

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
1	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-1-1001	Research Methodology:	Core	1	0	0	1
2	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-1-1002	Analytical Tools and Instