissinger, Laboratory Techniques in Electroanalytical Chemistry, Second edition, CRC Press, 2016.			
Reference Book: 1) R. Holze, Experimental Electrochemistry: A Laboratory Textbook, Second edition, Wiley-VCH, 2019.			
Mode of assessment: Internal assessment / FAT / Oral examination and others			
Recommended by Board of Studies	19-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF ADVANCED SCIENCES

DEPARTMENT OF CHEMISTRY

Integrated M.Sc. in Chemistry

Discipline Elective Courses

TCHY206L	Green Chemistry	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students to

1. identify eco-friendly methodologies for organic synthesis
2. get an idea of greener approaches using ultrasound and microwave methods

Course Outcomes:

At the end of the course, the students will be able to

1.choose chemical processes/products to reduce generation of hazardous waste
2.design organic synthesis using green synthetic methods to reduce waste
3.describe the solvent less and aquatic phase reactions
4.apply the knowledge of biocatalysts in organic synthesis

Module:1	**Principles**	**5 hours**

Evaluating the effects of chemistry - definition, tools and principles of green chemistry. Waste minimization, solvent-free and aqueous phase reactions.

Module:2	**Conventional Synthesis**	**6 hours**

Introduction- aldol condensation, oxidation and reduction, photochemical reactions. Alternative solvents, designing a green synthesis, industrial applications. Synthesis of Adipic acid.

Module:3	**Reactions Under sonication**	**5 hours**

Sonochemistry - introduction, types of sonochemical reactions. A few synthetic applications - substitution, addition, elimination, hydrolysis, esterification, oxidation, reduction (one example in each case).

Module:4	**Microwave mediated Reactions**	**3 hours**

Introduction to microwave mediated reactions - Applications to reactions (i) in water: Hofmann Elimination, hydrolysis (of benzyl chloride, methyl benzoate to benzoic acid), Oxidation (of toluene, alcohols); (ii) reactions in organic solvents: Diels-Alder reaction and Decarboxylation reaction.

Module:5	**Green Chemical Approach in Conventional Synthesis with PTC**	**7 hours**

Definition, mechanisms, reaction, preparation, advantages and types of PTC. Synthesis of nitriles, alkyl halides, elimination reactions, alkylation, oxidation using hydrogen peroxide, dihalocarbenes, crown ethers.

Module:6	**Green Approach in Solid Phase**	**11 hours**

Introduction to solid phase organic synthesis without using solvent- halogenation, Micheal addition, aldol condensation, Grignard reagent - Enzyme catalyzed reactions in organic synthesis

Module:7	**Green Approach in Extraction Process**	**6 hours**

Extraction and separation of phyto-constituents - hydro extraction, wet steam and dry extraction, head space extraction, super critical fluid extraction, microwave and ultra-sonication assisted extraction.

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1	Albert S. Matlack, "Introduction to Green Chemistry" CRC press, 2010.
2.	V. K. Ahluwalia and M. Kidwai, New Trends in Green Chemistry, Anamaya Publishers, New Delhi, 2007.

Reference Books

1.	Introduction to Renewable Energy, Solar Energy International, 2012

2.	Alternative Energy Sources, Michaelides, Efstathios E. (Stathis), Springer,Germany, 2012
3.	Chemat, Farid, Vian, Maryline Abert (Eds.) Alternative Solvents for Natural Products Extraction, 2014.
4.	Paul T. Anastas and John C. Warner, "Green Chemistry: Theory and practice", Oxford University Press, NewYork,1998.
5.	Rashmi Sanghi, M.M.Srivatsava, "Green Chemistry", Narosa Publishing house Chennai, 2003.
6.	Kennet Doxsee and James Hutchison, "Green Organic Chemistry: Strategies, Tools and Laboratory experiments", Thomson, 2004.
7.	Rashmi Sanghi and M. M. Srivatsav, "Green Chemistry: Environmentally Friendly Alternatives", Alpha Science International, New Delhi, 2003.
8..	Supercritical Fluid Extraction of Nutraceuticals and Bioactive Compounds Hardcover – November 28, 2007, Jose L. Martinez (Editor)

Mode of Evaluation: CAT / written assignment / Quiz / FAT			
Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY210L	Stereochemistry and Spectroscopy	L	T	P	C
		3	1	0	4
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students

1. understanding the basic concepts about the stereochemical, mechanistic and conformational aspects and students can learn to analyze the energy of the molecules with respect to the conformation and reactivity
2. imparting knowledge in the theory and applications of various spectroscopic techniques to understand the molecules structure and its reactivity

Course Outcome

At the end of the course the students will be able to

1. recall the basic terminology, concepts of isomerism and stereochemistry
2. explain the stereochemical, mechanistic and conformational aspects of chiral molecules
3. analyze the energy of the molecules with respect to the conformation and reactivity
4. distinguish molecules viz its structure, stereochemistry and its reactivity through various spectroscopic techniques

Module:1	**Stereochemistry in chiral axial molecules and atropisomerism**	**6 hours**

Concept of axial chirality – R and S nomenclature in chiral axis molecules, concept of prochirality, topicity, prostereoisomerism, equivalent, enantiotopic, diastereotopic ligands – Atropisomerism: Atropisomerism in sp^2 and sp^3 carbons with specific example. Resolution methods- Optical purity.

Module:2	**Conformations of acyclic molecules**	**8 hours**

Conformational analysis of acylic systems - conformation of simple 1,2-disubstituted ethane derivatives, S-cis and s-trans conformations in butadiene. Conformation and reactivity in acyclic systems - steric and stereo-electronic effects, stereo-electronic requirements for substitution, elimination, intramolecular rearrangements, neighbouring group participation reactions.

Module:3	**Conformations of cyclic molecules**	**8 hours**

Conformation of cyclohexane, mono, di and tri-substituted cyclohexane, cyclohexene, cyclohexanone, cis and trans decalins, rotaxanes. Effect of conformation on reactivity in cyclic molecules – substitution, elimination, oxidation-reduction of cyclohexanone, esterification and hydrolysis of cyclohexane carboxylic acids.

Module:4	**UV-Visible spectroscopy**	**9 hours**

UV-Visible Spectrophotometry – principle, Beer-Lambert's law, chromophores and auxo-chromes, effect of solvent on electronic transitions, hyper & hypo chromic shifts and red, blue shifts - Absorption spectra (λ_{max} calculations) of conjugated dienes, polyenes, α, β-unsaturated carbonyl compounds- Woodward –Hoffmann – Fieser Rules, Factors influencing the absorption. Applications of UV spectroscopy in distinguishing axial and equatorial conformers, inter and intra molecular hydrogen bonding and keto-enol tautomerism, in qualitative and quantitative methods.

Module:5	**IR spectroscopy**	**8 hours**

Infra-Red Spectroscopy – instrumentation, sampling techniques, selection rules, types of bonds, molecular vibrations, vibrational frequency, factors influencing group frequencies. Applications of IR spectroscopy to identify alkane, alkene, alkyne, aromatic and other organic compounds, identification of alcohols, ethers, phenols, amines and carbonyl compounds such as ketones, aldehydes, esters, amides, acids, conjugated carbonyls compounds. Effect of hydrogen bonding and effect of solvent on vibrational frequencies - quantitative studies.

Applications of IR spectroscopy in distinguishing axial and equatorial conformers, inter and

intra molecular hydrogen bonding and keto-enol tautomerism.		
Module:6	**NMR spectroscopy**	**12 hours**
Introduction, instrumentation, nuclear spin states and NMR active nuclei, resonance absorption, population of nuclear spin states, proton and carbon NMR- interaction of spin magnetic moment of a proton with external magnetic moment, chemical shift and shielding (both proton and carbon), nuclear spins in a magnetic field - Zeeman effect –Larmor's precession, spin-lattice and spin-spin relaxation processes - chemical equivalence, chemical environment, spin-spin splitting, coupling constant, geminal, vicinal, long-range, trans, aromatic, allylic coupling, splitting of NMR signals. Applications of NMR towards small molecules.		
Module:7	**Mass spectrometry**	**7 hours**
Introduction, principle, types of ions, base peak, parent ion/daughter ions (meta stable and isotopic peaks, fragmentation observed in various classes of compound, McLafferty rearrangement. Applications of mass spectra to elucidate molecules		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**
	Tutorial hours:	**15 hours**

Text Book(s)	
1.	Nasipuri, D., Stereochemistry of Organic Compounds: Principles and Applications, 4th edition, New Academic Science Publisher. 2012.
2.	Spectroscopy of Organic Compounds by P. S. Kalsi, New Age international Publishers,17th edition, 2016
Reference Books	
1.	Steric and Stereoelectronic Effects in Organic Chemistry, V. K. Yadav, Springer, 2016. G. Morris, Stereochemistry, RSC Tutorial Chemistry Text 1, 2001.
2.	Organic Spectroscopy Principles, Problems and Their Solutions, Jaggdamba Singh and Jaya Singh, A Pragadhi Edition, 2016.
3.	Ernest L Eliel, Samuel H. Wilen, Stereochemistry of organic compounds, Wiley India edition, 2008.
4.	R. M. Silverstein, G. C. Bassler, T. C. Morril, Spectrometric identification of Organic Compounds, John Wiley & Sons, Inc, 2007. W. Kemp, Organic Spectroscopy, ELBS, 2nd Edn., 1991.

Mode of Evaluation: CAT, Quiz , FAT			
Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY307L	States of Matter and Colloids	L	T	P	C
		3	1	0	4
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students

1. provide a broad overview of different states, and properties of soft matter
2. introduce the chemistry of soft materials including liquid crystals and colloids
3. point out the connections between different states of matter , in particular liquid crystals And colloids

Course Outcomes

At the end of the course, the students will be able to

1. explain the general concepts of gas phase reaction kinetics
2. evaluate temperature and pressure dependence of gas phase reactions
3. analyse relation between critical constants and van der Waal's constants
4. determine surface tension and viscosity of liquids
5. estimate critical solution temperature understand uses f liquid crystals
6. differentiate colloids, solutions and suspensions and know the purification techniques of colloids
7. compare the properties of gels and emulsions for separation of species

Module 1: Gaseous state	**5 hours**

Kinetic molecular model of a gas: postulates and derivation of the kinetic equation of gaseous state; Derivation of laws of gaseous state from equation of kinetic theory of gases; Different types of velocities-derivation of expressions for their calculation.

Module 2: Collision parameters of Gaseous state	**5 hours**

Collision frequency-collision diameter, mean free path and viscosity of gases including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy; Law of equipartition of energy, Degrees of freedom and molecular basis of heat capacities.

Module 3: Critical Phenomenon of Gaseous state	**6 hours**

Critical temperature, critical pressure, critical volume; PV isotherms of carbon dioxide; Derivation of van der Waal's equation of state, relationship between critical constants and van der Waal's constants; Reduced temperature, pressure and volume; Law of corresponding states.

Module 4: Liquid State	**6 hours**

Qualitative treatment of the structure of the liquid state, Vacancy theory of liquids and free volume in a liquid; Physical properties of liquids-vapour pressure, surface tension and coefficient of viscosity, and their determination; Effect of addition of various solutes on surface tension and viscosity, temperature dependence of viscosity of liquids and comparison with that of gases; Qualitative discussion of structure of water, cohesive forces; Mixture of liquids-Henry's law.

Module 5: Liquid crystal and Liquid mixtures	**7 hours**

Liquid crystals-general structural and electronic features of compounds existing in liquid crystalline forms; Classification of liquid crystals with suitable examples, theory of liquid crystals, applications of liquid crystals.

Liquid Mixture: Review of Raoult's law, ideal and non-ideal solutions; Completely miscible liquids-critical solution temperature (CST), effect of addition of salt on CST of phenol-water system; Immiscible liquids-steam distillation and its applications.

Module 6: Colloidal state	**10 hours**

Colloids-definition, differences between colloids, solutions and suspensions; Classification of colloids with suitable examples for each class; Sols-classification of sols and differences between lyophilic and lyophobic sols, hydrophilic and hydrophobic sols with suitable examples. Purification of colloids-dialysis; Stability of colloids and double layer theory; Zeta potential and stability of colloids; Coagulation; Hardy – Schulz law. Hofmeister's series; Protective colloids – gold number. **Properties of colloids:** Optical properties, kinetic properties, electrical properties such as electrophoresis and electro osmosis. Applications of colloids in medicine, pollution control-Cottrell precipitator-waste water treatment; Delta formation – smoke screen; Explanation of cleaning action of detergents; Separation of proteins.	
Module 7 : Emulsions	**4 hours**
Definition – classification, stability of emulsion, emulsifier and its action – Bancraft's rule. Gels-classification of gels, Imbibition, syneresis, thixotropy.	
Module 8: Contemporary Issues	**2 hours**
Total Lecture hours: **Tutorial hours:**	**45 hours** **15 hours**

Text Book(s)	
1.	Atkins Physical Chemistry,11th Edition by Peter Atkins, Julio De Paula, James Keeler; Oxford University press, 2018
2.	Principles Of Physical Chemistry, by B.R. Puri, L.R. Sharma, M.S. Pathania. 47th edition (2016), Vishal Publishing Co, India.
Reference Books	
1.	W. Castellan, Physical Chemistry, 7th Edition, Narosa Publishers, 2004.
2.	W. Kauzmann, Kinetic Theory of Gases (Thermal Properties of Matter, Vol I), Benjamin, Reading, MA, 1966.
3.	Walter Moore, Physical Chemistry, 5th Edition, Orient Longman, 2004.
4.	G.M. Barrow, Physical Chemistry 6th Edition, Tata McGraw Hill, 2020.

Mode of Evaluation: CAT, Quiz, Assignments, FAT			
Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY308L	Coordination and Organometallic Chemistry	L	T	P	C
		3	1	0	4
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students to

1. deliberate the structure and stability of coordination compounds
2. state various theories of coordination compounds
3. discuss reaction mechanism and energies of coordination compounds
4. investigate the applications of organometallic compounds

Course Outcomes:

At the end of the course the students will be able to

1. define the interaction and bonding between the metal salt and ligand systems
2. illustrate the geometry, structure and stability of the coordination compounds
3. devise a feasible mechanism involving various transition states and intermediates for transition metal complexes
4. classify the synthesized organometallic compounds based on stability
5. design new coordination and organometallic compounds for catalysis

Module 1	**Basic Concepts of Coordination Chemistry**	**5 hours**

Introduction – Coordinate bonding – double salts and complex salts. Classification of ligands – monodentate, bidentate and polydentate ligands. Coordination sphere, coordination number, chelate effect. HSAB principle, IUPAC nomenclature of coordination complexes (monometallic and bimetallic).

Module 2	**Isomerism and Bonding in Coordination Compounds**	**6 hours**

Isomerism – Constitutional and Stereoisomerism, linkage, ionization, hydrate, coordination, position isomerism, geometrical isomerism, cis and trans / fac and mer, optical isomerism. Werner's theory, Sidgwick theory – EAN and stability, Valence bond theory – hybridization, geometry, inner and outer orbital complexes, drawbacks of VBT.

Module 3	**Bonding Theories of coordination compounds**	**7 hours**

Crystal field theory - Crystal field effects, crystal field stabilization energy (CFSE), Ligand field strength and CFSE, pairing energies, high spin and low spin complexes, factors affecting CFSE. Evidence of crystal field splitting, spectrochemical series. Octahedral and tetrahedral coordination, tetragonal distortions from octahedral geometry, Jahn-Teller Theorem, square planar geometry, qualitative aspect of ligand field and MO Theory.

Module 4	**Reaction Mechanism in Complexes**	**7 hours**

Introduction to inorganic reaction mechanisms. Thermodynamic and kinetic stability. Kinetics of octahedral substitution. Ligand field effects and reaction rates. Mechanism of substitution in octahedral complexes. Associative, dissociative, interchange and conjugate base mechanisms. Outer sphere and inner sphere electron transfer reactions. Substitution reactions in square planar complexes, trans effect, theories of trans effect and mechanism of nucleophilic substitution in square planar complexes.

Module 5	**Introduction to Organometallic Chemistry**	**6 hours**

Coordination geometries, Hapticity, Hapticity vs Denticity. Electron counting – 16/18 electron rule, oxidation state and neutral atom method, Violation of 18 Electron rule. Metal carbonyls - classification, nomenclature, synthesis, reaction, characterization with FT-IR spectroscopy and bonding. Isoelectronic and isolobal replacement.

Module 6	**Main group and Transition Metal-based Organometallic compounds**	**7 hours**

Ligand types, Organometallic compounds of alkali metals – Lithium, Li-alkyls. Organometallic compounds of alkaline earth metals – Magnesium reagents - Zinc – Mercury – Boron group – Aluminium – Tin and Lead. Alkenes, dienes and alkynes – Allyl and -enyl complexes – Organocuprates, Zeise's salt and organozinc compounds - Metallacycles.		
Module 7	**Metallocenes and Alkylidene Complexes**	**5 hours**
Metallocene – bent metallocenes. Fluxionality and ring slippages of cp complexes – Half-sandwich complexes – Arene complexes – triple-decker – larger arenes ligands 7-, 8- and 9-membered rings. Alkylidene complexes – Fischer and Schrock carbenes – Vinylidene complexes – Ruthenium carbene complexes – olefin metathesis – M≡C triple bonds – Carbynes.		
Module 8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**
	Tutorial hours:	**15 hours**

Textbook(s)	
1.	J. D. Lee, Concise Inorganic Chemistry, Oxford University Press, 5th Edition, 2014.
2.	T. J. Colacot, Carin C. C. Johansson Seechurn, R. H. Grubbs, Organometallic Chemistry in Industry: A Practical Approach, Wiley-VCH; 1st edition, 2020.

Reference Books	
1.	J. E. Huheey, E. A. Kelter and R. L. Kelter, Principles of structure and reactivity, Inorganic Chemistry, Harper Collins College Publishers, 4th Edition, 2011.
2.	G. L. Miessler, P. J. Fischer, and D. A. Tarr, Inorganic Chemistry, Pearson, 5th Edition, 2014
3.	D. Steinborn and A. Harmsen, Fundamentals of Organometallic Catalysis, Wiley-VCH; 1st edition, 2011.
4.	F. A. Cotton and G. Wilkinson, Advanced inorganic Chemistry, John Wiley & Sons, 6th Edition, 2007.
5.	D. F. Shriver and P.W. Atkins, Inorganic Chemistry, Oxford University Press, 5th Edition, 2010.
6.	Anil Elias and B. D. Gupta, Basic Organometallic Chemistry, Universities Press, 2nd edition, 2013.

Mode of Evaluation: Written assignment, Quiz, CAT and FAT			
Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY309L	Industrial Organic Chemistry	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students to
1. classify usage of chemicals in industries
2. highlight the importance of organic chemicals in specific industries for their applications
3. propose different methods for preparation of Industrial chemicals

Course Outcomes

At the end of the course the students will be able to
1. classify the basic classification of industrially used organic chemicals
2. describe the manufacturing methods of industrial organic chemicals
3. categorise carbon based compounds for different applications
4. correlate industrial production of organic chemicals and their applications
5. identify specific organic chemicals in fuels, pesticides and fermentation industries

Module:1	**Chemical Technology**	**7 hours**

Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption. An introduction to the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills.

Module:2	**Chemistry of fuels**	**8 hours**

Classification - renewable and non-renewable fuels and their calorific value. Composition of crude petroleum, refining, different types of petroleum products and their applications. Fractional Distillation (Principle and process), cracking (Thermal and catalytic cracking), reforming petroleum and non-petroleum fuels (LPG, CNG, biofuel, biodiesel, fuels derived from biomass)

Module:3	**Lubricants**	**6 hours**

Classification of lubricants, lubricating oils (conducting and non-conducting), solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pour point, flash point, fire point) and their determination.

Module:4	**Oils and fats**	**6 hours**

Classification of oils, fat splitting, distillation of completely miscible and immiscible oils, hydrogenation of oils, rancidity, saponification value, iodine number, acid value. Soap and synthetic detergent, preparation of soap and detergent, different types of soap and their composition, surfactants (LAS, ABS, LABS), detergent binders and builders.

Module:5	**Fertilizers and Pesticides**	**8 hours**

Fertilizers - Different types of fertilizers. Manufacture of the following fertilizers: Urea and urea formaldehyde (slow release).
General introduction to pesticides (natural and synthetic), benefits and adverse effects, synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT); Organophosphates (Malathion); Quinones (Chloranil)

Module:6	**Industrial scale organic synthesis and Fermentation Industries**	**6 hours**

Comparison of laboratory scale and industrial scale organic intermediate with a specific example – adipic acid.
Aerobic and anaerobic fermentation - production of (i) ethyl alcohol (ii) antibiotics; penicillin, (iii) Lysine & Glutamic acid

Module:7	**Chemical waste management in industries**	**2 hours**

Recovery, recycling, and reuse of industrial waste, chemical waste, solid and liquid waste, labelling chemical waste.

Module:8	**Contemporary Issues**	**2 hours**

		Total Lecture hours:	**45 hours**
Text Book(s)			
1.	Klaus Weissermel, Hans Jurgen Arpe, Industrial Organic chemistry, 4th Edition, Wiley-VCH Verlag GmbH, (2013)		
2.	B.K.Sharma, Industrial chemistry I & II, Krishna Prakashan Publisher, India (2014)		
Reference Book(s)			
1	Mark A Benvenuto, Industrial Organic chemistry, 2017, Publisher : De Gruyter – Berlin/ Boston		
2	E. Stocchi: Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK, 2004		
3	P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi, 2006		
4	J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi, 2010		
5	P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi, 2005		
Mode of Evaluation: CAT 1 & CAT 2/written assignment / Quiz / FAT			
Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY310L	Energy Storage Devices	L	T	P	C
		3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

The course is aimed at students to
1. familiarise with different energy storage devices
2. identify the basic chemical and electrochemical issues of energy storage devices
3. utilize the fuel cell technology for different applications

Course Outcome:

At the end of course the student will be able to
1. select a proper energy storage device for a particular application
2. choose different battery technologies for appropriate use
3. synergize combination of super capacitors and batteries
4. identify areas where hydrogen can be used future energy source
5. design appropriate fuel cell pack for a specific application

Module 1: Renewable and non-renewable energy devices	**7 hours**
Energy and necessity of its storage, renewable and non-renewable energy sources; chemical and electrochemical energy storage systems and their applications; efficiency of energy storage Devices – Helmholtz and Gibb's functions; applications of energy storage devices – mobile storage applications – electric vehicles and medical devices.	
Module 2: Primary Batteries	**6 hours**
Galvanic cells, basic concepts of batteries and types - storage energy density, different primary batteries: zinc-manganese dioxide battery, Leclanché cell, metal-air batteries, primary lithium batteries – advantages and applications.	
Module 3: Secondary Batteries	**5 hours**
Lead-acid batteries – electrochemistry and recent developments, nickel-cadmium, nickel-metal hydride – performance, charge discharge characteristics and applications.	
Module:4 Lithium secondary batteries	**5 hours**
Lithium ion and lithium polymer batteries – differences; anode, cathode, electrolyte materials; state of charge, charge-discharge cycles, safety issues and technology challenges.	
Module 5 **Supercapacitors**	**7 hours**
Supercapacitors – comparison with ordinary capacitors - types of electrodes and electrolytes; electrode materials – high surface area activated carbons - metal oxide- and conducting polymers;, electrolytes - aqueous or organic, advantages and disadvantages of supercapacitors, applications of supercapacitors	
Module:6 **Fuel Cells**	**7 hours**
Fuel cells - direct energy conversion - maximum intrinsic efficiency of an electrochemical converter- physical interpretation, Carnot efficiency factor in electrochemical energy convertors; types of fuel cells - hydrogen oxygen cells, hydrogen air cell, alkaline fuel cell and phosphoric fuel cell, applications of fuel cells for domestic and large-scale power generation; modern trends – portable fuel cells for mobile applications.	
Module:7 **Solid Oxide Fuel cells**	**6 hours**
Structure of solid oxide fuel cells, differences between low and high temperature fuel cells – advantages and disadvantages; cathode, anode, electrolyte materials for solid oxide fuel cells; applications of solid oxide fuel cells.	
Module:8 **Contemporary issues:**	**2 hours**
Total Lecture hours:	**45 hours**

Text Book(s)

1.	Yves Brunet, “Energy Storage", Wiley-ISTE, 1st Edition, 2010.		
2.	Robert A. Huggins, “Energy Storage”, Springer, 2nd Edition, 2015.		
Reference Books			
1.	Fundamentals of Energy Storage by J. Jensen and B. Sorenson, Wiley-Interscience, New York		
2.	R M. Dell, D.A.J. Rand, "Understanding Batteries" RSC Publications, 1st edition, 2012.		
3.	A. J. Bard, L. R. Faulkner, Electrochemical Methods: Fundamentals, Applications, John Wiley: New York, 2000.		
4.	Fuel Cells: From Fundamentals to Applications by S Srinivasan, Springer.		
5.	Fuel cell Systems Explained, by James Larminie and Andrew Dicks, John Wiley & Sons, Inc.		
Recommended by Board of Studies		14-02-2022	
Approved by Academic Council		No. 65	Date 17-03-2022

TCHY311L	Separation techniques	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students to
1. understand the importance of separation process
2. know the different types of separation techniques
3. familiarise the application of separation techniques in the industry

Course Outcomes:

At the end of the course the students will be able to
1. recall the principles of separation of compounds
2. differentiate types of chemical separation techniques
3. apply the principles and the types of chromatographic separation techniques
4. compare the principles and applications of adsorption, partition chromatography techniques
5. identify the methods of separation of biomolecules
6. correlate principles of electrochemistry in separation techniques

Module:1	**Introduction**	**6 hours**

Principle and theory of separation- classification based on size, mass, complexation reaction, change of state and partition. purity-criteria; simple separation techniques ; crystallisation, precipitation, sublimation, solvent extraction; introduction, techniques, factors affecting solvent extraction; batch extraction, continuous extraction and counter current extraction; synergism. distillation-types, centrifugation.

Module:2	**Chemical methods**	**5 hours**

Separation of organic, inorganic compounds- complexation, masking and demasking; liquid-liquid extraction, solid phase extraction, solid phase micro extraction.

Module:3	**Chromatographic techniques**	**6 hours**

Classification of chromatography methods, principles of differential migration adsorption phenomenon; chromatographic separation-principles, types; general theory of column chromatography-chromatographic resolution, capacity factor, column selectivity, efficiency, peak capacity, optimisation of chromatographic separations.

Module:4	**Adsorption, Partition chromatography**	**7 hours**

Paper, Thin layer chromatography-principle, adsorbents and solvents. R_f values, factors effecting R_f values; development of the chromatogram; detection of the spots, applications; gas-liquid and liquid-liquid phase chromatography; adsorption chromatography, liquid–liquid chromatography. HPLC-basic principles and applications; hyphenated techniques-LC-MS and GC-MS

Module:5	**Super critical fluids chromatography**	**6 hours**

Super critical fluids-properties, examples; super critical fluid chromatography, extraction, super critical fluids in separation techniques; capillary super critical fluid chromatography.

Module:6	**Separation of Biomolecules**	**6 hours**

Affinity chromatography; dye ligand chromatography, covalent chromatography, hydrphobic interaction chromatography, ion exchange chromatography-introduction, action of ion exchange resins, separation of proteins, chiral chromatography; gel permeation chromatography

Module:7	**Miscellaneous methods of separation and purification**	**7 hours**

Separation of radionuclides, isotope dilution analysis;membrane based methods-ultra filtration, electrodialysis, electrophoresis, capillary electrophoresis,electrodeposition

Module:8	**Contemporary Issues**	**2 hours**

	Total Lecture hours:			**45 hours**
Text Book(s)				
1.	James M. Miller,Chromatography Concepts and Contrasts, 2005, Wiley			
Reference Books				
1.	Douglas A. Skoog. Fundamentals of Analytical Chemistry ,2004, Thomson-Brooks/Cole			
2.	Gary D. Christian, Purnendu K. Dasgupta, Kevin A. Schug · 2013,Analytical Chemistry,7th Edition,Wiely			
3.	R. P. Budhiraja Separation Chemistry, 2010, New Age International(P) limited			
4.	Mark F. Vitha, Chromatography: Principles and Instrumentation,2016, Wiley			
Mode of Evaluation: CAT / written assignment / Quiz / FAT				
Recommended by Board of Studies		14-02-2022		
Approved by Academic Council		No. 65	Date	17-03-2022

TCHY312L	Food Chemistry	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students to
1. acquire knowledge in the composition and quality of food and related items
2. explore modern trends in the food chemistry
3. identify different methods of food analysis

Course Outcomes:

At the end of the course the students will be able to
1. label the composition of various food items
2. reiterate the importance of carbohydrates, proteins and lipids in food
3. identify the food additives and food colorants
4. demonstrate modern technology in packed food and beverages
5. calculate a balanced diet based on nutritional value
6. analyse the quality of additives in food items

Module:1	**Sources and Composition**	**5 hours**

Composition of foods – general and specific for different foods of plant and animal origin. chemical constituents of foods; desirable and potentially undesirable food constituents and their importance; recommended dietary allowances (RDA).

Module:2	**Carbohydrates, lipids and proteins**	**7 hours**

Carbohydrates- classes, nomenclature and structure; dietary utilization and disturbances; Lipids-definition, classification and structure; fatty acids composition of natural lipids of plants and animal origin, essential fatty acids; role and use of natural lipids and tailor made fats in foods; proteins-physico-chemical properties of amino acids, peptides and proteins, structure-function relationship of proteins, essential amino acids. nutritional attributes of food and their implications.

Module:3	**Food Additives and preservatives**	**6 hours**

Food additives- artificial sweeteners – saccharin, cyclomate, asparatame – food flavours – esters, aldehydes and heterocyclic compounds; antioxidants; food colours – changes in cooking, restricted use; spurious colours;emulsifying and stabilizing agents, anti-caking agents, thickeners, firming agents; class I and class II preservatives as per PFA act; baking powder–yeast; taste enhancers – MSG-vinegar.

Module:4	**Nutraceuticals and antinutrients in Food**	**7 hours**

Health promoting phytochemicals–carotenoids, flavonoids, proanthocyanidins, other polyphenolic compounds; sulphur containing bioactives, isothiocyanates and indoles; process induced nutraceuticals in foods; natural plant toxicants and process induced toxicants in foods.

Module:5	**Vitamins and minerals**	**6 hours**

Vitamins-sources, toxicity and effect of processing and storage, general causes of variations and losses of vitamins in foods, minerals, nutritional aspects of minerals-mineral composition of foods; chemical and functional properties of minerals in foods.

Module:6	**Quality Assessment and Quality control**	**6 hours**

Quality-basic concepts; nutritional and sensory attributes and their assessments, causes of undesirable changes leading to quality deterioration in foods and their implications; determination of probable cause(s) of observed quality change in foods, specifications and standards: PFA, FPO, FDA, drug license, WHO standards, ISI specifications; packing and label requirements, essential commodities act, consumer protection act. AGMARK.

Module:7	**Food Adulteration, Contamination and Hygiene**	**6 hours**

Adulterants-common adulterants in different foods – milk and milk products, vegetable oils, and fats, spices and condiments, cereals, pulses, sweetening agents and beverages;

contamination with toxic chemicals – pesticides and insecticides; principles involved in the analysis of detection and prevention of food adulteration; safety-operational sense of food safety; potential food derived health hazard-microbial contamination, nutritional imbalance; pesticide residues, environmental contamination; naturally occurring compounds and permitted food additives;. testing food for its safety		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Alex V. Ramani, Food Chemistry, MJP Publisher, Hong Kong, 2019
2.	Kirk L. Parkin, Srinivasan Damodaran, Fennema's Food Chemistry, CRC Press, UK, 2017.
Reference Books	
1.	L.H Meyer, Food Chemistry, CBS Publishers, 2004
2.	Swaminathan M, Text Book on Food chemistry, Printing and Publishing CO., Ltd.,Bangalore. 1993
3.	DeMan, John M, Principles of food chemistry, 4th Edition, Springer, Switzerland 2018
4.	Kontogiorgos Vassilis , Introduction to Food Chemistry, , 1st Edition, Springer Nature, Switzerland 2022
5.	Norman N. Potter and Joseph H. Hotchkiss, Food Science, 5th Edition, CBS Publishers and Distributors, India, 2007

Mode of Evaluation: CAT, Quiz, Assignments, seminar, Group Discussion and FAT			
Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY315L	Materials of Industrial Importance	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students to
1. enable students to have fundamental understanding of different materials
2. correlate and integrate understanding ability with industrial usage of materials
3. provide overall information on the processes, practices and significance of materials in industries

Course Outcomes:

At the end of the course the students will be able to
1. list different materials used in industries
2. identify the importance of materials in real life applications
3. compare physical and chemical processes employed for transformation of raw materials into useful products
4. select relevant operational techniques useful for industries
5. extrapolate knowledge of materials chemistry to develop industrial products

Module:1	**Materials Evolution**	**6 hours**

Materials – milestones of progress, ores and minerals, extraction of aluminium, iron, lead and copper. Alloys of iron and titanium in different fields. Carbon fibre and its industrial use. Ceramics - classification, industrial importance.

Module:2	**Silicates**	**6 hours**

Glass - classification (silicate and non-silicate glasses), manufacture and processing of glass, composition and properties of soda lime glass, lead glass, borosilicate glass, fluorosilicate, photosensitive glass.

Module:3	**Catalysts**	**8 hours**

General principles and properties of catalysts, homogenous and heterogeneous catalysts and industrial applications, phase transfer catalysts. Application of zeolites in petrochemical industry - cracking, reforming, dewaxing, isomerisation. Metal catalysts and uses - three way catalytic converter in automobiles.

Module:4	**Paints**	**6 hours**

Requirements of a good paint, primary constituents of paints and their functions. Formulation of primers - zinc rich epoxy, micaceous iron oxide, zinc chromate. Special paints - luminescent, heat retardant, fire retardant, eco-friendly paint, water-repellent, aluminium paints - advantages and disadvantages.

Module:5	**Explosives & Propellants**	**5 hours**

Definition, classification and properties of explosive chemicals – lead azide, nitrobenzene, TNT, PETN, picric acid, cyclonite (RDX), nitro glycerine, nitro cellulose, manitol, guanidine nitrate. Rocket propellants – types and properties. Safe handling and disposal of explosive materials. N-iodo heterocycles

Module:6	**Industrial Polymers**	**6 hours**

Polymerisation, classification of polymers and plastics. Examples and industrial applications of PVC, polyethylene, Bakelite, nylon-66, natural rubber. Polymers in fiber industry - structure, properties and application of fibers. Electronic polymers - physical and chemical properties of electronic polymers and their applications.

Module:7	**Resins, Adhesives and Lubricants**	**6 hours**

Resins - cationic and anionic resins, water treatment, Adhesives – theories of adhesion, classification, examples, resins, cellulose, acrylic, polyvinyl, elastomers, inorganic

adhesives, vegetable glue and animal glues. Lubricants - mechanism of lubrication, classification of lubricants, additives used in the lubricants, properties of lubricants, examples of lubricants, liquid, semisolid and solid lubricants.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	B. R. Puri, L. R. Sharma and K. C. Kalia, "Principles of Inorganic Chemistry", Vallabh Publications, (2016).
2.	Kenneth C Ludema, Layo Ajayi, "Friction, Wear, Lubrication" A Textbook in Tribology, Second Edition, ISBN 9781482210170, by CRC Press, (2019).

Reference Books

1.	V. R. Gowariker and N.V. Viswanathan, Polymer Science, New age International Publishers, (2015), New Delhi
2.	Katyal Mohan, P. L. Soni, "Textbook of Inorganic Chemistry", Sultan Chand & Sons, (2017).
3.	R. D. Madan, Sathyaprakash's Modern Inorganic Chemistry, S. Chand and Co. Ltd, (2014).
4.	K. Kumar and J. Paulo Davim, Composites and Advanced Materials for Industrial Applications, (2018), Portugal.
5.	Prakash G. More, Comprehensive Industrial Chemistry. Published by Pragati Prakashan, (2018), Meerut.

Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & FAT			
Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

Course Code	Course Title	L	T	P	C
TCHY408L	Computational Chemistry	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. Grasp the essential theoretical background of computational chemistry.
2. Explore a variety of computational methods and tools for scientific computing.
3. Hands-on practices on scientific computations for executing chemical research problems.

Course Outcome

1. Realize the requirements of computational chemistry in a chemical science discipline.
2. Create a platform for solving real-world problems through computational chemistry.
3. Solve multi-electron systems using the practical implementation of quantum chemical methods.
4. Explore the advances in modern electronic structure computation methods.
5. Relate computational chemistry to descriptive chemistry.
6. Apply appropriate computational methods in their scientific research problems.

Module:1	Introduction to Electronic Structure Methods and Strategies	5 hours

The promise of computational chemistry, Computational Strategies-Coordinate systems, Geometry optimization, Self-consistent Field (SCF), Variational Principle, Concept of the Potential Energy Surfaces, Conformational Analysis, Born-Oppenheimer approximation, Koopmans theorem, normal mode vibrations, Intrinsic Reaction Coordinate (IRC) analysis,

Module:2	Molecular Mechanics and Semi-empirical methods	4 hours

Principles of Molecular Mechanics, Potential Energy Functional Forms, Force Field Parameterization, Modern Force Fields, Force Fields, and Docking. Semi-empirical Philosophy, Semi-empirical methods, and Parameterization, Latest Developments in Semi-empirical molecular orbital theory, Performance of Semi-Empirical Methods.

Module:3	*Ab-initio* Methods and Basis Sets	8 hours

Ab-initio Philosophy, Hartree method, Hartree-Fock theory, electron spin and Pauli principle, antisymmetric wave functions and Slater determinants, Roothaan-Hall equations, Size Consistency and Size Extensivity, electron correlation problem, Perturbation theory. Basis set approximation, Slater and Gaussian type of orbitals, Types of Basis Sets: split-valence basis sets, polarization, and diffuse functions, correlation-consistent basis sets, limitations of basis sets.

Module:4	DFT methods and Solvation models	8 hours

Theoretical Motivation: Density Functional Theory (DFT), Hohenberg and Kohn Theorem, Kohn–Sham Theory, Kohn–Sham Self-consistent Field Methodology, Exchange-correlation Functionals, Excited Electronic States and Time-dependent DFT, General Performance of DFT. Structural and dielectric properties of the solvent medium, SCF reaction field (SCRF), implicit and explicit solvation methods, implicit solvent, and hybrid models.

Module:5	Hybrid Methods and Relativistic Theory	5 hours

Combined methods, like the combination of quantum chemical methods and molecular mechanics (QM/MM) or ONIOM for the description of biochemical

problems, for example, the interaction of a drug and a receptor. Relativistic quantum chemistry, Relativistic Effects, Relativistic Effective Core Potential (RECP) for heavy elements.		
Module:6	**Molecular dynamics (MD)**	**5 hours**
Introduction of molecular dynamics, Integration of classical equations of motion, Sampling, accuracy, and stability, Calculating properties, Improving performance, time steps and time scale considerations, implementation of thermostats and barostats, periodic boundary conditions, biomolecule simulations, practical aspects of simulations, *Ab-initio* molecular dynamics (AIMD).		
Module:7	**Hands-on practices on the Computational Chemistry Concepts**	**8 hours**
Geometry Convergence and Geometrical Parameters, Understanding of electrostatic, van der Waals and hydrophobic interactions, Hydrogen bonding, Ground state, Excited States, Transition State structure modeling, Exploring the energy landscape and its minima, charge density, and electron density; Frontier Molecular orbital Analysis, Natural Bond Orbital Analysis, Binding energy, stability constant, Wavefunction analysis, Quantitative Structure-Activity Relationships (QSAR), Descriptors for chemical reactivity and selectivity: DFT and other quantum chemical descriptors, Molecular Docking.		
Module:8	**Contemporary Issues**	**2 hours**
Industry Expert Lecture		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	F. Jensen, *Introduction to Computational Chemistry*, 3rd Edition, John Wiley & Sons Ltd, UK, 2017.

Reference Books

1.	C. J. Cramer, Essentials of Computational Chemistry, 2nd Edition, John Wiley & Sons, UK, 2004.
2.	Errol G. Lewars, Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics, 2nd Edition, Springer, 2011.

Mode of Evaluation: CAT, Quiz, digital assignment and FAT			
Recommended by Board of Studies	19-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY409L	Group Theory for Chemists	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

The course aims:

1. To familiarize the students with principles of group theory and symmetry that directly relates to chemical problems.
2. Predict the symmetry's effect on various molecular properties including dipole moment, chirality, spectral selection rule, energy levels and molecular orbitals.

Course Outcomes

At the end of the course, students should be able to

1. Describe the concepts of symmetry and symmetry operations in molecules.
2. Compare the properties of symmetry point groups.
3. Examine the mathematical representation of point groups.
4. Establish the relationship between quantum mechanics and group theory.
5. Apply quantum chemistry and group theory to spectroscopy.
6. Explain bonding in organic and inorganic systems, using symmetry and group theory.

Module:1	Symmetry elements and symmetry operations	6 hours

Symmetry elements, relation between symmetry elements and symmetry operations, product of symmetry operations- for linear and nonlinear molecules.

Module:2	Properties of group and symmetry point group	7 hours

Concepts and properties of a group, group multiplication tables, Similarity transformation, Definition of Class, Classes of symmetry operations and geometrical significance of class, Definition and determination of symmetry point group of various molecules with illustrative examples, subgroup, determining the chirality and dipole moment from molecular symmetry

Module:3	Matrix Representation and Character Table	7 hours

A brief overview of matrices and vectors, Definition of basis and matrix formulation of different symmetry operations, Matrix representation of point groups – examples-reducible representation, Application of reduction formula, properties of irreducible representations, Great orthogonality theorem, Construction of character tables.

Module:4	Quantum mechanics and group theory	7 hours

Wave functions as bases for irreducible representations, vanishing of integrals, Direct Product, and spectroscopic selection rule, symmetry properties of atomic orbitals, Projection operator, Symmetry Adapted Linear Combination (SALC) - application in the construction of MO for simple molecules.

Module:5	Symmetry of molecular vibrations	6 hours

Molecular Vibrations, Normal co-ordinates, Symmetry of normal mode vibrations, Determining the symmetry of Infrared and Raman active vibrations from character tables (with illustrative examples)

Module:6	Symmetry principle applied to organic systems	6 hours

Molecular orbitals, LCAO-MO approach, HMO method, Hybrid orbitals, Hückel approximation, Symmetry factoring of secular equations, Carbocyclic systems with representative examples

Module:7	**Symmetry principle applied to inorganic systems**	**6 hours**
Construction of molecular orbitals in AB_4 and AB_6 inorganic complexes, Free ion configuration, terms and states, splitting of levels and terms in a chemical environment, and correlation diagrams.		
Module:8	Industry Expert Lecture	
	Total Lecture hours:	**45 hours**
Text Book(s)		
1. F.A. Cotton*, Chemical Applications of Group Theory*, 3rd Edition, Wiley India Edition, 2009. 2. P. W. Atkins and Julio de Paula, 2018, International 11th Edition, Oxford University Press, United Kingdom.		
Reference Books		
1. Group Theory and Chemistry by David M. Bishop. Dover Publications Inc. 1993. 2. P. K Bhattacharya, Group theory and its applications, 3rd Edition, Himalaya Publishing House, 2007.		
Mode of Evaluation: Written Examinations, Quiz and Assignments		
Recommended by Board of Studies	19-01-2024	
Approved by Academic Council	No. 73	Date 14-03-2024

Course Code	Course Title	L	T	P	C
TCHY410L	Polymer Chemistry	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. Understandingthe basic concepts about polymers/macromolecules and thepolymerization techniques.
2. Imparting knowledge in theory/instrumental analysis of important industrial polymers.

Course Outcomes

At the end of the course the student will be able to:

1. Recollect and understand the fundamental concepts in terms of nomenclature, classification of polymers and synthesis.
2. Use their understanding about the catalytic polymerization processes with mechanisms for industrial applications.
3. Analyze the properties of various polymers through spectroscopic and analytical data.
4. Evaluate the properties of different types of polymers with respect to their stability and applications.
5. Design new polymeric materials required for the organic transformation reactions as well as industrial applications.

Module: 1	Introduction to Polymers	4 hours

Introduction – monomer – polymer - types, concept of macromolecules, nomenclature and classification, degree of polymerization, functionality, T_g and T_m, copolymer types: random, alternating, graft and block, tacticity of polymers.

Module: 2	Polymerization Methods, Mechanisms and Techniques	9 hours

Polymer - preparation - mechanism of - controlled radical, atom transfer radical polymerization (ATRP), Reversible addition fragmentation chain transfer (RAFT), Group transfer, Nitroxy mediated polymerization (NMP), Cationic, anionic and coordination polymerization (metallocene and non-metallocene). Ring opening polymerization (ROP) and Ring opening metathesis polymerization (ROMP) methods, Copolymerization - structure-property relationships.
Polymerization techniques – bulk, solution, melt, suspension, emulsion and dispersion. Stereoselective polymerization using single-site and multi-site catalysts.

Module: 3	Characterization of Polymers	7 hours

Number and weight average molecular weight, molecular weight distribution (Đ), polydispersity index (PDI) - methods of determining molecular weight of polymers – End group analysis, Viscometry, Size-exclusion chromatography (SEC), Determination of branching – GPC and Intrinsic Viscosity, Effect of molecular weight on the properties of polymers, Thermal analysis of polymers - DSC, TGA, TG-DTA. Morphology – SEM, HRTEM.

Module: 4	Addition Polymerization	4 hours

Synthesis, structure, properties and applications of PE - Poly(ethylene), PP - Poly(propylene), PS - Poly(styrene), PVC - Poly(vinyl chloride), PVA – Poly(vinyl alcohol), PAN - (Poly(acrylonitrile), PMMA - Poly(methyl methacrylate), EVA - Ethylene-vinyl acetate/poly(ethylene-vinyl acetate) and fluorine containing co-polymers.

Module: 5	**Step-Growth Polymerization**	**4 hours**
Synthesis, structure, properties and applications of polyesters, polyamides. epoxides, phenolics, polyurethanes, polycarbonates, PEEK and silicone polymers.		
Module: 6	**Polymer Processing**	**7 hours**
Moulding techniques - injection, compression, extrusion and blow molding, compounding of polymers -principles, use of additives to enhance/protect the polymer properties. Compounding of plastics - type, structure, chemistry, mechanism and suitability of antioxidant, heat stabilizer, UV stabilizer, hindered amine light stabilizer (HALS), antistatic, lubricants, blowing, nucleating and crosslinking agents, flame retardant and compatibilizer. Role and types of fillers - surface treatment and coupling agent.		
Module: 7	**Specialty Polymers**	**8 hours**
Liquid crystalline polymers - main chain and side chain types, Phase morphology, Conducting polymers – mechanism of conduction in PANI, polyacetylene, polypyrroles. Energy harvesting nanogenerators – piezo and triboelectric materials, self-healing polymers and hydrogels.		
Module: 8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. F.W. Billmeyer, Textbook of Polymer Science, 3rd Ed., Wiley, N.Y. 1984.
2. G. Odian, Principles of Polymerization, 4th Ed., Wiley, N.Y. 2004.
3. J.R. Fried, Polymer Science and Technology, 3rd Ed., Prentice Hall, 2014.
4. J. W. Nicholson, The Chemistry of Polymers, Third Edition, RSC publishing, © The Royal Society of Chemistry, 2006, ISBN 0–85404–684–4.

Reference Books

1. N. Hadjichristidis et al., Block copolymers: Synthetic strategies, physical properties and applications, Wiley, N.Y. 2002.
2. M. Chanda, S.K. Roy, Industrial Polymers, specialty polymers and their applications, 1st Ed., CRC Press, 2008.
3. R.J. Young, P.A. Lovell, Introduction to polymers, 3rd Ed., CRC Press, 2011.
4. Z. Tadmor, C.G. Gogos, Principles of Polymer Processing, 2nd Ed., Wiley-Interscience, 2013.

Mode of Evaluation: CAT, written assignment, Quiz and FAT

Recommended by Board of Studies	19-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY411L	Bioinorganic Chemistry	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

The course is aimed at:

1. Introducing the interdisciplinary field of Bioinorganic Chemistry.
2. Understanding the roles of various metal ions, respiratory proteins and metalloenzymes.
3. Familiarizing the bio-assisted concepts of photosynthesis and nitrogen fixation
4. Understand the significance of metal-based compounds as therapeutics

Course Outcomes

At the end of the course, the student should be able to

1. Understand various biochemical processes involved in biological systems.
2. Design model compounds that can mimic biomolecules.
3. Understand the structural aspects of medicinal compounds.
4. Design drug molecules and characterize them.
5. Create interest to pursue research work in related fields.

Module: 1	Introduction to bioinorganic chemistry	5 hours

Metal ions: Essential and trace metal ions – alkali, alkaline earth and transition metal cations.

Ligands: Ligand types – macrocylic ligands and mixed ligands. Template effect, ionophores.

Coordination chemistry related to bioinorganic chemistry – thermodynamic and kinetic aspects.

Biological Molecules: Proteins, nucleic acids and prosthetic groups.

Module: 2	Respiratory proteins	6 hours

Heme iron proteins, porphyrin system, substituent effects. Oxygen carriers - haemoglobin, myoglobin- structural characteristics and Bohr effect. Non-heme oxygen carriers - hemerythrin and hemocyanin, model compounds and models for transport.

Module: 3	Metalloenzymes	9 hours

Electron transfer proteins: blue copper, iron-sulphur proteins – ferridoxins, rubredoxin, and cytochromes.

Redox enzymes**:** Cu, Zn based superoxide dismutase - structure and biological functions Cytochrome P450, Manganese enzyme and xanthine oxidase. Haem enzymes- peroxidase and catalase - Interchangeability of zinc and cobalt enzyme. Blue-oxidases (ascorbate oxidase, ceruloplasmin, laccase) and non-blue oxidases (amine oxidase, galactose oxidase, lysyl oxidase, cytochrome C oxidase).

Module: 4	Metal ion transport and storage	6 hours

Metal ion transport and storage: Ferritin, Transferrin and Siderophores.

Metalloenzymes (Redox and Non-Redox) - activation of small molecules - methane monooxygenase and hydrogenases - activation of H_2 and their synthetic models.

Module: 5	Nitrogen fixation and photosynthesis	6 hours

Introduction – types of nitrogen fixing microorganism, nitrogenase enzyme – metal cluster in nitrogenase - nitrogen fixation pathway- biosynthesis of ammonia -

biological redox reaction – photosynthesis.		
Module: 6	**Physical methods in bioinorganic chemistry**	**6 hours**
Electronic and vibrational spectroscopy of metalloproteins – electron paramagnetic resonance of biologically interesting transition-metal centers - Circular Dichroism (CD) / Magnetic Circular Dichroism (MCD) - Extended X-ray absorption fine structure (EXAFS), X-ray absorption near-edge structure (XANES).		
Module: 7	**Metal Complexes as probes and drugs**	**5 hours**
Metal complexes as probes: metal complexes as probes of nucleic acid, Function of metal ions in genetic regulation, metal DNA and RNA interactions – potential binding sites. Role of hazardous materials - nitric oxide, cyanide and methyl isocyanate.		
Module: 8	**Industry Expert Lecture**	2 **hours**
	Total Lecture hours: 45 hours	

Text Book(s)

1. S. J. Lippard and J.M. Berg, Principles of Bioinorganic Chemistry, University Science Books, U.S., 1994.

Reference Books

1. Advanced Inorganic Chemistry, F.A. Cotton and G. W. Wilkinson. John Wiley & Sons, 6th Ed. 1999.
2. J.E. Huheey, E. A. Kelter and R. L. Kelter, Principles of structure and reactivity, Inorganic Chemistry, Harper Collins College Publishers, 4th Edition, 2011.
3. M.N. Hughes, Inorganic Chemistry of Biological Processes, John Wiley & Sons, 2nd Edition, 1985.
4. Lawrence Que, Jr, Physical Methods in Bioinorganic Chemistry: Spectroscopy and Magnetism, University Science Books (2000).

Mode of Evaluation: Written Examinations, Quiz and Assignments			
Recommended by Board of Studies	19-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY412L	Asymmetric Synthesis	3	0	0	3
Pre-requisite	TCHY203L, TCHY302L	Syllabus version			
		1.0			

Course Objectives

The course is aimed at:

1. Understanding basic concepts about synthesis and reaction mechanisms of various asymmetric organic reactions with respect to the configuration, asymmetry and various stereo-chemical, mechanistic and conformational aspects.
2. Imparting knowledge in the theory and applications of various spectroscopic techniques which are very important characterization techniques for asymmetric synthesis.

Course Outcomes

At the end of the course, students should be able to

1. Recall the fundamental principles concepts of asymmetric synthesis.
2. Interpretation of the results through various analytical techniques.
3. Understand the concepts related to reaction path ways to investigate mechanism of the reactions.
4. Empathetic role of various Lewis Acid and Base involved in asymmetric reactions.
5. Understand the concepts related to asymmetric organocatalysis and its use in waste minimization and green catalytic aspects.

Module:1	Fundamental Aspects	6 hours

Methods of asymmetric induction – kinetic control and thermodynamic control, auxiliary control, substrate control, reagent control, and solvent control; kinetic resolution and dynamic kinetic resolution, chiral discrimination; desymmetrization (chemical and enzymatic).

Module:2	Analytical Techniques	6 hours

Chiral lanthanide shift reagents and chiral HPLC, chiral GC, determination of absolute configuration by NMR and X-Ray crystallography. Optical rotatory dispersion techniques and Circular Dichroism: Principle, circular birefringence and circular dichroism, Cotton effect, Types of ORD curves, Application of plain dispersion curves, α-halo ketone and octant rules, applications for the determination of conformation and configuration.

Module:3	Nucleophilic, Electrophilic and Radical Addition Reactions	7 hours

Nucleophilic additions to cyclic and acyclic carbonyl compounds, Cram's rule, Felkin's model, addition to chelated carbonyl compounds, Prelog's rule and its applications, Electrophilic initiated cyclization, Aldol reactions: (1) Achiral enolates with achiral aldehydes (2) Achiral enolates with chiral aldehydes. (3) Chiral enolates with achiral aldehyde. (4) Chiral enolates with chiral aldehydes. Stereochemistry of free radical cyclization reactions, free radical reactions of organoboranes, alkenylsilanes and allylsilanes.

Module:4	Chiral Brønsted acid/base and Lewis-acid/base	6 hours

Chiral Brønsted Acid-Assisted Lewis Acid (BLA): Diels Alder Reaction, Cycloaddition, Michael Addition, □-Lactone Synthesis, Lewis Acid-Assisted (LLA); Allylation; LBA (Combination of Lewis Acids and Chiral Brønsted Acids): allylation reactions. enantioselective protonation of silyl enol ethers and ketene disilyl acetals; Chiral Phosphoric Acids (PAs)

Module:5	Important asymmetric name reactions	6 hours

Sharpless epoxidation and dihydroxylation; Jacobsen-Katsuki and Shi epoxidation, CBS reduction, Midland-alpine borane reduction, Noyori asymmetric reduction, Aldol reactions using Evans' oxazolidinones. Simon-Smith cyclopropanation reaction.		
Module:6	**Asymmetric organo-catalyst**	**6 hours**
Amine Catalysis (iminium catalysis, enamine catalysis, and SOMO catalysis); Hydrogen-bonding catalysis (Thiourea, Squaramide, etc.); NHC-catalysis		
Module:7	**Metal-catalyzed asymmetric C-C bond formation**	**6 hours**
Enantioselective ene and cycloaddition reactions, enantioselective alkene metathesis: Ring-Opening/Ring-Closing Metathesis (RORCM) and Ring-Opening/Cross Metathesis (ROCM); Asymmetric organozinc mediated Reaction. Metal catalyzed reactions (Palladium, Copper, Molybdenum, Nickel). Carbonyl-Ene Reaction, intra- and intermolecular.		
Module:8	**Contemporary Issues**	
	Industry Expert Lecture	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. A. Berkessel and H. Gröger, Asymmetric Organocatalysis: From Biomimetic Concepts to Applications in Asymmetric Synthesis, Wiley-VCH (2005).
2. D. Nasipuri, Stereochemistry of Organic Compounds-Principle and Applications, 4th Revised Ed., New Academic Science, 2012.
3. Ernest L. Eliel and Samuel H. Wilen, Stereochemistry of Organic Compounds, Wiley; 1st edition, 2008.
4. J. March and M. B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 6th Edition, Wiley, 2013.
5. L. Kurti and B. Czako, Strategic Applications of named Reactions in Organic Synthesis, Elsevier Academic Press, 2005.

Reference Books

1. I. L. Finar, Organic Chemistry Vol. I & Vol. II, Longman (Cambridge), 2011.
2. W. Carruthares, Iain coldham, Modern Methods of Organic Synthesis South Asia Edition, Cambridge University Press, Fourth Edition, 2015.
3. R.M. Silverstein, G. C. Bassler, T. C. Morril, Spectrometric identification of Organic Compounds, John Wiley & Sons, Inc, 2010.
4.Peter K., Vollhardt, C., and Schore N. E., Organic Chemistry, W. H. Freeman and Company, 2010.
5. Pine S. H., Organic Chemistry, Tata McGraw Hill, 5th edition, 2008.
6. R. Chang, Chemistry, 1st Indian Edition, Tata-McGraw Hill, 2007.
7. Guidebook to Mechanism in Organic Chemistry (6th Edition), Peter Sykes, Longman Scientific & Technical, 1985.
8. Grossman, R. B. The Art of Writing Reasonable Organic Reaction Mechanisms, 2nd edition, Springer, 2010.
9. Noyori, Asymmetric Catalysis in Organic Synthesis, John Wiley & Sons, 1994.
10. F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry Part B: Reaction and Synthesis, Springer, 5th Edition, 2010.
11.T. Punniyamurthy, Catalytic Asymmetric Synthesis, Open Education Resource (OER) LibreTexts Project, 2021.

Mode of Evaluation: Written Examinations, Quiz and Assignments			
Recommended by Board of Studies	19-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY413L	Advanced Spectroscopy	3	0	0	3
Pre-requisite	TCHY210L	Syllabus version			
		1.0			

Course Objectives

The course is aimed at:

1. Understanding the advancement in instrumentation and application of UV, IR, ^{1}H NMR, ^{13}C NMR, 2D NMR, solid state, and Mass spectrometry.
2. Imparting knowledge in the theory and applications of the spectroscopic techniques which are very important characterization techniques to understand the structure of the molecules in chemistry.

Course Outcomes

At the end of the course, students should be able to

1. Understand the concepts about the basic principles, theory and instrumentation of UV, IR, spectroscopic techniques and their significance in structural elucidation of various small to large molecules.
2. Understand the concepts about the basic principles, theory and instrumentation of ^{1}H NMR, ^{13}C NMR, 2D-NMR and solid-state NMR spectroscopy and their significance in structural elucidation of various small to large molecules.
3. Understand the concepts about the basic principles, theory and instrumentation, various ionization, separation and deduction techniques and to analyse the Mass spectral data for mass spectral data to derive the information regarding the Molecular weight as well as mass fragmentation patterns and the other structural features of the molecules.
4. Evaluate the UV, IR, NMR and mass spectral data to elucidate the structure of the small and complex molecule and the other structural features of the molecules.

Module:1	Advanced Proton NMR Spectroscopy	8 hours

Principles and Instrumentation: Continuous wave method, pulse technique, FT NMR-sample preparation-chemical shift and its measurements, solvent effect, factors affecting the chemical shift including anisotropic effect-relaxation processes-spin-spin coupling, coupling constant and Karplus equation-vicinal coupling-the effect of proton exchange reactions -first and second order spectra-simplification of complex spectra-NOE effects-shift reagents

Module:2	^{13}Carbon NMR spectroscopy	8 hours

Principles and Instrumentation, FT-NMR- Pulse technique-Behaviour of magnetization subjected to RF pulse-Relaxations: spin-lattice and dipole-dipole relaxation and other relaxations - coupling constants-theoretical aspects of nuclear shielding such as local diamagnetic shielding, neighbour anisotropy shielding, local paramagnetic shielding - factors affecting the Chemical shift and Coupling constants: ^{1}H and ^{13}C, coupling with other nuclei - ^{1}H decoupling methods - empirical relationships and empirical additivity rules - chemical shift reagents, solvent effect-chemical shift and structure elucidations. Measurements of T_1 and NOE-Dynamic ^{13}C NMR-DEPT methods.

Module:3	2-Dimensional NMR spectroscopy	5 hours

Introduction and applications 2D NMR techniques: H-H-COSY, C-H-COSY, TOCSY, NOESY, HMBC, HSQC to simple organic molecules.

Module:4	Solid State NMR spectroscopy - Introduction	4 hours

Introduction-Origin-Basic principles and methods of high-resolution NMR of solids-Magic angle spinning- Interactions in the solid state-MAS-CP method. Disadvantages and advantages of the technique.		
Module:5	**Mass spectrometry**	**7 hours**
Introduction, Instrumentation-Advanced Ionization techniques such as, EI, CI, ESI, APCI, FAB, MALDI, Field desorption-mass analyzers such as Quadrupole Analyzer, ion trap, Time-of-flight Analyzer - Applications of mass spectra to elucidate molecular formula and structure.		
Module:6	**ESR Basic Principles and Applications**	**5 hours**
ESR principle and instrumentation, Electronic Zeeman effect – ESR spectrum of hydrogen atom (first order treatment) - g factors – Hyperfine splitting – interactions affecting the energies of unpaired electrons in the transition metal ion complexes – zero field splitting – Kramer's degeneracy – anisotropy in the hyperfine coupling constant – nuclear quadrupole interactions - ESR of organic radicals in solution – McConnell's relation.		
Module:7	**Structural identification of organic molecules using various spectral techniques**	**6 hours**
Analysis of UV- Vis, IR, NMR and Mass spectral data towards the structural elucidation of simple organic molecules.		
Module: 8	**Contemporary Issues**	**2 hours**
	Industry Expert Lectures	
	Total Lecture hours:	**45 hours**

Text Book(s)

1. P. S. Kalsi Spectroscopy of Organic Compounds, New Age international Publishers,17th edition, 2016.
2. Robert M. Silverstein, Francis X. Webster, David J. Kiemle, David L. Bryce, Spectrometric Identification of Organic Compounds, Wiley, 8th Edition, 2015.
3. William Kemp, Organic Spectroscopy, MACMILLAN; SECOND edition, 2019.

Reference Books

1. James Keeler, Understanding NMR Spectroscopy, Wiley India Pvt Ltd; Second edition, 2013.
2. Kali Shankar Mukherjee Bodhisattwa Mukhopadhyay, Organic Spectroscopy through Solved Problems, , First Edition, 2013.
3. Jaggdamba Singh and Jaya Singh, Organic Spectroscopy Principles, Problems and Their Solutions, A Pragadhi Edition, 2016.
4. Elementary Organic Spectroscopy, Principles and Chemical Applications, S. Chand and Company, Fifth Revised Edition, 2013.

Mode of Evaluation: Written Examinations, Quiz and Assignments

Recommended by Board of Studies	19-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY414L	Biophysical Chemistry	3	0	0	3
Pre-requisite	TCHY207L, TCHY207P	Syllabus version			
		1.0			

Course Objectives

The course is aimed at:

1. Recognize the fundamental principles of various physical events as well as the physical characteristics of biomolecules.
2. Compare the principles and practical applications of different biophysical techniques and macromolecular analysis.
3. Understand the importance of biochemical assays using various biophysical methods.

Course Outcomes

At the end of the course, students should be able to

1. Evaluate hydrogen bonding, hydrophobic interactions and ionic interactions.
2. Analyze the primary, secondary, tertiary and quaternary features in structural elucidation of Biomolecules.
3. Predict the stability, thermodynamics and denaturation of biomolecules.
4. List the various applications of enzymes and their applications in chemical synthesis.
5. Integrate optical and spectroscopic techniques, properties and Ramachandran Plot for establishing the structures of biomolecules.
6. Determine the macromolecular size of biomolecules through microscopic techniques.
7. Apply chromatographic and centrifugation techniques for protein purification.

Module:1	Intermolecular interactions	6 hours

Structure of ice and liquid water, Hydrogen bonding, hydrophobic interactions and water as universal solvent in biological systems; Ionic interactions, hydrophobic versus ionic interactions; buffers and Henderson-Hasselbalch equation.

Module:2	Structure of biomolecules	7 hours

Biomolecules – introduction, building blocks of biopolymers. Primary structure of proteins, end group determination, amino acid analysis and the Edman degradation (protein sequencing), Ramachandran plot and the secondary structure of proteins: α-helix, β-pleated sheet, β-bend and collagen triple helix. Tertiary structure and structural motifs - protein folding and domai structure of proteins. Oligomeric proteins

Module:3	Stability and thermodynamics of biomolecules	6 hours

Disulfide bond, formation of specific disulfide link, Disruption of hydrophobic interactions by urea and other denaturants; Two state models of protein stability, chemical denaturation and stabilization, surface denaturation; Principles of ionization equilibrium of side chain, equilibria in proteins.

Module:4	Nucleotides and nucleic acids	6 hours

Ribonucleotides and deoxyribonucleotides – introduction. Structural features of nucleic acids-base pairing, double helical structure of DNA and forces stabilizing nucleic acid structure. Methods used in nucleic acid separation and characterization, nucleic acid sequencing.

Module:5	Biophysical Analysis: Chromatographic Techniques and Ultracentrifugation	6 hours

Protein purification by size exclusion, GPC and ion exchange chromatographic

techniques. Ultracentrifugation - Sedimentation velocity and equilibrium-determination of molecular weights.		
Module:6	**Biophysical Analysis: Optical and Spectroscopic techniques**	**6 hours**
Optical and Spectroscopic techniques for nucleic acid and protein quantification, determination of protein secondary structure, biomolecular modifications by UV-Visible, Fluorescence, IR, NMR, Mass, MALDI and CD.		
Module:7	**Biophysical Analysis: Microscopic techniques**	**6 hours**
Macromolecular size determination, microscopic techniques, Protein aggregation, Self-assembly, Surface Morphology, by Light Microscopy - Fluorescence Microscopy, Atomic Force Microscope; Electron Microscopy - Scanning Electron and Transmission Electron Microscopes.		
Module:8	Industry Expert Lecture	**2 hours**
	Guest Lecture by Industrial Expert	
	Total Lecture hours:	**45 hours**

Text Book(s)

1. P Narayanan, *Essentials of Biophysics*, (2016) *2nd Edition,* New Age International, New Delhi, India.

Reference Books

1. Cantor and Schimmel, *Biophysical Chemistry*, *Vols. I - III*, (2008) W. H. Freeman & Co., USA.
2. Alan Cooper, *Biophysical chemistry*, (2011) *2nd Edition* RSC publishing, UK.
3. J. L. Gurth and A. Gurth, *Biophysical Chemistry*, (2015) *9th Edition,* Pragati Prakashan, Meerut, India.
4. D. L. Nelson & M. M. Cox, *Lehninger's Principles of Biochemistry*, (2021) *8th Edition* Published by W. H. Freeman & Co. New York.

Mode of Evaluation: Written Examinations, Quiz and Assignments			
Recommended by Board of Studies	19-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY416L	Medicinal Chemistry	3	0	0	3
Pre-requisite	TCHY203L, TCHY302L	Syllabus version			
		1.0			

Course Objectives

The course is aimed at:

1. To show the chemistry behind the development and activity of pharmaceutical materials.
2. Students should gain the knowledge of mechanism of action and adverse effects of drugs
3. To understand how the recent pandemic transformed human understanding on deadliest virus.

Course Outcomes

At the end of the course, students should be able to

1. Predict a drugs properties based on its structure
2. Describe the factors that affect its absorption, distribution, metabolism, and excretion,
and hence the considerations to be made in drug design.
3. Explain the relationship between drug chemical structure and its therapeutic properties
4. Recent pandemic has taught several lesson sot mankind. Designed to give the knowledge of different theories of drug actions at molecular level and also to identify different targets for the development of new drugs against this deadliest virus.

Module:1	Drugs and Their Action	6 hours

Introduction to drugs, prodrugs and soft drugs, classification of drugs, source of drugs and lead molecules, routes of administration, introduction to drug action pharmacokinetic phase, ADME (absorption, distribution, metabolism and elimination).

Module:2	Drug discovery	7 hours

Introduction, stereochemistry and drug design (structurally rigid groups, conformation and
configuration), solubility and drug design - importance of water solubility, solubility and drug
structure - incorporation of water solubilizing groups in a structure and
position of water solubilizing attached groups- salt and cocrystal formation.

Module:3	Introduction to Receptors	6 hours

Introduction, targets, Agonist, antagonist, partial agonist. Receptors, theories of drug receptor interaction, receptor types, drug synergism, Drug resistance, physicochemical factors influencing drug action. Isosterism and bioisosterism.

Module:4	Pharmacokinetics	6 hours

Profiling of drug : (ADMET-Absorption, Distribution, Metabolism, Excretion and Toxicity with a case study.

Module:5	Medicinal chemistry of anti-diabetic drugs	7 hours

Introduction, Types of diabetics, Drugs used for the treatment (Metformin, Glitazones), chemical classification, SAR, Mechanism of action, Study the treatment strategy of diabetic mellitus. Chemistry of insulin, sulfonyl ureas.

Module:6	**Anti-Cancer agents**	**7 hours**
Classification, mechanism of action of drugs (a metal based – cisplatin and a nonmetal-based drug- avastin), employed for the treatment of cancer. Current treatment strategy for cancer.		
Module:7	**Coronavirus**	**4 hours**
Coronavirus, mechanism of disease manifestation, Vaccines, possible drugs for covid treatment. Pandemic lessons.		
Module:8	Industry Expert Lecture	**2 hours**
	Total Lecture hours: 45 hours	
Text Book		
1. Foye's Principles of Medicinal chemistry-Victoria F. Roche, S.William Zito, Thomas L.Lemke and David A.Williams, 8th edition, 2018. 2. An Introduction to Medicinal Chemistry - Graham L. Patrick, 6th edition, Oxford University Press, 2017.		
Reference Books		
1. Burger's Medicinal Chemistry, Drug Discovery and Development, Donald J. Abraham, David P. Rotella, Alfred Burger, Academic press, 2010. 2. Burger's Medicinal Chemistry and Drug Discovery, 1999 Vol-I, Ed. M.E.Wolf, John Wiley. 3. Mark W Hallday and Richard B Silverman, Organic chemistry of drug design and drug action, third edition, AP, 2014.		
Mode of Evaluation: Written Examinations, Quiz and Assignments		
Recommended by Board of Studies	19-01-2024	
Approved by Academic Council	No. 73	Date 14-03-2024

Course Code	Course Title	L	T	P	C
TCHY417L	Quality Control and Quality Assurance	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives:

The course is aimed at:

1. Ascertain the quality of the finished product and finally its validation to facilitate its marketlaunch.
2. Gain knowledge about ICH guidelines, i.e., the organization that sets and governs the lawsand rules for all the quality tests
3. Assess the quality of the formulation and assuring the compliance of standards.

Course Outcome:

At the end of the course, students should be able to

1. Recall the importance and methods of quality assurance in a pharmaceutical industry
2. Understand the concept of auditing, quality of auditing, and personal responsibilitiesinvolved in quality control of an organization.
3. Analyze the documentations associated with manufacturing, master formula, distribution,returned goods and recovered materials.
4. Apply the knowledge of the validation process at different levels, including personal,equipment, and regulatory aspects.
5. Evaluate the quality of various process and factors influencing the stability of products, andquality of packaging materials.
6. Design to give a quality assurance and control process involving documentation, regulatory and other aspects in a pharmaceutical industry

Module:1	Concept and Philosophy	6 hours

Total Quality Management (TQM), Good Laboratory Practice (GLP), Good Manufacturing Practice (GMP).

Module:2	Quality Audit	6 hours

Quality audit, Standard Operating Procedure (SOP), International Conference Harmonisation (ICH), ISO-9000, ISO14000.

Module:3	Organization and personnel responsibilities	7hours

Training, Hygiene, Premises: Location, Design, Plant layout, Construction, Maintenance and Sanitations. Environmental control, Sterile areas, control of contamination.

Module:4	Documentation & Handling	5 hours

Manufacturing documents, Master Formula, batch formula Record, Distribution of records,Handling of returned goods, Recovered materials and Reprocessing.

Module:5	Regulatory aspects of Pharmaceuticals	7 hours

Validation of Personnel, Equipment and cleaning methods, regulatory aspects of pharmaceutics.

Module:6	Quality process	5 hours

In-process quality Control on various dosage forms, Sterile and non- sterile operations.

Module:7	Quality control of packaging materials:	7 hours

Types of plastics, primary and secondary packaging materials (glass, closures, cartons, blister and their control), Factor affecting stability of formulations, and shelf - life prediction, techniques to determine and improve shelf life.		
Module:8	**Contemporary Issues**	**2 hours**
	Industry Expert Lecture	
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Quality Assurance of Aseptic Preparation Services: Standards Part A | Fifth edition, Alison MBeaney Royal Pharmaceutical Society and the NHS Pharmaceutical Quality Assurance Committee,2016.
2. Managing for quality and performance excellence ninth edition James R.Every, William M.Lindsay South-western Cengage Learning 2014.

Reference Books

1. Sed mtiazhaider. (2011). Pharmaceutical Master Validation Plan: The Ultimate Guide to FDA.
2. Ira R. Berry, Robert A Nash (2013), Pharmaceutical process validation, 3rd Rev Edition.Marcel Dekker.

Recommended by Board of Studies	19-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY418L	Inorganic Photochemistry and Spectroscopy	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

The course is aimed at:

1. Applying the principles of photochemistry in chemical methods and in medical photochemistry.
2. Characterization of inorganic materials using relevant spectral techniques.

Course Outcomes

At the end of the course, students should be able to

1. Understand the importance of Inorganic Photochemistry.
2. Apply photophysical processes for versatile applications.
3. Analyze and interpret photoredox reactions as well as examine and classify photochemical reactions in coordination complexes.
4. Structural elucidation of inorganic materials by vibrational and resonance spectral tools.
5. Characterization of inorganic materials by Mössbauer spectroscopic techniques.

Module:1	Photochemistry	4 hours

Introduction to photochemistry - photochemical *Vs* thermal reactions – absorption of light by molecule – reaction pathway of electronically excited molecules - fluorescence and phosphorescence – Jablonski diagram. Photochemical smog, atmospheric ozone layer, photodegradation of organic pollutants.

Module:2	Binuclear photophysical process	5 hours

Quantum yields and experimental determination, numerical problems on quantum efficiency, quenching of excited states, fluorescence life time, Stern–Volmer equation, mechanism of quenching - heavy atom quenching, excimer and exciplex.

Module:3	Ligand field photochemistry	6 hours

Photochemistry of Co (III), Pt (II) and Ru (IV) complexes: substitution, isomerisation, racemization, aquation, rearrangement and electron transfer reactions.

Module:4	Vibrational spectroscopy	8 hours

Vibrations in simple molecules (water, carbon dioxide and acetylacetone) and their symmetry notations– group vibrations and limitations - exclusion principle, combined uses of IR and Raman spectroscopy in the structural characterization of simple molecules: H_2O, ClF_3^-, NO_3^-. Effects of coordination and ligand vibrations, use of group vibrations in the structural elucidation of metal complexes - cyanide, thiocyanide, nitrate, sulphate. Effects of isotopic substitution and the vibration spectra of complexes - $Ni(CO)_4$, $Fe(CO)_5$ and both isomeric forms of $Co_2(CO)_8$

Module:5	Nuclear magnetic resonance spectroscopy	9 hours

Spin systems – chemical shifts and coupling constants (spin- spin coupling involving different nuclei - (^1H, ^{19}F, ^{31}P, ^7Li, ^{15}Si, ^{27}Al, ^{119}Sn) interpretations and application in inorganic compounds; effects of quadrupole nuclei (^{10}B, ^{11}B) on ^1H NMR spectra, fluxional behaviour of molecules, NMR of paramagnetic molecules – isotopic shift

contact and pseudo contact interactions.		
Module:6	**Electron paramagnetic resonance spectroscopy**	**6 hours**
Factors affecting g and A tensors in metal species - hyperfine interactions; Zero field splitting and Kramers degeneracy, spectra of Mn(II), Fe(II), Co(II), Cu(II), Ni(II) complexes and their biological applications.		
Module:7	**Mössbauer spectroscopy**	**5 hours**
Introduction and instrumentation technique, Doppler shift and recoil energy, isomer shift and its interpretation, quadrupole interactions, effect of magnetic field, applications to metal complexes – metal carbonyls, Fe-S cluster and Sn compounds.		
Module:8	**Industry Expert Lecture**	2 **hours**
	Guest lectures from industry and, research & development organizations	
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Julia A Wienstein, Inorganic Photochemistry, Springer, 2013.
2. Torn Bitterley, Photochemistry of Transition Metal Complexes, Elsevier, 2011.
3. R. S. Drago, Physical Methods in Inorganic Chemistry, Saunders College Publishers, 1992.
4. A.K. Brisdon, Inorganic Spectroscopic methods, Oxford Science publications, 2005.

Reference Books

1. Rachel C Evans, Peter Douglas, Hugh D Buren, Applied Photochemistry, Springer, 2013.
2. B.J. Palmer, Photochemistry of Inorganic and Organometallic complexes Elsevier, 2012.
3. E.A.V, Ebsworth, Structural Methods in Inorganic Chemistry, 3rd edition, ELBS, Great Britain 1987.
4. P. J. Wheatley, Determination of molecular structure, Dover Publications, 1981.
5. J. Iggo, NMR spectroscopy in Inorganic Chemistry, Oxford Science publications, 2005.
6. Solomon & Lever, Edts, Inorganic Electronic Structure and Spectroscopy, Wiley, 2002.

Mode of Evaluation: Written Examinations, Quiz and Assignments

Recommended by Board of Studies	19-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY419L	Organic Photochemistry	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

The course is aimed at

1. Imparting knowledge in the theory and applications of various aspects of photochemistry.
2. Understanding the synthesis and mechanism of various reactions related to the synthesis by photochemistry

Course Outcomes

At the end of the course, students should be able to

1. Recall the fundamental principles of photochemical reactions.
2. Understand the concepts related to light induced organic synthesis, mechanisms and the functions of various reagents.
3. Analyze the product distribution and the stereochemistry of various organic products derived from photochemistry.
4. Evaluate the photochemical reactions based on the influence of the substituents on substrate molecules.

Module:1	Introduction to Photochemistry	8 hours

Energy of molecules -Thermal Energy- Photochemical Energy, Electronic transitions and Spin multiplicity. Nomenclature of excited states - fate of the excited molecules, their physical processes-Jablonski diagram. Photolytic cleavage, Laws of photochemistry, Quantum yield.

Module:2	Basics concepts on Fluorescence and Phosphorescence Spectroscopy	4 hours

Introduction, fluorophores-properties, solvent and environmental effects., turn-on and turn-off fluorescence and fluorometric sensors.

Module:3	Photochemistry of carbonyl compounds	8 hours

Photochemistry of carbonyl compounds- Norrish Type I & II reactions. Intramolecular hydrogen abstraction by carbonyl oxygen. Addition of carbonyl oxygen to carbon-carbon double bond (Paterno Buchi); α-cleavage reactions in acyclic, cyclic and β, γ-unsaturated ketones. β-Cleavage in ketones. Intra and intermolecular hydrogen transfer reactions in carbonyl compounds. Photo dimerization of α, β unsaturated ketones (cyclopentenone).

Module:4	Photo Rearrangements	5 hours

Photo rearrangement of enones, dienones, Epoxy ketone. Photo Wolf and Fries rearrangement, Di-π-methane rearrangement, Oxa- Di-π-methane rearrangement.

Module:5	Photo redox reactions	5 hours

Photoreduction of carbonyl compounds and aromatic hydrocarbons, Photochemical oxidation-Mechanism, Photo oxidation of olefines.

Module:6	Photochemistry of alkenes, dienes, aromatic compounds, diazo compounds and azides	8 hours

cis-trans isomerization and dimerization of olefins, photochemistry of conjugated olefins in solutions, photoisomerization of aromatic compounds. Photoaddition of alkenes to aromatic benzenoid compounds. Addition of oxygen to aromatic hydrocarbons (aromatic photo substitution), photochemistry of diazo compounds

(one example) and azide (one example).			
Module:7	**Photo substitution reactions at sp^3 carbon**		**4 hours**
Barton, Hoffman-Loffler-Freytag, Sandmayer, Gomberg-Bachmann, Pschorr and Hunsdiecker reactions.			
Module:8	**Lecture of industrial expert**		**3 hours**
	Total Lecture Hours		**45 hours**
Text Book(s)			
1. March's Advanced Organic Chemistry by Michael Smith and Jerry March Wiley-Interscience, Sixth Edition 2007. 2. Photochemistry and Pericyclic Reactions by Jagadamba Singh and Jeya Singh New Academic Science Limited, 4th Edition 2019. 3. Principles of fluorescence chemistry by Joseph Lakowicz, Springer, Third Edition, 2006.			
Reference Books			
1.Introduction to Organic Photochemistry by John Coyle, Wiley-interscience 1991. 2.Photochemistry: Volume 42, Specialist Periodical Reports by Elisa Fasani and Angelo Albini, RSC Publication, 2014.			
Mode of Evaluation : Written Examinations, Quiz and Assignments			
Recommended by Board of Studies	19-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY420L	Industrial Catalysis	3	0	0	3
Pre-requisite	TCHY207L, TCHY207P, TCHY208L	Syllabus version			
		1.0			

Course Objectives

The course is aimed at:

1. Providing basic concepts of catalysis, catalyst preparation and characterization techniques.
2. Explaining the principles, design and operations of catalytic reactors.
3. Imparting knowledge on the environmental and industrial applications of catalytic processes.

Course Outcomes

At the end of the course, students should be able to

1. Define the fundamentals and terminologies used in catalysis
2. Describe surface adsorption phenomena and surface area measurement methods
3. Recognize heterogeneous catalytic processes and the types of catalytic reactors
4. Suggest preparation methods for various solid catalysts
5. Compare different techniques to characterize catalysts
6. Recognize the applications of catalysts in industries and environmental remediation

Module:1	Fundamentals of catalysis	6 hours

Catalysis – introduction. Classification - homogeneous and heterogeneous catalysis, biocatalysis – enzymes, organocatalysis, electrocatalysis and photocatalysis – applications. Surface reaction - Eley-Rideal (ER) mechanisms. Energy profile of a catalyzed reaction. Definitions and formulae - conversion, selectivity, contact time, time on stream, weight hour space velocity (WHSV), turnover number (TON) and turnover frequency (TOF).

Module:2	Adsorption on catalyst surface	7 hours

Chemisorption and physisorption. Types of adsorption isotherms - Freundlich, Langmuir and BET isotherms. Determination of surface area using BET isotherm – surface area, pore volume and pore size. IUPAC classification of pores - classification based on pore size – micro, meso, macro – classification based on shape - types of N_2 adsorption isotherms – BJH and NLDFT methods of pore size analysis - hysteresis and capillary condensation – types of hysteresis.

Module:3	Preparation of solid catalysts	6 hours

Preparation of solid catalyst – sol-gel, hydrothermal, and template assisted synthesis – examples from metal oxides, zeolites and mesoporous materials. Preparation of supported catalysts: impregnation – incipient and wetness impregnation, deposition precipitation, co-precipitation and ion-exchange.

Module:4	Characterization of catalysts	6 hours

Techniques for characterization of catalysts - diffraction and microscopic techniques: XRD, SEM, TEM, XPS, UV-Vis DRS, FTIR. Stability analysis - TPD, TPR and TPO.		
Module:5	**Reaction engineering**	**6 hours**
Heterogeneous catalysis reaction steps - external diffusion, internal diffusion, adsorption, surface reaction, desorption, rate limiting step. Catalytic reactor design - types of reactors. Diffusion within catalyst pores, diffusion and reaction in heterogeneous catalysis - mass transfer/reaction rate limited reactions. Catalyst deactivation and regeneration. Reactors for homogeneous catalysis.		
Module:6	**Industrial catalytic processes**	**6 hours**
Heterogeneous catalytic processes: cracking, reforming, alkylation, isomerization, hydrogenation, dehydrogenation, hydrodesulfurization. Homogeneous catalytic processes: hydrogenation, hydroformylation, stereoregular polymerization, Wacker process and olefinic metathesis.		
Module:7	**Environmental catalysis**	**6 hours**
Advanced oxidation process – homogeneous and heterogeneous - Fenton catalysts. Photocatalysis for pollutant degradation – TiO_2, three-way catalytic converter, catalysis for conversion of CO_2 to value added products, catalysis for conversion of biomass to fuels and value added products.		
Module:8	Industry Expert Lecture	**2 hours**
	Total Lecture hours:	**45 hours**
Text Book(s)		
1. Corrado Garlisi, Giovanni Palmisano, and Samar Al Jitan, Heterogeneous Catalysis - Fundamentals, Engineering, and Characterizations, Elsevier, 2022. 2. B.Viswanathan, S. Sivasanker, A. V. Ramaswamy, Catalysis: Principles and Applications, Narosa Publishing House, 2011.		
Reference Books		
1. Jens Hagen, Industrial Catalysis: A Practical Approach, John Wiley & Sons, 2006. 2. Viswanathan, S.Kannan and R.C. Deka, “Catalysts and surfaces: Characterization techniques”, Alpha science international Ltd., UK., 2006. 3. Synthesis of Solid Catalysts, Editor(s): Prof. Dr. Krijn P. de Jong, Wiley-VCH Verlag GmbH & Co. KgaA, 2009.		
Mode of Evaluation: Written Examinations, Quiz and Assignments		
Recommended by Board of Studies	19-01-2024	
Approved by Academic Council	No. 73	Date 14-03-2024

TCHY390J	Study Project	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. The student will be able to analyse and interpret published literature for information pertaining to niche areas.
2. Scrutinize technical literature and arrive at conclusions.
3. Use insight and creativity for a better understanding of the domain of interest.

Course Outcome:

1. Retrieve, analyse, and interpret published literature/books providing information related to niche areas/focused domains.
2. Examine technical literature, resolve ambiguity, and develop conclusions.
3. Synthesize knowledge and use insight and creativity to better understand the domain of interest.

Module Content

This is oriented towards reading published literature or books related to niche areas or focussed domains under the guidance of a faculty.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews.

Recommended by Board of Studies	18-02-2022		
Approved by Academic Council	No.65	Date	17-03-2022

TCHY392J	Design Project	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. Students will be able to upgrade a prototype to a design prototype.
2. Describe and demonstrate the techniques and skills necessary for the project.
3. Acquire knowledge and better understanding of design systems.

Course Outcome:

1. Develop new skills and demonstrate the ability to upgrade a prototype to a design prototype or working model.
2. Utilize the techniques, skills, and modern tools necessary for the project.
3. Synthesize knowledge and use insight and creativity to better understand and improve design systems.

Module Content

Students are expected to develop new skills and demonstrate the ability to develop prototypes to design prototype or working models related to an engineering product or a process.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews.

Recommended by Board of Studies	18-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY393J	Laboratory Project	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. The student will be able to conduct experiments on the concepts already learnt.
2. Analyse experimental data.
3. Present the results with appropriate interpretation.

Course Outcome:

1. Design and conduct experiments in order to gain hands-on experience on the concepts already studied.
2. Analyse and interpret experimental data.
3. Write clear and concise technical reports and research articles

Module Content

Students are expected to perform experiments and gain hands-on experience on the theory courses they have already studied or registered in the ongoing semester. The theory course registered is not expected to have laboratory component and the student is expected to register with the same faculty who handled the theory course. This is mostly applicable to the elective courses. The nature of the laboratory experiments is depended on the course.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews.

Recommended by Board of Studies	18-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY395J	Computer Project	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. Students will be able to analyse complex engineering processes.
2. Describe the applications and limitations of a given engineering process.
3. Present the results in written reports and oral presentations.

Course Outcome:

1. Utilize programming skills/modelling to analyse complex engineering processes/problems.
2. Demonstrate the ability to evaluate the applicability and limitations of the given engineering process.
3. Communicate effectively through written reports, oral presentations, and discussion.

Module Content

Students are expected to use programming skills or modelling to analyse complex engineering processes. The student should be able to evaluate the application and limitations of the said engineering processes.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews.

Recommended by Board of Studies	18-02-2022		
Approved by Academic Council	No.65	Date	17-03-2022

TCHY397J	Special Project	L	T	P	C
		0	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. Students will be able to identify and solve problems in a time-bound manner.
2. Describe major approaches and findings in the area of interest.
3. Present the results in a clear and concise manner.

Course Outcome:

1. To identify, formulate, and solve problems using appropriate information and approaches in a time-bound manner.
2. To demonstrate an understanding of major approaches, concepts, and current research findings in the area of interest.
3. Write clear and concise research articles for publication in conference proceedings/peer-reviewed journals.

Module Content

This is an open-ended course in which the student is expected to work on a time bound research project under the supervision of a faculty. The result may be a tangible output in terms of publication of research articles in a conference proceeding or in a peer-reviewed Scopus indexed journal.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – project report to be submitted, presentation and project reviews.

Recommended by Board of Studies	18-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

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Ability Enhancement Compulsory Courses

TENG101L	Effective English Communication	L	T	P	C
		2	0	0	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To enhance the basic communication skills
2. To enable the learners develop proficiency in general and academic writing
3. To expose the learners to the nuances of receptive skills

Course Outcome

1. Use appropriate vocabulary and grammar in writing sentences and paragraphs
2. Write effective letters and E-mails in workplace situations
3. Read and comprehend different texts at the intermediate level
4. Demonstrate effective listening and speaking skills with clear pronunciation

Module:1	**Vocabulary**	**2 hours**
	Synonyms and Antonyms, Prefixes and Suffixes, Word Formation, One Word Substitution, frequently used Idioms and Phrases, Homophones and Homonyms	
Module:2	**Grammar**	**4 hours**
	Parts of Speech, Articles, Tenses, Sentence Structure, Types of Sentences, Subject-Verb Agreement, Connectives and Conjunctions	
Module:3	**Drafting Paragraphs**	**4 hours**
	Elements of Paragraph writing, Keywords Development, Topic Sentence, Writing Paragraphs using Connectives	
Module:4	**Email and Letter Writing**	**4 hours**
	Email writing and etiquettes; Letter writing- process, form and structure, types of formal letters - permission, apology and request	
Module:5	**Reading**	**5 hours**
	Mechanics of Reading, Types of Reading- Skimming and Scanning, Intensive & Extensive, Reading Strategies- Summarizing; Reading short stories and essays for comprehension	
Module:6	**Listening**	**4 hours**
	Process, Types, Barriers**,** Effective Listening strategies, Comprehension of speech, Listening to short speeches and Note taking	
Module:7	**Speaking**	**5 hours**
	Introduction to phonetics, need and use of it - Word stress and Sentence stress - Intonation- rate of speech, pitch, tone – Clarity of voice- Nuances of delivery; modes of delivery, guidelines for effective delivery	
Module:8	**Contemporary Topics**	**2 hours**
Guest Lectures from Industry and, Research and Development Organizations		
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Rizwi, Ashraf. (2017).*Effective Technical Communication*. New Delhi:McGraw-Hill Education

Reference Books

1. Watkins, P. (2018). *Teaching and Developing Reading Skills: Cambridge Handbooks for Language teachers.* India: Cambridge University Press.
2. Koneru Aruna. (2020*). English Language Skills for Engineers.* India: McGraw Hill

	Education.
3.	Wren, P.C. & Martin, H. (2018). *High School English Grammar & Composition* N.D.V. Prasada Rao (Ed.). New Delhi: S. Chand & Company Ltd
4.	Delvin, J. (2017). *How to Speak and Write Correctly*. California, US: Create Space Independent Publishing Platform.
Mode of Evaluation: CAT / written assignment / Quiz / FAT / Seminar / group discussion	

Recommended by Board of Studies	28.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TENG102L	Technical English Communication	L	T	P	C
		2	0	0	2
Pre-requisite	NIL	**Syllabus version**			
		1.0			

Course Objectives:

1. To develop LSRW skills for effective communication in professional situations
2. To enhance knowledge of grammar and vocabulary for meaningful communication
3. To understand information from diverse texts for effective technical communication

Course Outcomes:

1. Use grammar and vocabulary appropriately while writing and speaking
2. Apply the concepts of communication skills in formal and informal situations
3. Demonstrate effective reading and listening skills to synthesize and draw intelligent inferences
4. Write clearly and significantly in academic and general contexts

Module:1	**Introduction to Communication**	**4 hours**
	Nature and Process - Types of communication: Intra-personal, Interpersonal, Group-verbal and non-verbal communication / Cross-cultural Communication - Communication Barriers and Essentials of good communication - Principles of Effective Communications	
Module:2	**Grammatical Aspects**	**4 hours**
	Sentence Pattern - Modal Verbs - Concord (SVA) - Conditionals - Error detection	
Module:3	**Written Correspondence**	**4 hours**
	Job Application Letters - Resume Writing - Statement of Purpose	
Module:4	**Business Correspondence**	**4 hours**
	Business Letters: Calling for Quotation, Complaint & Sales Letter – Memo - Minutes of Meeting - Describing products and processes	
Module:5	**Professional Writing**	**4 hours**
	Paraphrasing & Summarizing - Executive Summary - Structure and Types of Proposal – Recommendations	
Module:6	**Team Building & Leadership Skills**	**4 hours**
	Principles of Leadership - Team Leadership Model - Negotiation Skills - Conflict Management	
Module:7	**Research Writing**	**4 hours**
	Interpreting and Analysing a research article - Approaches to Review Paper Writing - Structure of a research article - Referencing	
Module:8	**Guest Lecture from Industry and R&D organizations**	**2 hours**
	Contemporary Issues	
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Raman, Meenakshi & Sangeeta Sharma. (2015). *Technical Communication: Principles and Practice*, (3rd Edition). India: Oxford University Press.
Reference Books	
1.	Taylor, Shirley & Chandra .V. (2010). *Communication for Business A Practical Approach* 4th Edition. India: Pearson Longman.
2.	Kumar, Sanjay & Pushpalatha. (2018). *English Language and Communication Skills for Engineers.* India: Oxford University Press.
3.	Koneru Aruna. (2020*). English Language Skills for Engineers.* India: McGraw Hill Education.
4.	Rizvi, M. Ashraf. (2018). *Effective Technical Communication* 2nd Edition. Chennai: McGraw Hill Education.
5.	Mishra, Sunitha & Muralikrishna,C. (2014). *Communication Skills for Engineers*. India: Pearson Education.
6.	Watkins, P. (2018). *Teaching and Developing Reading Skills: Cambridge Handbooks for Language teachers*. India: Cambridge University Press.
Mode of Evaluation : CAT / Assignment / Quiz / FAT / Group Discussion	

Recommended by Board of Studies		28.06.2021	
Approved by Academic Council	No. 63	Date	23.09.2021

TENG102P	Technical English Communication Lab	L	T	P	C
		0	0	2	1
Pre-requisite	NIL	**Syllabus version**			
		1.0			

Course Objectives:

1. To use appropriate grammatical structures in professional communication
2. To improve English communication skills for better employability
3.To enhance meaningful communication skills in writing and public speaking

Course Outcomes:

1.Demonstrate professional rhetoric and articulate ideas effectively
2. Interpret material on technology and deliver eloquent presentations
3. Apply receptive and productive skills in real life situations and develop workplace communication

Indicative Experiments

1.	**Grammar & Vocabulary** Error Detection **Activity:** -Worksheets
2.	**Listening to Narratives** Interviews of eminent personalities & Ted Talks **Activity:** Listening Comprehension / Summarising
3.	**Video Resume** SWOT Analysis & digital resume techniques **Activity:** Preparing a digital résumé for mock interview
4.	**Product & Process Description** Describing and Sequencing **Activity:** Demonstration of product and process
5.	**Mock Meetings** Types of meetings and meeting etiquette **Activity: Conduct of meetings and drafting minutes of the meeting**
6.	**Reading research article** Scientific and Technical articles **Activity:** Writing Literature review
7.	**Analytical Reading** Case Studies on Communication, Team Building and Leadership **Activity:** Group Discussion
8.	**Presentations** Preparing Conference/Seminar paper **Activity:** Individual/ Group presentations
9.	**Intensive Listening** Scientific documentaries **Activity:** Note taking and Summarising
10.	**Interview Skills** Interview questions and techniques **Activity:** Mock Interviews

Total Laboratory Hours	**30 hours**

Mode of Assessment: Continuous Assessment / FAT / Written Assignments / Quiz/ Oral Presentation and Group Activity.

Recommended by Board of Studies	28.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TENG103P	Technical Report Writing	L	T	P	C
		0	0	2	1
Pre-requisite	Technical English Communication	**Syllabus version**			
		1.0			

Course Objectives:

1. To augment specific writing skills for preparing technical reports
2. To think critically, evaluate, analyse general and complex technical information
3. To acquire proficiency in writing and presenting reports

Course Outcomes:

1.Write error free sentences using appropriate grammar, vocabulary and style
2. Synthesize information and concepts in preparing reports
3. Demonstrate the ability to write and present reports on diverse topics

Indicative Experiments

1.	**Advanced Grammar, Vocabulary and Editing** Usage of Tenses - Adjectives and Adverbs - Jargon vs Technical Vocabulary – Abbreviations - Mechanics of Editing: Punctuation and Proof Reading **Activity:** Worksheets
2.	**Research and Analyses** Synchronise Technical Details from Newspapers - Magazines - Articles and e-content **Activity**: Writing introduction and literature review
3.	**Systematisation of Information** Techniques to Converge Objective-Oriented data in Diverse Technical Reports **Activity:** Preparing Questionnaire
4.	**Data Visualisation** Interpreting Data - Graphs - Tables – Charts - Imagery - Infographics **Activity:** Transcoding
5.	**Introduction to Reports** Meaning - Definition - Purpose - Characteristics and Types of Reports **Activity:** Worksheets on Types of reports
6.	**Structure of Reports** Title – Preface – Acknowledgement - Abstract/Summary – Introduction - Materials and Methods – Results – Discussion - Conclusion - Suggestions/Recommendations **Activity:** Identifying the structure of report
7.	**Report Writing** Data Collection - Draft an Outline and Organize Information **Activity:** Drafting reports
8.	**Supplementary Texts** Appendix – Index – Glossary – References – Bibliography - Notes **Activity:** Organizing supplementary texts
9.	**Review of Final Reports** Structure – Content – Style - Layout and Referencing **Activity:** Examining clarity and coherence in final reports
10.	**Presentation** Presenting Technical Reports **Activity:** Planning, creating and digital presentation of reports
	Total Laboratory Hours **30 hours**

Mode of assessment: Continuous Assessment / FAT / Assignments / Quiz / Presentations / Oral examination

Recommended by Board of Studies	28.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TCHY140L	Environmental Studies	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. To make students understand and appreciate the unity of life in all its forms and the implications of life style on the environment.
2. To broaden the understanding of global climate changes and the importance of renewable sources of energy.
3. To give students a basic understanding of the major causes of environmental degradation on the planet, with specific reference to Indian situation
4. To inspire students to find ways in which they can contribute personally and professionally to prevent and rectify environmental problems.

Course Outcome:

Upon Completion of the course, the students will be able to

1. Students will recognize the environmental issues in a problem oriented interdisciplinary perspectives.
2. Students will understand the key environmental issues, the science behind those problems and potential solutions.
3. Students will demonstrate the significance of biodiversity and its preservation.
4. Students will identify various environmental hazards.
5. Students will design various methods for the conservation of resources.
6. Students will formulate action plans for sustainable alternatives that incorporate science, humanity, and social aspects.
7. Students will have foundational knowledge enabling them to make sound life decisions as well as enter a career in an environmental profession or higher education.

Module:1	**Environment and Natural Resources**	**7 hours**

Definition, scope, importance; need for public awareness on natural resources Forest resources – use, exploitation, causes and consequences of deforestation. Water resources – use of surface and subsurface water; dams - effect of drought, water conflicts. Land resources - Land degradation, soil erosion and desertification. Indian Case studies. Food resources – Definition,
world food problems, Traditional and modern agriculture and its impacts and remedies.

Module:2	**Energy Resources**	**7 hours**

Definition for renewable and non-renewable energy resources. Non-renewable energy resources - oil, Natural gas, Coal, Nuclear energy. Renewable energy - Solar energy, Hydroelectric power,
Ocean thermal energy, Wind and geothermal energy. Biomass energy and Bio Gas.

Module:3	**Ecosystem and Biodiversity**	**5 hours**

Concept of ecosystem, Structure and functions of an ecosystem, Food chains, food webs. Energy flow in an ecosystem, ecological pyramids and ecological succession. Case studies: Bio magnification of DDT. Biodiversity-Bio-geographical classification of India, hotspots, values of
biodiversity. Threats to biodiversity - Case study. Conservation of bio-diversity. GM Crops

Module:4	**Environmental changes and Remediation**	**6 hours**

Air, water, soil, Thermal Pollution: Causes, effects and control measures; Nuclear hazard. Solid waste Management- Causes, Effects and control measures. Floods, earthquakes, cyclones,

tsunami and landslides, Case studies.		
Module:5	**Global Climatic Change and Mitigation**	**5 hours**
Global climate change and greenhouse effect – Kyoto Protocol, Carbon sequestration, Acid rain, Ozone depletion problem – Montreal Protocol.		
Module:6	**Social Issues and the Environment**	**6 hours**
Urban problems related to energy and sustainable development, Water conservation, Rain water harvesting, Wasteland Reclamation. Environment Protection Act - Prevention and control of Pollution of Air and Water. Wildlife protection and Forest Conservation Acts.		
Module:7	**Human Population and the Environment**	**7 hours**
Population growth, variation among nations, population explosion, Family Welfare Programme, Environment, Women and Child Welfare, Human rights, HIV/AIDS, Role of information Technology on environment and human health. Discussion on current environmental issues / topics by an Industrial expert or faculty		
Module:8	**Contemporary issues**	**2 hours**
Lecture by Industry Experts		
	Total Lecture hours:	**45 hours**
Lecture by Industry Experts		
Text Book(s)		
1.	Anubha Kaushik and C.P. Kaushik, Environmental Science and Engineering, 2016, 5th Edition, ISBN: 978-81-224-4013-3, New Age International.	
2.	G. Tyler Miller Jrand Scott E. Spoolman, Living in the Environment, 2012. 17th Edition, ISBN-13: 978-0-538-73534-6, Brooks / Cole.	
Reference Books		
1.	Environmental Science and Engineering by Anjali Bagad, 2014, 1st Edition, ISBN-10: 9350997088, Technical Publications.	
2.	Introduction to Environmental Engineering by Masters, 2015, 3rd Edition,	
3.	Basic Environmental Sciences For Undergraduates by Dr.Tanu Allen, Dr.Richa K. Tyagi Dr.Sohini Singh, 2014, 1st Edition, ISBN-10: 938375827, Vayu Education of India.	
Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & FAT		

Recommended by Board of Studies	28.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

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Skill Enhancement Courses

TCSE201E	Programming in Java	L	T	P	C
		3	0	2	4
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives

1. To apply the core Java fundamentals to learn the advanced concepts in J2SE.
2. To design and develop web application development and database connectivity using Servlets, JSP and JDBC.
3. To apply the advanced Java frameworks for the problems in Scientific Domain.

Course Outcomes

1. Provide a basic understanding of core Java concepts.
2. Comprehend Java's support in parallel programming, GUI creation and network programming.
3. Design and develop server side programming using Servlets.
4. Design and implement Java Applications for real world problems involving Database Connectivity.
5. Design, Develop and Deploy dynamic web applications using Servlets and Java Server Pages.

Module:1	**Java Basics:**	**4 hours**

History of Java, Java buzzwords, JVM architecture, Data types, Variables, Scope and life time of variables, arrays, operators, control statements, type conversion and casting, simple Java program.

Module:2	**Object Oriented Programming:**	**5 hours**

Class Fundamentals, Object & Object reference, Constructor & initialization code block, Modifiers, Nested Methods, Argument Passing Mechanism, Method Overloading, Recursion, Dealing with Static Members, Inheritance, Finalize() Method, Native Method. Use of "this "reference, Use of Modifiers with Classes & Methods.

Module:3	**Exception Handling:**	**5 hours**

The idea behind Exception, Exceptions & Errors ,Types of Exception, Control flow in Exceptions, JVM reaction to Exceptions ,Use of try, catch, finally, throw, throws in Exception Handling ,In-built and User Defined Exceptions, Checked and un-Checked Exceptions.

Module:4	**Array & String:**	**6 hours**

Defining an Array, Initializing & Accessing Array, Multi –Dimensional Array, Operation on String, Mutable & Immutable String, Using Collection Bases Loop for String, Tokenizing a String, Creating Strings using String Buffer.

Module:5	**Thread:**	**6 hours**

Understanding Threads , Needs of Multi-Threaded Programming ,Thread Life-Cycle, Thread Priorities ,Synchronizing Threads, Inter Communication of Threads ,Critical Factor in Thread –Deadlock

Module:6	**Files, Streams, Object serialization and JDBC**	**8 hours**

Java I/O streams Working with files Serialization and deserialization of objects Lambda expressions, Collection framework List, Map, Set Generics Annotations, accessing databases using JDBC connectivity.

Module:7	**Java Server Technologies: Servlet**	**9 hours**

Web Application Basics, Architecture and challenges of Web Application, Introduction to servlet, Servlet life cycle, Developing and Deploying Servlets, Exploring Deployment , Descriptor (web.xml), Handling Request and Response, JSP Tags and Expressions - JSP Expression Language (EL) - Using Custom Tag.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Herbert Schildt, The Complete Reference-Java, Tata Mcgraw-Hill Edition, Eighth Edition, 2014.
2.	Richard M. Reese, Jennifer L. Reese, Alexey Grigorev, Java: Data Science Made Easy, Pocket Publishing, 2017.
Reference Books	
1.	Nicholas S. Williams, Professional Java for Web Applications, Wrox Press, 2014.
2.	Ed Burns, Chris Schalk, Java Server Faces 2.0, The Complete Reference, McGraw-Hill Publishers, 2010.
3.	Christian Bauer, Gavin King, Gary Gregory, Java Persistence with Hibernate, 2015.
4.	Rajat Mehta, Big Data Analytics with Java, Pocket Publishing, 2017.

List of Experiments (Indicative)	
Basic Java Programs	2 hours
Inheritance and Polymorphism	3 hours
Multidimensional arrays and looping constructs.	2 hours
Exception handling, File handling, String handling	4 hours
String handling and Inheritance	4 hours
Multithreaded Programming	4 hours
Problems on Application development	3 hours
Program to register students' data using JDBC with MySQL Database.	2 hours
Creating and configuring servlets, HTTP methods	3 hours
Servlets and JSP	3 hours
Total Laboratory Hours	**30 hours**

Recommended by Board of Studies	12-07-2021		
Approved by Academic Council	No. 64	Date	16-12-2011

TCHY201P	Analytical Instrumentation	L	T	P	C
		0	0	4	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students to

1. learn on wet chemical analysis and handling of chemical apparatus
2. be able to handle instruments in developing methods for chemical analysis as well as characterize compounds and materials
3. be capable of designing robust protocol for analysis after coupling more instruments together

Course Outcome

At the end of the course the students will be able to

1. understand thoroughly the principles of spectroscopy including NMR and Raman, chromatography, elemental analysis, thermoanalytical and diffraction techniques
2. engineering and designing characterization techniques for new compounds and materials.

Indicative Experiments		**Duration**
1.	**UV-Vis Diffuse Reflectance Spectroscopy (UV-DRS**) and **Fluorescence Spectroscopy**: Theory, instrumentation, and scope; Hands-on training on instrument operation and analysis.	6 hours
2.	**Atomic Absorption Spectroscopy:** Theory, instrumentation, and scope; Hands-on training on instrument operation and analysis.	6 hours
3.	**Gas Chromatography:** Theory, instrumentation, and scope; Hands-on training on instrument operation and analysis..	6 hours
4.	**High Performance Thin Layer and Liquid Chromatography (HPTLC-HPLC):** Theory, instrumentation, and scope; Hands-on training on instrument operation and analysis.	6 hours
5.	**Thermal Analysis (DSC/TGA/DTA):** Theory, instrumentation, and scope; Hands-on training on instrument operation and analysis.	6 hours
6.	**CHN Elemental Analyser:** Theory, Instrumentation, and scope; Hands-on training on instrument operation and analysis.	6 hours
7.	**Nuclear Magnetic Resonance Spectroscopy:** Theory, instrumentation, and scope; Hands-on training on Instrument operation and analysis.	6 hours
8.	**GC-MS:** Theory, instrumentation, and scope; Hands-on training on Instrument operation and analysis.	6 hours
9.	**Raman Spectroscopy:** Theory, instrumentation, and scope; Hands-on training on instrument operation and analysis.	6 hours
10.	**X-ray Diffraction:** Theory, instrumentation, and scope; Hands-on training on instrument operation and analysis.	6 hours
	Total Laboratory Hours	60 hours

Mode of assessment : Quiz, Viva-voce

Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

Course Code	Course title	L	T	P	C
TCHY202P	Sophisticated Analytical Instrumentation	0	0	4	2
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. Impart training in operating instruments for the analysis of various chemical constituents.
2. Imparting knowledge in the theory and applications of various spectroscopic techniques as characterization techniques for different fields of science.

Course Outcome

1. Utility of analytical instrumentations for analysing industrial and environmental samples.
2. Apply the concept for data interpretation through analytical instruments.
3. Hands on experience in operating various analytical instrumentation techniques.

	EXPERIMENTS	
1.	Functional group identification of organic compounds using FT-IR spectroscopy.	4 hours
2.	Preparation and identification of chromophores using UV-visible spectrophotometry.	4 hours
3.	Quantification of quinine and riboflavin by spectrofluorimetry.	4 hours
4.	Separation of organic compounds by HPLC technique.	4 hours
5.	Identification of volatile organic compounds by GC-MS technique.	4 hours
6.	Synthesis and characterization of simple drug molecules by NMR spectroscopy.	4 hours
7.	Qualitative and quantitative analysis of inorganic mixture by Flame AAS.	4 hours
8.	Separation and structural characterization of an organic mixture by LC-MS technique.	4 hours
9.	Surface characterization of materials by FE-SEM and HR-TEM analyses.	4 hours
10.	Material characterization by p-XRD and surface area analysis by BET.	4 hours
	Total Laboratory Hours	**40 hours**

Textbook(s)

1. Principles of Instrumental Analysis, Douglas A. Skoog, F. James Holler, Stanley R. Crouch, 7th Edition, Cengage India, 2017.

Reference Books

1. Introduction to Spectroscopy, a Guide for Students of Organic Chemistry, Pavia, D. Lampman, G. and Kriz, G, 3rd Edition, Thomson Learning, Boston, 2001.
2. Vogel's qualitative inorganic analysis, J. Basset, R.C Denney, G.H Jefferey and J.Mendham, 5th Edition, Pearson Education India, 2008.

Mode of assessment: Continuous assessment / FAT / Oral examination and others

Recommended by Board of Studies	19-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

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Open Elective Courses

TCHY313L	Nanomaterials	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students to

1. understand basic concepts of nanomaterials and their characterisation techniques
2. acquire knowledge on the properties of nanomaterials and their synthetic techniques
3. familiarise with the application of nanomaterials and related hazards

Course Outcomes:

At the end of the course the students will be able to

1. recall the basic concepts of nanoscience and the terminologies used in nanoscience
2. compare the properties of nanomaterials with bulk materials
3. analyse preparation techniques for the production of significant nanomaterials
4. select an appropriate technique for characterisation of nanomaterials
5. recognise the application of nanomaterials in different fields and their associated problems

Module:1	**Introduction and Classification of Nanomaterials**	**6 hours**

Definition of a nanosystem – Classification based on origin, composition and dimension – comparison of nano and bulk materials – quantum dots, quantum wells, quantum rods and quantum wires - Nanosized metals, alloys, semiconductors and ceramics.

Module:2	**Properties of Nanomaterials**	**5 hours**

Surface to volume ratio – Quantum confinement in nanomaterials – size dependency on optical properties, catalytic properties, magnetic properties, thermal properties, electrical properties and the melting point of nanomaterials

Module:3	**Top-down approach in Nanomaterials preparation**	**6 hours**

General issues and concerns in nanomaterials synthesis. Top-down approach – Mechanical milling technique, laser ablation technique, sputtering technique, electro-explosion method (Advantages and Limitations).

Module:4	**Bottom-up approach in Nanomaterials preparation**	**7 hours**

Bottom-up approach – sol-gel synthesis method, Chemical vapour deposition (CVD), Co-precipitation, Chemical reduction, Solvothermal, Green synthesis (Advantages and Limitations). Top-down approach vs Bottom-up approach.

Module:5	**Metal and Semiconductor Nanomaterials**	**7 hours**

Synthesis, properties and uses – metal nanoparticles (Au and Ag nanoparticles), metal oxide nanoparticles (ZnO nanoparticles), metal chalcogenide (CdS and CdSe nanoparticles) and nano-porous materials (silica and zeolite nanoparticles).

Module:6	**Characterization of Nanomaterials**	**6 hours**

Fundamental concepts of spectroscopic and microscopic techniques – Principles and applications of Dynamic Light Scattering (DLS) technique, UV-Visible (UV-Vis) spectroscopy. Shape and size characterisation of nanomaterials – Overview of Powder X-ray diffraction (XRD), Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM).

Module:7	**Application of Nanomaterials**	**6 hours**

Application of nanomaterials in solar energy conversion and photo-catalysis. Nanoelectronics –Nano-polymers with a special architecture, nanomaterials for data storage and display devices. Chemical sensors and biosensors. Environmental application – Nanotoxicology challenges.

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)			
1.	"Introduction to Nanoscience", G.L. Hornyak, J. Dutta, H.F. Tibbals, A.K. Rao, CRC Press, ISBN: 978-1-4200-4805-6.		
2.	Pradeep T., A Textbook of Nanoscience and Nanotechnology, Tata McGraw Hill Education Pvt. Ltd., 2012.		
Reference Books			
1.	Hornyak, G. Louis, Tibbals, H. F., Dutta, Joydeep, (2009) "Fundamentals of Nanotechnology", CRC Press,		
2.	Barhoum, A., & Makhlouf, A. S. H. (2018). Emerging Applications of Nanoparticles and Architecture Nanostructures (pp. 255-278). Amsterdam, The Netherlands: Elsevier.		
3.	Binns, C. (2021). Introduction to nanoscience and nanotechnology. John Wiley & Sons.		
4.	Tahir, M. B., Sagir, M., & Asiri, A. M. (Eds.). (2021). Nanomaterials: synthesis, characterization, hazards and safety. Elsevier.		
5.	Rao, C.N.R., Müller, A. and Cheetham, A.K. (Eds.), (2005) "Chemistry of Nanomaterials", Wiley – VCH.		
Mode of Evaluation: CAT, written assignment, Quiz and FAT			
Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY314L	Dyes and Pigments	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at students to

1. empowering the students to have a fundamental understanding of dyes and pigments
2. offer routes for nurturing innovative concepts of the techniques adopted in textile industries
3. allow students with evolving ideas in chemistry to be beneficial in addressing social requirements
4. create individuals competent in basic applications of dyes and pigments.
5. offer prospects to create paths for self-reliant in terms of acquaintance and applied learning

Course Outcomes:

At the end of the course the students will be able to

1.summarise the concepts for usage of dyes and pigments
2. evaluate the principles of the application of dyes for different fibers
3. apply concepts for the improvement of color combinations
4. explore the important ideologies of dyeing methods and their applications
5. design new techniques of pigmentation to enhance the quality of fabrics

Module:1	**Introduction to dye chemistry**	**4 hours**

Definition of dyes, properties (color and fastness), important milestones in the development of synthetic dyes.Nomenclature of commercial dyes with at least one example. Suffixes – G, O, R, B, 6B, L, S - color index and color index number.

Module:2	**Classification of dyes**	**10 hours**

Based on the constitution (Examples with structures), Azo dyes - a)Mono-azo dyes –Orange; b)Bis-azo dyes – Congo Red; c)Tris-azo dyes – Direct Deep Black. Triphenylmethane dyes - a)Diamines–Malachite Green; b)Triamines –Crystal Violet; c)Phenols – Phenolphthalein.
Heterocyclic dyes – a) Xanthenes – Eosin; b) Azines – Safranine T; c) Thiazine – Methylene Blue.
Anthraquinone dyes- Alizarin, Alizarin Cyanine Green G, Indanthrone;
Phthalocyanines - Monastral Fast Blue.Based on the applications-Definition, fastness properties and applicability on substrates, examples with structures and uses.
Acid dyes – Orange II, Alizarin Cyanine Green G, Basic dyes – Crystal Violet, Bismark Brown.
Direct Cotton Dyes – Chrysophenine G. Azoic dyes – Diazo components: Fast Red B Base, Fast Blue B Base; Coupling components: Naphthol AS, Naphthol AS-G. Mordant dyes – Eriochrome Black T, Alizarin. Vat dyes – Indigo, Indanthrene. Disperse dyes–Celliton Scarlet B, Disperse Yellow 6G

Module:3	**Types of Dyes and Mechanism of actions**	**5 hours**

Azo Dyes- Principles governing azo coupling-mechanism of diazotization-Coupling with amines, coupling with phenols. Effect of chromophores and autochrome on the color intensity of dyes with few examples (Resorcinol, 2,4-diaminoanisole, *p*-amino-*o*-cresol, *p*-phenylene diamine, *m*-aminophenol). Relation of color to resonance in the following classes of dyes: Azo, Triphenylmethane, Anthraquinone.

Module:4	**Synthesis and Applications of Dyes**	**6 hours**

Synthesis and Applications of Dyes – I Synthesis, reactions, and applications of Di and Triphenyl methane dyes, acridine dyes, malachite green, para-Rosaniline, crystal violet.
Synthesis and Applications of Dyes – II Azine, Oxazine, and Triazine Dyes.

Module:5	**Dyeing of Fibres**	**6 hours**

Introduction to fibers, types of fibers with structures, and classes of dyes applicable to the

natural fibers like cotton, wool, and synthetic fibers like nylon, polyester, etc. Forces binding dyes to the fibers: Ionic forces, hydrogen bonds, Van der Waals forces, covalent linkages. Basic operations involved in a dyeing process: Preparation of fiber for dyeing, preparation of the dye bath, application of the dye, and finishing. Environmental impact on the toxicity of dyes: Toxicity of dyes and their ill effect on health and their solution.		
Module:6	**Pigments**	**7 hours**
Introduction and a basic idea of pigments, the difference between dyes and pigments, Classification of pigments- organic and inorganic pigments - Important characteristics of inorganic pigments, organic pigments, toners, and lakes. Classification of organic pigments with suitable examples, i.e., ionic pigments (lakes of acid and basic dyes), non-ionic pigments (azo, indigoids, anthraquinone), Application and uses of pigments.		
Module:7	**Plants and Industrial Pigments**	**5 hours**
Introduction: porphyrins, carotenoids, anthocyanins, and betalains. Chlorophyll - structure, extraction, and mechanism of absorbance of color in chlorophyll, anthocyanins, betalains and carotenoids. Application of pigments in paints, plastics, synthetic fibers, and ink industry.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
	1 Industrial Dyes – Chemistry, Properties, Applications, Hunger K. (Ed), Wiley-VCH, Weinheim, 2003 2 Color Chemistry, 3rd Edition, Heinrich Zollinger, Wiley – VCH 2003 3 The Chemistry of Synthetic Dyes – Vol III, Venkataraman, K., Academic Press, 1972
Reference Books	
1	Industrial Organic Pigments – Production, Properties, Applications, Herbst W. and Hunger K., VCH Verlag, Weinheim, 1997
2	Chemistry of Synthetic Dyes and Pigments, Lubs H. A., Robert E Krieger Publishing Company, New York, 1977
3	Metal Free Synthetic Dyes 2018 Elsevier Inc.
4	Handbook of textile and industrial dyeing Woodhead Publishing Limited, 2011
5	DYES AND PIGMENTS: NEW RESEARCH, ARNOLD R. LANG Nova Science Publishers, Inc. New York, 2009
6	Techniques of Dyeing and Printing. Hemlatha Jain Ane Publications, New Delhi, 2010
7	Synthetic Dyes Dr. G.R. Chatwal ISBN Number : 978-81-8488-219-3, Himalaya Publishing House Mumbai, 2016

Mode of Evaluation: CAT / written assignment / Quiz / FAT / Project / Seminar / group discussion / field work (include only those that are relevant to the course. Use ',' to separate the evaluations. Eg. CAT, Quiz and FAT			
Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

Course Code	Course Title	L	T	P	C
TCHY421L	Surface Analytical Techniques	3	0	0	3
Pre-requisite	TCHY207L,TCHY207P,TCHY303L,TCHY303P	Syllabus version			
		1.0			

Course Objectives

The course is aimed at:

1. Imparting knowledge concerning fundamentals of physical principles and measurement methods used for surface characterization.
2. Developing capacity to establish measurement methods and the ability to use the instruments.
3. Interpretation, discussion and conclusion devising from experimental data.
4. Scientific-technical knowledge and ability acquisition to solve specific problems associated with materials development and characterization.

Course Outcomes

At the end of the course, students should be able to

1. Apply different electron microscopic techniques for understanding the process involved in surface analysis.
2. Utilize the working principles of photoelectron spectroscopic techniques for evaluating the surface chemical composite and oxidation states.
3. Apply X-ray related techniques for phase composition and chemical analysis of various compounds.
4. Evaluate surface and structural features of materials using various electron microscopic techniques.
5. Evaluate the utility of various surface mass spectrometric techniques for analyzing various inorganic and organic compounds.
6. Apply the principles and working of various scattering techniques for surface analysis.
7. Apply the principles of laser related surface analysis techniques for various applications.

Module:1	Electron Spectroscopy	5 hours

Definition of material surface - Introduction to surface analysis. Classification of Electron Stimulated Microanalysis Methods. Auger Electron Spectroscopy (AES) – Auger Process – Principle, Instrumentation and Applications.

Module:2	Photoelectron Spectroscopy	7 hours

Introduction to photoelectron spectroscopy. Interaction of X-ray with Solids - Photoelectric Effect and Photoemission. X-ray Photoelectron Spectroscopy (XPS) – Principle, Instrumentation, Binding Energy, Chemical Shifts, Spectral Information, Depth Profiling, Imaging and Applications. Ultraviolent Photoelectron Spectroscopy (UPS) – Basic Principle and Spectral Information. Comparison between XPS and UPS - Merits and Demerits.

Module:3	X-Ray Methods of Analysis	7 hours

Theory of X-Ray spectral lines. X-Ray Diffraction (XRD) - Principles, Instrumentation and Applications of powder and single crystal XRD. X-Ray Absorption Spectroscopy (XAS) and X-Ray Fluorescence Spectroscopy (XRF) – Basic Principles, Instrumentation, Chemical Analysis and Applications. Energy-Dispersive X-Ray Spectroscopy (EDXS) – Principles, Qualitative Spectral Information and Imaging of Element Distribution.		
Module:4	**Electron Microscopy**	**7 hours**
Transmission Electron Microscope (TEM), Scanning Electron Microscope (SEM), Scanning Transmission Electron Microscope (STEM) – Working Principles, Instrumentation and Applications. Comparison among TEM, SEM and STEM. Atomic Force Microscopy (AFM) – Principles, and Mode of AFM Operation. Scanning Tunneling Microscopy (STM).		
Module:5	**Molecular Surface Mass Spectrometry**	**6 hours**
Introduction to Secondary Ion Mass Spectrometry (SIMS). Comparison between static and dynamic SIMS – Basic Concepts, Experimental Requirements, Secondary Ion Formation, Instrumentation and Applications.		
Module:6	**Scattering Techniques**	**7 hours**
Rutherford Backscattering Spectroscopy (RBS) – Introduction, Principles, Instrumentation, Spectral Information, Depth Resolution and Applications. Low-Energy Ion Scattering (LEIS) – Principles, Information, LEIS Information, Quantification and Applications. Surface-Enhanced Raman Scattering (SERS) – Introduction, Instrumentation and Applications.		
Module:7	**Laser related Techniques**	**4 hours**
Laser Ablation, Laser Secondary Neutral Mass Spectrometry (Laser-SNMS) and Laser Raman Spectroscopy – Basic Concepts and Applications.		
Module:8	**Industry Expert Lecture**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. An Introduction to Surface Analysis by XPS and AES. John F. Watts and John Wolstenholme, 2nd Edn., 2020, John Wiley & Sons Ltd., NY, USA.
2. Ewing's Analytical Instrumentation Handbook. Edited by Nelu Grinberg and Sonia Rodriguez, 4th Edn., 2019, CRC Press, Taylor & Francis Group, NY, USA.

Reference Books

1. Surface and Thin Film Analysis - A Compendium of Principles, Instrumentation, and Applications. Gernot Friedbacher and Henning Bubert, 2nd Edn., 2011, Wiley-VCH Verlag & Co. KGaA, Germany.
2. Surface Analysis – The Principal Techniques. Edited by John C. Vickerman, and Ian S. Gilmore, 2nd Edn., 2009, John Wiley & Sons Ltd., UK.
3. Surface Characterization Techniques: From Theory to Research. Ramesh Kumar, 2021, Walter De Gruyter GmbH & Co KG, Germany.

Mode of Evaluation: Written Examinations, Quiz and Assignments

Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY422L	Pharmaceutical Technology	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

The course is aimed at:

1. To explain the different techniques employed in the production of tablets and capsules.
2. To outline the different drug delivery systems.
3. To illustrate the various pharmaceutical packaging materials and their quality control.

Course Outcomes

At the end of the course, students should be able to

1. List the methods of tablet preparation and the types of tablet coating processes.
2. Classify the types of capsules, their quality control tests, and packaging.
3. Explain the different techniques of microencapsulation and the evaluation of microcapsules.
4. Describe the general manufacturing process of parenteral products and the relevant quality control tests.
5. Elucidate the different drug delivery systems and categorize the various Pharmaceutical packaging materials.

Module:1	Tableting Technology	8 hours

Introduction - types and classes of tablets – uniformity- particle size- solubility of drug substances - formulation of tablets – Modern techniques in granulation - methods of tablet preparation - operations involved in tablet manufacturing - tablet compression - auxiliary equipment – packaging - problems in tablet manufacturing - tablet coating - types of tablet coating processes - specialized coatings - tablet coating equipment - process parameters - problems and remedies for tablet coating - In Process Quality Control (IPQC) tests for tablets.

Module:2	Capsules Technology	6 hours

Introduction - hard gelatin capsules (HGC) - soft gelatin capsules (SGC) - quality control tests for capsules - special types of hard gelatin and soft gelatin capsules – packaging -capsules manufacturing techniques.

Module:3	Microencapsulation	5 hours

Introduction - core materials - coating materials – techniques (chemical and physical methods) of microencapsulation -evaluation of microcapsules- applications of microencapsulation.

Module:4	Parenteral Products	6 hours

Introduction - formulation requirements - general manufacturing process- tray drying – freeze -fluidized bed drying-quality control tests (sterility test, pyrogen test, bacterial endotoxin test, leakage test and particulate matter testing) for parenteral products – packaging.

Module:5	Novel Drug Delivery Systems	6 hours

Oral controlled release drug delivery systems - parenteral controlled drug delivery systems -targeted drug delivery systems – nanoparticles - transdermal drug delivery systems – wound healing systems.

Module:6	**Packaging Techniques**	**6 hours**
Introduction - pharmaceutical packaging materials- packaging and stability of products - containers for pharmaceutical use - qualification and quality control of packaging components – packaging machinery.		
Module:7	**Packaging Technology**	**6 hours**
Introduction - BFS Technology - Anti-Counterfeit Packaging Technologies – Quality Analysis - Packaging designs		
Module:8	Industry Expert Lecture	**2 hours**
	Contemporary Issues	
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Kushwaha P., Handbook of Pharmaceutical Technology, 2015, 1st ed., Jaypee BrothersMedical Publishers Private Limited, India.
2. Prager G, Practical Pharmaceutical Engineering, 2019, Ist ed., John Wiley and Sons,Inc., USA.

Reference Books

1. Bharath S., Pharmaceutical Technology: Concepts and Applications, 2013, 1st ed.,Pearson Education India, India.
2. Agarwal G., Kaushik A., Pharmaceutical Technology, Volume I, 2017, 1st ed., CBS Publishers & Distributors, India.
3. Murthy R.S.R., Kar A., Pharmaceutical Technology, Volume II, 2017, 2nd ed., New AgeInternational Private Limited, India.

Mode of Evaluation: Written Examinations, Quiz and Assignments			
Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY423L	Drug Design	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

The course is aimed at:

1. Imparting knowledge on the principles and applications of various levels of drug design and development
2. Understanding and performing computational skill for understanding the mechanism, interaction forces in drug actions, quantitative measurement of biological responses.

Course Outcomes

At the end of the course, the student should be able to

1. Demonstrate the steps involved in the drug discovery and design process.
2. Choose the ideal target in drug design.
3. Predict the functional groups involved in drug action and modifications required for a better biological response.
4. Differentiate the pharmacophore and perform conformational searching.
5. Understand the importance of Computers in Medicinal chemistry and Drug Design.
6. Evaluate and formulate QSAR Models.

Module:1	Fundamentals of Drug Design	7 hours

Introduction- drugs, agonist, antagonist, inhibitors-different types, lead molecule, lead discovery, random and non-random screening, drug metabolism studies, clinical observations, drug targeting without lead, natural products as lead molecules, existing drugs as lead. Drug-Likeness and other compound filter mechanism.

Module:2	Targets in Drug Action	7 hours

Targets in drug design: various targets in drug action, Enzymes as drug targets, membrane drug targets, RNA, DNA, Miscellaneous drug targets, evaluating a structure for structure-based drug design.

Module:3	Optimizing target interactions	8 hours

Structure-Activity Relationship, Drug optimization: Strategies, optimizing access to the target, Optimizing hydrophilic / hydrophobic properties. Methods to drugs more resistant to chemical and enzymatic degradation. Isosteres and Bioisosters.

Module:4	Pharmacophore and its Mapping	5 hours

Pharmacophore, 2D and 3D pharmacophore, Data base searching, conformational search, random conformational search, methods to derive pharmacophore, Pharmacophore Mapping.

Module:5	Computers in medicinal chemistry	7 hours

Molecular and Quantum Mechanics, Drawing Chemical structures, 3D structures, Energy minimizations, Molecular properties, conformational analysis, identification of active conformation and 3D pharmacophore.

Module:6	Molecular interaction	6 hours

Concept of Virtual screening, Structure-Based Virtual Screening (in silico), Protein Ligand Docking, Scoring Functions for Protein Ligand Docking, Practical Aspects of Structure-Based Virtual Screening.

Module:7	Quantitative Structure Activity Relationship (QSAR)	5 hours

Graphs and Equations, Physicochemical Properties: Hydrophobicity, Electronic effects, Steric features, Hansch Equation, Craig Plot, Topliss Scheme, Free Wilson Approach. Introduction to 3 D QSAR.			
Module:8	Industry Expert Lecture		
	Total Lecture hours:		**45 hours**
Text Book(s)			
1) An Introduction to medicinal chemistry, Graham P Patrick, Seventh Edition, Oxford university press, 2023. 2) Richard B Silverman, The organic chemistry of drug design and drug action:, third edition, Elsevier publishers, 2014. 3) Hugo Kubinyi, QSAR: Hansch Analysis and Related Approaches, , Vol.1, VCH Publishers, 2006.			
Reference Books			
1) Kenneth M. Merz, Jr, Dagmar Ringe, Charles H. Reynolds, Drug Design: Structure- and Ligand- Based Approaches, Cambridge University Press, 2010. 2) Tommy Liljefors, Povl Krogsgaard-Larsen, Ulf Madsen, Textbook of Drug Design and Discovery, Third Edition, CRC Press, 2006. 3) Tomasz Puzyn, Jerzy Leszczynski, Mark T. Cronin, Recent Advances in QSAR Studies: Methods and Applications, Springer, 2010. 4) Donald J. Abraham, David P. Rotella, Alfred Burger, Burger's Medicinal Chemistry, Drug Discovery and Development Academic press, 2010.			
Mode of Evaluation: Written Examinations, Quiz and Assignments			
Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY424L	Biophysics	3	0	0	3
Pre-requisite	TCHY207L, TCHY207P	Syllabus version			
		1.0			

Course Objectives

The course is aimed at:

1. Analyze physics concepts applied in biology
2. Deduce importance of molecular machines, membrane logistics, and macromolecular transition
3. Apply various biophysical techniques and their applications

Course Outcomes

At the end of the course, students should be able to

1. Recall the molecular forces and their interactions and various physical laws
2. Identify the various types of kinetics and models involved in cell dynamics
3. Apply the principles and applications of various biophysical methods/techniques
4. Recognize macromolecular transition
5. Evaluate the function of molecular machines.
6. Determine the applied aspects of biophysics through membrane logistics, and networks

Module:1	**Chemical and Physical setup of the cell**	**6 hours**
Intra and inter molecular forces, chemical bonds, bond length, bond angle, dipole moment, electrostatic interactions and Hydrogen bonding interactions, small molecules and macromolecules.		
Module:2	**Mathematical Biophysics**	**6 hours**
Boltzman Distribution, Ficks law, Grahams law, Gibbs free energy, Reynolds number, Fokker– Planck equation, Gibbs–Donnan effect, Nernst equation.		
Module:3	**Cell functioning models**	**6 hours**
Michaelis-Menten kinetics, Goldbeter-Koshland kinetics, Hodgkin–Huxley model, Vector field models, Bifurcation theory, Deterministic and Stochastic models.		
Module:4	**Methods in Structural Biology**	**6 hours**
Mass Spectrometer, NMR, Circular dichroism, XRD, FTIR, SEM and TEM.		
Module:5	**Macromolecular transition**	**6 hours**
Polymer elasticity and stretching, Effects of physical factors on Polymers, Allostery.		
Module:6	**Molecular machines and enzymes**	**6 hours**
Enzyme saturation kinetics, Catalytic transition, Energy landscape, Cytoskeletal-rotary polymerization -rotary motors.		
Module:7	**Membrane logistics and Bioelectrical networks**	**7 hours**
Osmotic effects, Membrane potential, Ion pumping, Chemiosmotic mechanism in mitochondria. Action potential, Ohmic conductance, Voltage gating, Neuromuscular junction.		
Module:8	Industry Expert Lecture	**2 hours**
	Guest Lecture by Industrial Expert	
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Nelson P. Biological Physics with New Art. First edition, MacMillan Higher Education, 2013.

Reference Books

1. Buxbaum E. Biophysical Chemistry of Proteins: An Introduction to Laboratory Methods, Springer (2011).			
Mode of Evaluation: Written Examinations, Quiz and Assignments			
Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY425L	Organic Electronics and Sensors	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

The course is aimed at:

1. Understanding the significance and principles of organic chemistry in the field of electrical and computer science
2. Enriching and appreciating the usage of organic chemistry in the field of development of OLEDs, organic battery materials, liquid crystals and chemical sensors

Course Outcomes

At the end of the course, students should be able to

1. Appreciate the fundamentals of electronic and optoelectronic concepts.
2. Apply the knowledge of silicon and semiconductor oxides for solar energy conversions.
3. Acquire knowledge on organic electronics and its applications.
4. Apply organic electronics in the fabrication and applications of OLEDs, organic batteries, in industrial and medical aspects.
5. Analyze various direct and indirect output sensors and apply it in the production of sensors.
6. Demonstrate the chemistry of liquid crystals and its applications.

Module:1	Electronic and Optoelectronic materials	7 hours

Capacitance and Dielectrics, Current, Resistance and Electromotive Force, Conductors and Semiconductors, and Insulators-Introduction-Band theory. Electronic Structures and Charge Carrier Generation in Organic Optoelectronic Materials -Charge Transport in Conducting Polymers Small Organic Molecules for Electronics and Opto-Electronics.

Module:2	Silicon, Semiconductor oxides and its Applications	7 hours

Principles of solar energy conversions –Types of solar cells- Silicon - Manufacture, extraction, purification and applications – Photoelectrochemistry, photoelectrochemical cells- photovoltaic cells, principles, semi-conductor electrodes - TiO_2, $SrTiO_3$, CdS, CdSe, photo-sensitizers and dye sensitizer.

Module:3	Organic Electronics- semiconductors	8 hours

Conjugated organic molecules, polymers, oligomers, dendrimers-OLED: structure, light emissions-basic principles-. Host and fluorescent and phosphorescent dopant (guest) materials; comparison of fluorescent and phosphorescent - polymers, possessing semiconductor properties - n-type and p-type polymer semiconductors, and their optoelectronic devices, organic light-emitting diodes (OLEDs), organic field-effect transistors (OFETs), organic electrochemical transistors (OECTs), organic thermoelectrics (OTEs), organic photovoltaics (OPVs).

Module:4	Fabrication of Semiconductors and OLEDs	6 hours

Advantages of organic semiconductors over traditional inorganic semiconductors, - solution processability, inherent flexibility integration of organic semiconductors into large-scale, flexible and wearable electronics and thermoelectric generators. OLEDs- Fabrication methods: Vacuum deposition, spin coating- Display Characteristics-OLEDs Vs LCD- Applications- Advantages and Disadvantages.

Module:5	**Organic Battery materials**	**6 hours**
Development of organic materials for energy and healthcare applications. Next-generation batteries - environmentally friendly and safer battery technologies - electrochemical energy storage devices including organic batteries - by using new IL-based electrolytes, redox flow batteries and polymer batteries-polymer electrolytes and polymer active materials for advanced post-lithium batteries.		
Module:6	**Chemical Sensors for organic molecules**	**5 hours**
Introduction and Principles- Types- direct and indirect output sensors, electrical sensors, metal oxide sensors (Sn, Zn, Fe, Zr, Ti, W)- Construction and Operation- Ethanol/CO sensors- Zr/Ca oxide solid electrolyte- operation and use- active and passive photometric sensors, pH sensors, membrane sensors, thermo-chemical sensors and biochemical sensors.		
Module:7	**Liquid crystals**	**6 hours**
Introduction- Liquid crystals-isotropy, anisotropy-Mesomorphic states: thermo tropic and lyotropic-Vapour phase-temperature diagram of true liquids and liquid crystals-Classification: Nematic, chiral nematic, smectic, cholesteric, columnar phase, polymer liquid crystals- Molecular arrangements in liquid crystals. Application of liquid crystals.		
Module:8	Industry Expert Lecture	
	Total Lecture hours:	**45 hours**
Textbook(s)		
1. Organic Electronics: Foundations to Applications Stephen R Forrest Oxford University press 2023.		
Reference Books		
1. Puri, Sharma & Pathania, Principles of Physical Chemistry, 47th edition- 2020, Vishal publishing Company. 2. De Gonnes, P.G., Prost, J. The physics of liquid Crystals, 2nd edition, Oxford Press, New York-1995. 3. Webster Howard- "Better Displays with Organic Films: Organic Displays Coming to Market", Scientific American, Feb. 2004, vol 290, issue 2. 4. M.A. Baldo *et al*., "Highly efficient phosphorescent emission from organic electroluminescent devices", Nature 395, 151-154, 1998. 5. Electroactive Polymer Electro chemistry, methods and applications, Ed. Michael E.G. Lyons, Springer-Verlag New York Inc, reprinted 2013.		
Mode of Evaluation: Written Examinations, Quiz and Assignments		
Recommended by Board of Studies	20-01-2024	
Approved by Academic Council	No. 73	Date 14-03-2024

Course Code	Course Title	L	T	P	C
TCHY426L	Phytochemistry	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

The course is aimed at:

1. To develop a thorough knowledge of natural products with its properties, biological functions and medicinal applications.
2. To develop knowledge on alkaloids, terpenoids, flavonoids and their sources.
3. To explain concepts related to methods of isolation and separation of bioactive compounds.
4. To become familiar with pharmacological action, chemistry and applications of glycosides, purines, steroids.
5. To provide in-depth knowledge of vitamin chemistry and its uses.

Course Outcomes

At the end of the course, students should be able

1. To identify the various sources of natural drugs.
2. To understand the isolation methods, chemistry, structure elucidation and applications of alkaloids, terpenoids, flavonoids, glycosides, purines, steroids, Marine natural products.
3. To apply the modern analytical techniques for lead molecule discovery.
4. To evaluate the bioactive compounds and study for various pharmacological activities.
5. To Design and synthesize new drugs from natural entities.

Module:1	Pharmacognosy	6 hours

Pharmacognosy: Introduction, Classification, Scope in herbal drug industry, Sources of Bioactive compounds: Plants, minerals, animals etc. standardization of herbal drugs: WHO guidelines Methods of drug evaluation: Determination of Foreign moisture, LOD, Ash Value, Extractable Value, Determination of Swelling index, Foaming Index and their significance.

Module:2	General Isolation Techniques	6 hours

General methods of extraction: Maceration, Percolation, Immersion and Soxhlet. Advanced techniques: counter current, steam distillation, supercritical gases, sonication, microwave assisted extraction and adsorption techniques.

Module:3	Alkaloids and Terpenoids	8 hours

Alkaloids: Classification, chemistry of Alkaloids, General methods of structural elucidation, (structure, nomenclature, identification tests, properties and applications) - Ephedrine, Morphine, Papaverine, Quinine, Atropine.

Terpenoids: Introduction, classification, chemistry, and uses of Citral, Menthol, pentacyclic triterpenoids – betulinic acid, ursolic acid, lupeol, amyrins.

Module:4	Glycosides & Purines	7 hours

Glycosides: Basic ring system, chemistry (structure, nomenclature, identification tests, properties and applications) and pharmacological activity of Cardiac glycosides - Digoxin, Sarasapogenin, saponin, Hecogenin.

Purines: Chemistry - structure, nomenclature, identification tests, properties and medicinal uses of Caffeine.

Module:5	Steroids	7 hours

Introduction to steroids, nomenclature, stereochemistry of steroids: Chemistry and

applications of cholesterol, Ergosterol, Lanosterol.		
Module:6	**Plant Pigments**	**6 hours**
Occurrence, nomenclature, and general methods of structural determination, isolation and synthesis of quercetin, cyanidin, Hirsutidin.		
Module:7	**Marine Natural Products**	**5 hours**
Introduction, Importance of Marine bioactive compounds, general Methods of Isolation and purification, Marine biomedicals under the class of Cardiovascular, Anticancer, Antimicrobial, Anti-inflammatory and Antibiotic drugs.		
Module:8	Industry Expert Lecture	
	Total Lecture hours:	**45 hours**
Text Book(s)		
1. Gurdeep Chatwal (2007), Organic chemistry of Natural products, Volume I&II, Himalaya publishing House. 2. S.V.Bhat, B.A. Nagasampagi (2005), Chemistry of Nat. Prod, Narosa Publishers.		
Reference Books		
1. I.L. Finar (2005), Organic Chemistry, Volume II, Stereochemistry and chemistry of natural products, 5th edition. Pearson Education Publishers. 2. J. B. Harborne (2005), Phytochemical methods, 3rd edition Indian reprint, Springer. 3. N.Raman (2006), Phytochemical techniques 1st Edition, New India publishing agency, New Delhi.		
Mode of Evaluation: Quizzes, CAT, Assignments, Group Discussions and Term End Exams.		
Recommended by Board of Studies	20-01-2024	
Approved by Academic Council	No. 73	Date 14-03-2024

Course Code	Course Title	L	T	P	C
TCHY427L	Bioinformatics	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. To introduce students to bioinformatics concepts and tools.
2. To illustrate the application of bioinformatics in chemistry, biochemistry, biology, and computer science.
3. To give students both a theoretical background and a working knowledge of the techniques employed in bioinformatics.

Course Outcomes

At the end of the course, students should be able to

1. Explore various tools and databases used in biological data analysis
2. Understanding and working with different biological file formats retrieval of biological data
3. Create alignment of sequences using pairwise and multiple sequence methods
4. Relate biological interpretation of analysis results
5. Analyze the diverse biological data types, including DNA, RNA, and proteins
6. Analyze the big data in bioinformatics in the R environment
7. Apply machine learning techniques to solve biological problems

Module:1	Introduction to Bioinformatics	7 hours

Basic concepts in Bioinformatics, Application of Bioinformatics, Basic biomolecular concepts: Protein and amino acid, DNA & RNA, Sequence, structure and function. Forms of biological information, Types of Nucleotide Sequence: Genomic DNA, Complementary DNA (cDNA), Recombinant DNA (rDNA), Expressed sequence tags (ESTs), Genomic survey sequences (GSSs). DNA sequencing methods: Basic and Automated DNA sequencing, DNA sequencing by capillary array and electrophoresis, Gene expression data.

Module:2	Bioinformatics Resources	6 hours

The knowledge of databases and bioinformatics tools available, Biological databases- Primary and secondary, EMBL, GenBank, NCBI, EBI, ExPASy, RCSB, DDBJ. organization of databases: data contents, purpose and utility. Open access bibliographic resources and literature databases: PubMed, BioMed Central, Public Library of Sciences (PloS), CiteXplore.

Module:3	Sequence Alignments and Visualization	7 hours

Introduction to Sequences, Basic concepts of sequence similarity, identity and homology; Alignments and Dynamic Programming, Local alignment and Global alignment (algorithm and example), Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm). Methods for presenting large quantities of biological data: sequence viewers (Artemis, SeqVISTA), 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol), and Anatomical visualization.

Module:4	Structure and derived databases	7 hours

Structure Databases: PDB, NDB, PubChem, ChemBank, FSSP, DSSP; Derived Databases: InterPro, Prosite, Pfam, ProDom; Metabolic pathway database (KEGG pathway database), Concept of metabolome and metabolomics. Data generation; Generation of large-scale molecular biology data. (Through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-ray diffraction, and

microarray).		
Module:5	**Bioinformatics Database search engines**	**6 hours**
Bioinformatics Database search engines – Text-based search engines (Entrez, DBGET / LinkDB). Sequence similarity-based search engines (BLAST and FASTA). Motif-based search engines (ScanProsite and eMOTIF). Structure similarity-based search engines (Combinatorial Extension, VAST, and DALI). Proteomics tools:- ExPASy server, EMBOSS. Metabolomics tools.		
Module:6	**Big Data Analytics in Bioinformatics**	**5 hours**
Introduction to Big Data: Characteristics, data structures, and data repositories; exploratory analysis of big data in R environment, Bioconductor, Microarray, and next-generation sequencing (NGS) data analysis in R environment.		
Module:7	**Machine learning in bioinformatics**	**5 hours**
Basics of machine learning, machine learning methods and their applications to problems in bioinformatics, Classification (supervised learning): partitioning data into training and test sets; feature selection; logistic regression; support vector machines; artificial neural networks; decision trees; nearest neighbors, cross-validation. Exploratory data analysis (unsupervised learning): dimensionality reduction, anomaly detection, clustering.		
Module:8	**Contemporary issues**	**2 hours**
	Industry Expert Lecture	
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools, Supratim Choudhuri, 2014, Academic Press.

Reference Books

1. Big Data Analytics in Bioinformatics and Healthcare, Baoying Wang, Ruowang Li, William Perrizo, 2019.
2. Bioinformatics: The Machine Learning Approach, Second Edition, By Pierre Baldi and Søren Brunak, 2001, The MIT Press.

Mode of Evaluation: Written Examinations, Quiz and Assignments			
Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY428L	Bioanalytical and Forensic Analysis	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

The course is aimed at

1. Understanding the principles of antigen-antibody interactions, immunoanalytical techniques, Immunodiffusion and immunofluorescent assays.
2. Getting insight into forensic toxicology and biochemical, physical and chemical methods of forensic analysis.

Course Outcomes

At the end of the course, the student should be able to

1. Demonstrate Knowledge of Antigen-Antibody interactions and Apply them in biological analysis.
2. Analyze samples using immunodiffusion, electrophoresis and ELISA techniques in biochemical analysis.
3. Demonstrate Knowledge about fundamental aspects of forensic toxicology.
4. Analyze narcotics, stimulants, depressants, hallucinogens, alcohol, metabolites in blood and other matrices
5. Analyze the biological samples including blood, Semen, DNA and finger prints
6. Apply destructive and non-destructive physical and chemical methods of analysis of forensic samples
7. Identify the forgery documents and analyses them.

Module:1	Introduction to Immunology	7 hours

Introduction, antigens, antibodies, structure and characteristics of antibodies, polyclonal and monoclonal antibodies. Concepts and applications of Antigen-Antibody Interactions, strength and characteristics of Antigen - Antibody interaction; Zone of equivalence and its significance in analysis. Cross-Reactivity.

Module:2	Immuno analytical techniques	7 hours

Immunodiffusion: The principle of single and double immunodiffusion. Electrophoresis - Gel, SDS-PAGE, Immuno and Capillary. Principles of Enzyme-linked immunoassays Types - Direct, Indirect, Sandwich and Competitive ELISA Techniques - Use of Chemiluminescence in ELISA. Elementary ideas of Fluorescence immunoassays.

Module:3	Forensic analysis	7 hours

Introduction to forensic science. Theory of forensic analysis: Comparative analysis, Classification of poisons based on physical states; Study of common poison; Mode of action, chemical properties. Methods of administration and their action in the body. Collection and preservation of drug evidence, Qualitative and quantitative analyses by colour tests, microcrystalline tests.

Module:4	Forensic Chemistry and Toxicology	6 hours

Scope and significance Narcotic Drugs and Psychotropic Substances (NDPS) drugs in forensic science. Classification and characterization of NDPS drugs, Preliminary analysis of drugs - Barbiturates, Alcohol, Hallucinogens and club drugs, reporting of drug cases.

Module:5	Biological Sample analysis	6 hours

Analysis of biological samples (Qualitative and Quantitative): Blood, Semen, Urine

and Saliva. Blood spatter analysis, DNA, Hairs and Fiber analyses. Fingerprint analysis; Isolation and sample preparation.		
Module:6	**Physical and chemical methods**	**6 hours**
Forensic Analysis of explosives: Introduction, types and analysis of explosives. Analysis of gunshot residues, modern methods of analysis of GSR from the shooting hand and target with special reference to clothing. Arsons.		
Module:7	**Questioned document**	**6 hours**
Definition and types of questioned documents. Instruments used to prepare documents, ink and their types, physical and chemical examination, papers and their types, manufacturing and examination of paper. Principle of Handwriting Identification.		
Module:8	Industry Expert Lecture	
	Total Lecture hours:	**45 hours**
Text Book(s)		
1. Introduction to forensic science and criminalistics, Howard Harris, Henry C Lee, Publisher: CRC Publishers, 2019, Second edition, ISBN-13: 978-1498757966. 2. Immunology: An Introductory Textbook, Anil K Sharma, Publisher: Pan Stanford Publishing Ltd, 2019, ISBN- 978-981- 4774-51-2.		
Reference Books		
1. Forensic Chemistry by A Lucas, Publisher: Forgotten Books (5 May 2017), ISBN-13: 978-1330672037. 2.Forensic Chemistry (Advanced Forensic Science Series) by Max M. Houck, Publisher: Academic Press (12 January 2015), ISBN-13: 978-0128006061. 3. Criminalistics: An Introduction to Forensic Sciences, Richard Saferstein, Publisher: Pearson Education, 2015, ISBN: 13:978-0-13-345882-4. 4.Kuby Immunology by Judith A. Owen, Jenni Punt , Sharon A. Stranford , Patricia P. Jones, Publisher: W H Freeman & Co (Sd); 7 edition (25 January 2013), ISBN-13: 978-1429219198.		
Mode of Evaluation: Written Examinations, Quiz and Assignments		
Recommended by Board of Studies	20-01-2024	
Approved by Academic Council	No. 73	Date 14-03-2024

Course Code	Course Title	L	T	P	C
TCHY429L	Intellectual Property Rights	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Outcomes

1. To understand the fundamental legal principles and importance relating to trademarks
2. To describe the need of copy right acts and its importance
3. To explain the legal and practical steps needed to ensure the intellectual property rightsremain valid and enforceable
4. To analyze current and emerging issues relating to the intellectual property protection,including those relating to indigenous knowledge or culture, information technology especially in pharmaceutical industry
5. To give examples of patent issues related to neem, turmeric and basmati.
6. To do critical analysis relating to the development and reform of intellectual propertyright institutions and their likely impact on creativity and innovation

Module:1	Looking Back: TRIPs Ahead	5 hours
The evolutionary past, Unfolding future, Technology, Intellectual Assets and value realization, the knowledge canopy, Balancing act International Technology Trade.		
Module:2	**Trade Marks**	**6 hours**
Trade Marks and copy Rights; Essentials of Trade mark-Reasons for illegal protection- Procedure for registration, Infringement of Registered Trademarks, Assignments of Trade marks.		
Module:3	**Copyrights**	**5 hours**
Introduction, Characteristics- Items covered under copyright – Rights, copyright owner-Infringement- Remedies for infringement, CDA and TTA, IP Laws.		
Module:4	**IPR Tool Kit**	**6 hours**
IPR Tool and Terminology, International and regional Agreement/ Treaties in IPR, The Current Global IPR Snapshot, Global patent ownership, The patenting process.		
Module:5	**Patents**	**6 hours**
Inventory Homework prior to Discussion with patent Attorney, Patenting systems, Issues relating to turmeric, basmati, Neem –Inventions not patentable –Rights of patentee- current developmentsInfringement of patents. Article related to IPR.		
Module:6	**Traditional Knowledge and patents in pharmaceutical Industry**	**6 hours**
Bio-piracy, Intellectual property protection of living species, Traditional knowledge and prior Art, Nurturing role of patents in pharmaceutical Industry –Recent changes in IPR Laws, impacting pharmaceutical industry, chemical industry.		

Module:7	**Challenges Ahead**	**9 hours**
Knowledge assets –A case study Intellectual cooperation in the pharmaceutical industry / Chemical industry, Recent Milestone payments in Drug industry, Litigation in the pharmaceutical sector, case study, Essential of a trade secret Controlling overuse of IPR, Exhaustion principle, parallel import- Challenges ahead, Emerging IPR Management imperatives, Implementing GRIPS.		
Module:8	Contemporary Issues	**2 hours**
Industry Expert Lectures		
	Total Lecture hours:	**45 hours**

Text Book(s)

1	Prabuddha Ganguli- Intellectual Property Rights, Unleashing the knowledge economy, Tata McGraw-Hill, 2003.
2	Srinivasalu - Intellectual Property Rights, Regal publication: 2001.

Reference Books

1	A.K.Ahuja Law related Intellectual Property Rights Lexis Nexis 3rd Edition 2017.
2	K.C.Kailasam and Ramu Vedaraman Law of Trademarks-Including International Registration under Madrid protocol and Geographical Indication, Lexis Nexis 4th Edition 2017.
3	Fink carsten and meskus keithe, Intellectual Property and development lesson from recent economic research Washington D.C 2005.
4	Richard stim; Intellectual property Rights; Trade mark and patent Canada Delmar cengag learning 2001.
5	V.K.Ahuja Intellectual Property Rights in India Lexis Nexis 2nd edition,2015.

Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course title	L	T	P	C
TCHY430L	Inorganic Materials of Industrial Importance	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. To enable students to have a fundamental understanding of different materials.
2. To correlate and integrate understanding ability with industrial usage of materials.
3. To provide overall information on the processes, practices and significance of materials in industries.

Course Outcome

At the end of the course, the student will be able to

1. Get awareness on application of hydrogen and its compounds in industry.
2. Gain knowledge on application of carbon and silicon containing materials.
3. Understand the importance of fertilizers and pigments.
4. Learn about metals and metal compounds.
5. Comprehend the importance of alloys.

Module:1	Inorganic materials in industry	6 hours

Introduction; primary inorganic materials, bulk and commodities chemicals, fine and specialty chemicals, and inorganic peroxido compounds

Module:2	Carbon based materials	6 hours

Carbon modifications, diamond, graphite, carbonization and graphitization; Glassy and foamed carbon; carbon black.Fillers - synthetic and natural, applications; Metallic hard materials.

Module:3	Silicon compounds	7 hours

Industry important organo-silicon compounds, industrial silicone products. Inorganic solid, zeolites and catalysts, inorganic fibers; Construction materials; Enamel and ceramics.

Module:4	Pigments	5 hours

Inorganic pigments; TiO_2, lithopone, ZnS, ZnO and Fe_2O_3; Corrosion protection pigments; Luminescent and magnetic pigments.

Module:5	Mineral fertilizers	5 hours

Nitrogen fertilizers, ammonium nitrate and urea; Phosphorous containing fertilizers, Potassium containing fertilizers; Economic importance of fertilizers.

Module:6	Metals and metal compounds	7 hours

Metallic lithium and its compounds; Metallic sodium, sodium borates; Potassium and its compounds, KOH and K_2CO_3. Alkaline earth metals and its compounds; Beryllium and magnesium; Calcium, strontium and barium; Manganese, manganese compounds and their applications.

Module:7	Alloys	7 hours

Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels.

Module:8	Lectures by industry experts	2 hours

Every student should undergo an industry expert lecture program to understand the preparation and applications of industrial useful materials in order to promote

innovation.				
	Total Lecture hours:			**45 hours**
Text Book(s)				
1.	Industrial Inorganic Chemistry by K H Buechel, H -H Moretto, P Woditsch; Wiley-VCH 2nd Ed.2. Inorganic Chemistry: An Industrial and Environmental Perspective by T W Swaddle, AP 1997.			
2.	Industrial Chemistry, Vol 1, E. Stocchi, Ellis Horwood Ltd, 1990.			
Reference Books				
1.	J.A.Kent, Riegel's Handbook of Industrial Chemistry, 9th ed, CBS publishers, 1997.			
2.	Katyal Mohan, P. L. Soni, "Textbook of Inorganic Chemistry", Sultan Chand & Sons, (2017).			
3.	Prakash G. More, Comprehensive Industrial Chemistry. Pragati Prakashan, (2018), Meerut.			
4.	B. R. Puri, L. R. Sharma and K. C. Kalia, "Principles of Inorganic Chemistry", Vallabh Publications, (2016).			
Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & FAT				
Recommended by Board of Studies		20-01-2024		
Approved by Academic Council		No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY431L	Bioorganic Chemistry	3	0	0	3
Pre-requisite	TCHY203L	Syllabus version			
		1.0			

Course Objectives

The course is aimed at:

1. Understanding the concepts of synthesis and structure of nucleic acids, protein and enzymes and their functions
2. Familiarizing basic concepts of bioorganic chemistry and biochemical models and their applications in organic synthesis and industry applications.

Course Outcomes

At the end of the course, students should be able to

1. Explain the electronic effects and concepts related to the classification of enzymes and bio-synthetic approaches and mechanisms.
2. Apply their understanding about role of biocatalysts in organic synthesis.
3. Analyze the properties of various biocatalysis reactions and the product distributions.
4. Evaluate the properties and comparison of different types of biocatalysts with respect to their usefulness in organic transformation reactions.
5. Design new organic transformation reactions using bio-synthetic approaches.

Module: 1	Electronic effects and Prosetereo isomerism in Organic Chemistry	10 hours

Inductive effect, Resonance effect, Hyper conjugative effects, Field effects, hydrogen bonding, steric inhibition of resonance - Electromeric effect- London forces- application of these effects to simple molecules- alcohols, amines, carboxylic acids and ketones.

Homotopic and Heterotopic ligands and faces: Nomenclature of stereo heterotopic ligands and faces. Biological stereospecificity- Manifestation of biological stereoselectivity in Krebs cycle- Biological stereo selectivity by enzyme dehydrogenase and glycerol kinase.

Module:2	Introductory stereochemistry to Bio-organic Chemistry	5 hours

Chirality - prochiral- R, S notation for simple chiral molecules (up to six carbon atoms)-Stereo electronic requirements for the reactions-Stereo selectivity and stereo specificity-Asymmetric induction: Definition- Cram's Rule (four models)-Prelog's rule.

Module:3	Basic concepts in Bioorganic Chemistry	4 hours

Basic considerations, proximity effects in bioorganic synthesis, molecular adaptation- Bio-isosterism, molecular recognition at the supramolecular level.

Module:4	Biocatalysts in Organic Synthesis	6 hours

Enzyme- Properties, Nomenclature and Classification. Pros and cons of biocatalyst, Mechanistic Aspects, Coenzymes, Enzyme Sources, Immobilized enzymes. Homo and heterogeneous biocatalysts.

Hydrolysis of esters, amides, phosphates epoxides, nitriles- Oxidations of alcohols, aldehydes, Sulfoxidation, Baeyer-Villiger oxidation, Hydroxylation of Aromatic Compounds.

Module:5	Developments in crown ether chemistry-I	10 hours

Macrocyclic ethers- introduction and nature of donor sites.

Enzyme model- introduction, Application to Host-guest Complexation chemistry –

Chiral recognition and catalysis – Stereo-selective transport – Ionophores, membrane chemistry-micelles. *Bis* and Photo responsive crown ethers. Regulation of membrane transport phenomenon.		
Module:6	**Developments in crown ether chemistry-II**	**7 hours**
Cyclodextrines, enzyme design using steroid template, Remote functionalization, biomimetic polyene cyclisation. Chemical mutations and site directed mutagenesis. Chemical mutations and semi synthetic enzymes- Molecular recognition.		
Module:7	**Enzymes in Organic synthesis**	**5 hours**
Synthesis of esters, Lactones, amides, peptides and peracid		
Module:8	Industry Expert Lecture	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Kurt Faber, Bio-transformations in Organic Chemistry, 7th Edition, Springer.
2. An Introduction to Medicinal Chemistry- Vth Edition Graham L Patrick (Qxford 2013).
3. Burger's Medicinal Chemistry & Drug discovery, Vol 1-3, 15th Ed, 2014.
4. P. S. Kalsi and J. P. Kalsi, Bioorganic, Bioinorganic and Supramolecular Chemistry, New Age Publications 3rdEdition 2017.

Reference Books

1. John E. McMurry and Tadhg P. Begley, The Organic Chemistry of Biological Pathways, 2nd Editions, ISBN-10: 193622156X: ISBN-13: 978-1936221561).
2. Bio-organic Chemistry, Harish Kumar and Parmjit S. Panesar, published by Narosa Publishing House Pvt. Ltd., New Delhi, [2012].
3. Foye's Principles of Medicinal Chemistry, by David A. Williams PhD, 7th Edition, 2012.
4. Biocatalysts: An Industrial Perspective, Print ISBN**:**978-1-78262-619-0, 2017, RSC Publishers.

Mode of Evaluation: Written Examinations, Quiz and Assignments

Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF ADVANCED SCIENCES

DEPARTMENT OF CHEMISTRY

Integrated M.Sc. in Chemistry

Project and Internship

Course Code	Course Title	L	T	P	C
TCHY497J	Project	0	0	0	2
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

To provide sufficient hands-on learning experience related to the area of specialization with a focus on research orientation

Course Outcomes

At the end of the course students should be able to

1. Formulate specific problem statements for ill-defined real-life problems with reasonable assumptions and constraints.
2. Perform literature search and / or patent search in the area of interest.
3. Design and Conduct experiments
4. Perform error analysis / benchmarking / costing
5. Synthesise the results and arrive at scientific conclusions
6. Document the results in the form of technical report/presentation

General Guidelines

1. Identification of real-life problems
2. Field visits can be arranged by the faculty concerned
3. 6 – 10 students can form a team (within the same / different discipline)
4. Minimum of eight hours on self-managed team activity
5. Appropriate scientific methodologies to be utilized to solve the identified issue
6. Solution should be in the form of fabrication/coding/modeling/product design/process design/relevant scientific methodology(ies)
7. Consolidated report to be submitted for assessment
8. Participation, involvement and contribution in group discussions during the contact hours will be used as the modalities for the continuous assessment of the theory component
9. Project outcome to be evaluated in terms of technical, economical, social, environmental, political and demographic feasibility
10. Contribution of each group member to be assessed
11. The project component to have three reviews with the weightage of 20:30:50

Mode of Evaluation: (No FAT) Continuous Assessment of the project done – Mark weightage of 20:30:50 – project report to be submitted, presentation and project reviews.

Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY498J	Research Project 1	0	0	0	4
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

To provide sufficient hands-on learning experience related to the area of specialization with a focus on research orientation

Course Outcomes

At the end of the course students should be able to

1. Formulate specific problem statements for ill-defined real-life problems with reasonable assumptions and constraints.
2. Perform literature search and / or patent search in the area of interest.
3. Design and Conduct experiments
4. Perform error analysis / benchmarking / costing
5. Synthesise the results and arrive at scientific conclusions
6. Document the results in the form of technical report/presentation

General Guidelines

1. Identification of real-life problems
2. Field visits can be arranged by the faculty concerned
3. 6 – 10 students can form a team (within the same / different discipline)
4. Minimum of eight hours on self-managed team activity
5. Appropriate scientific methodologies to be utilized to solve the identified issue
6. Solution should be in the form of fabrication/coding/modeling/product design/process design/relevant scientific methodology(ies)
7. Consolidated report to be submitted for assessment
8. Participation, involvement and contribution in group discussions during the contact hours will be used as the modalities for the continuous assessment of the theory component
9. Project outcome to be evaluated in terms of technical, economic, social, environmental and feasibility.
10. Contribution of each group member to be assessed
11. The project component to have three reviews with the weightage of 20:30:50

Mode of Evaluation: (No FAT) Continuous Assessment of the project done – Mark weightage of 20:30:50 – project report to be submitted, presentation and project reviews.

Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course Code	Course Title	L	T	P	C
TCHY499J	Research Project 2 / Internship	0	0	0	8
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

To provide sufficient hands-on learning experience related to the area of specialization with a focus on research orientation

Course Outcomes

At the end of the course students should be able to

1. Formulate specific problem statements for ill-defined real-life problems with reasonable assumptions and constraints.
2. Perform literature search and / or patent search in the area of interest.
3. Design and Conduct experiments
4. Perform error analysis / benchmarking / costing
5. Synthesise the results and arrive at scientific conclusions
6. Document the results in the form of technical report/presentation

General Guidelines

1. Identification of real-life problems
2. Field visits can be arranged by the faculty concerned
3. 6 – 10 students can form a team (within the same / different discipline)
4. Minimum of eight hours on self-managed team activity
5. Appropriate scientific methodologies to be utilized to solve the identified issue
6. Solution should be in the form of fabrication/coding/modeling/product design/process design/relevant scientific methodology(ies)
7. Consolidated report to be submitted for assessment
8. Participation, involvement and contribution in group discussions during the contact hours will be used as the modalities for the continuous assessment of the theory component
9. Project outcome to be evaluated in terms of technical, economical, social, environmental, political and demographic feasibility
10. Contribution of each group member to be assessed
11. The project component to have three reviews with the weightage of 20:30:50

Mode of Evaluation: (No FAT) Continuous Assessment of the project done – Mark weightage of 20:30:50 – project report to be submitted, presentation and project reviews.

Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

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SCHOOL OF ADVANCED SCIENCES

DEPARTMENT OF CHEMISTRY

Integrated M.Sc. in Chemistry

Non-graded Core Courses

TCHY101N	Introduction to Science	L	T	P	C
		0	0	0	2
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objective:

- To make the student comfortable and get familiarized with the facilities available on campus
- To make the student aware of the exciting opportunities and usefulness of science to society
- To make the student understand the philosophy of science

Course Outcome:

- To know the infrastructure facilities available on campus
- To rationally utilize the facilities during their term for their professional growth
- To appreciate the scientific principles, involve in life-long learning and take up science practice as a service to society

General Guidelines

1. Student should observe and involve in the activities. Both general activities and those which are discipline-specific should be included here.
2. Student should get familiarized with the infrastructure facilities available on campus during the general induction, school induction programme and also from the institutional website.
3. Student should attend the lecture by industries, including those on career opportunities, organized by the School and probably involve in 'Do-it-yourself' projects.
4. Activities under 'Do-it-Yourself' will be detailed by the School.
5. Student should prepare a report on the activities and observations, as per the specified format, and submit the same in institutional LMS, VTOP for further evaluation

   General instruction on formatting: Document to be prepared with the titles given in the template; Arial type with font size of 12 to be used; photographs can be included in the document as per the requirement; 1.5 line spacing to be used.

Mode of Evaluation: Evaluation of the submitted report and interaction with the students

Recommended by Board of Studies	30.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

ISSC101N	Essence of Traditional Knowledge	L	T	P	C
		0	0	0	2
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives:

1. To impart the knowledge on Indian tradition and Culture.
2. To enable the students to acquire the traditional knowledge in different sectors.
3. To analyze and understand the Science, Management and Indian Knowledge System.

Course Outcomes:

1. Familiarize the concept of Traditional Indian Culture and Knowledge.
2. Explore the Indian religion, philosophy and practices.
3. Analyze and understand the Indian Languages, Culture, Literature and Arts.
4. Gives a clear understanding on the Indian perspective of modern scientific world and basic principles of Yoga and holistic health care system of India.
5. Enable knowledge on Legal framework and traditional knowledge.

Module:1	**Introduction to Traditional Knowledge**	
Traditional knowledge: Definition, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge, characteristics, Traditional knowledge vis-a-vis Indigenous knowledge, Traditional knowledge Vs Western Knowledge.		
Module:2	**Culture and Civilization**	
Introduction to Culture and Civilization, Culture and Heritage, Characteristics features of Indian Culture, Importance of Culture, Cultural practices in Ancient India, Medieval India and Modern India.		
Module:3	**Languages and Literature**	
Indian Languages and Literature: the role of Sanskrit, significance of scriptures to current society, Indian philosophies, other Sanskrit literature and literatures of South India.		
Module:4	**Religion and Philosophy**	
Religion and Philosophy: Religion and Philosophy in ancient India, Religion and Philosophy in Medieval India, Religious Reform Movements in Modern India (selected movements only).		
Module:5	**Fine Arts in India**	
Indian Painting, Indian handicrafts, Music, divisions of Indian classic music, modern Indian music, Dance and Drama. Science and Technology in India, Development of science in ancient, medieval and modern India. Traditional Medicine – Herbal Healing - Yoga and Pranayama practices.		
Module:6	**Traditional Knowledge in different sectors**	
Traditional knowledge and engineering, Traditional medicine system, Traditional knowledge in agriculture, Dependence of Traditional Societies on food and healthcare needs; Importance of conservation and sustainable development of environment, Management of biodiversity and Protection of Traditional knowledge.		
Module:7	**Legal framework and Traditional Knowledge**	
Introduction on Legal framework and Traditional Knowledge: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, The protection of traditional knowledge bill, 2016.		
Total Lecture Hours:		**60 hours**

Text Books :

1.	Shikha Jain, Parul G Munjal And Somya Joshi,(2020) Traditional Knowledge Systems And Cultural Heritage, Aryan Books International, India.
2.	Anindya Bhukta(2020), Legal Protection for Traditional Knowledge: Towards A New

	Law for Indigenous Intellectual Property, Emerald Publishing Limited, United Kingdom.
Reference Books :	
1.	Traditional Knowledge System in India, by Amit Jha, 2009.
2.	Basant Kumar Mohanta & Vipin Kumar Singh (2012), "Traditional Knowledge System & Technology in India", Pratibha Prakashan, India.
3.	S. Baliyan, Indian Art and Culture, Oxford University Press, India.
4	http://indiafacts.org/author/michel-danino/
5.	GN Jha (Eng. Trans.) Ed. R N Jha, Yoga-darshanam with Vyasa Bhashya, Vidyanidhi Prakasham, Delhi,2016.
Mode of Evaluation: Quiz and Term End – Quiz	

Recommended by Board of Studies	16-11-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

Course Code	Course Title	L	T	P	C
BSSC102N	Indian Constitution	0	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

This Course is an introduction of Indian Constitution and basic concepts highlighted in this course for understanding the Constitution of India.

Course Outcome

At the end of the course, the student will acquire:

1. A basic understanding of Constitution of India.
2. The ability to understand the contemporary challenges and apply the knowledge gained from the course to current social contemporary legal issues.
3. The understanding of constitutional remedies.

Module:1	Introduction to Indian Constitution	5 hours

Introduction to the constitution of India and the Preamble - Sources of Indian Constitution - Features of Indian Constitution - Citizenship - Fundamental Rights and Duties - Directive Principles of state policy

Module:2	Union Government and its Administration Structure of the Indian Union	8 hours

Federalism, Centre- State relationship - President: Role, Power and Position - Prime Minister and Council of ministers - Cabinet and Central Secretariat - Lok Sabha - Rajya Sabha- The Supreme Court and High Court: Powers and Functions

Module:3	State Government and its Administration	4 hours

Governor- Role and Position - Chief Minister and Council of Ministers - State Legislative Assembly - State secretariat: Organization, Structure and Functions

Module:4	Local Administration	7 hours

District's Administration Head- Role and Importance - Municipalities: Introduction, Mayor and role of Elected Representative - Panchayati Raj: Composition and Functions Evolution and 73rd and 74th Amendments - Zila Parishad and district administration: Composition and Functions Elected officials and their roles, CEO Zila Panchayat: Position and role- Panchayat Samiti: Composition and Functions - Gram Panchayat: Composition and Functions Importance of grass root democracy

Module:5	Election Commission	6 hours

Role of Chief Election Commissioner - State Election Commission - Functions of Commissions for the welfare of SC/ST/OBC and women.

	Total Lecture hours:	30 hours

Reference Books				
1.	Durga Das Basu, Introduction to the Constitution of India, Gurgaon; LexisNexis, 2018 (23rd edn.)			
2.	M.V.Pylee, India's Constitution, New Delhi; S. Chand Pub., 2017 (16th edn.)			
3.	J.C Johari, Indian Government and Politics, Shoban Lal & Co., 2012			
4.	Noorani, A.G , Challenges to Civil Rights Guarantees in India, Oxford University Press 2012.			
5.	R. Bhargava, (2008) 'Introduction: Outline of a Political Theory of the Indian Constitution', in R. Bhargava (ed.) Politics and Ethics of the Indian Constitution, New Delhi: Oxford University Press.			
6.	Bidyut Chakrabarty & Rajendra Kumar Pandey, Indian Government and Politics, SAGE, New Delhi, 2008			
7.	G. Austin, The Indian Constitution: CornerStone of a Nation, Oxford, Oxford University Press, 1966			
Mode of Evaluation**:** CAT, Written assignment, Quiz and FAT				
Recommended by Board of Studies		27-10-2021		
Approved by Academic Council		No. 68	Date	19-08-2022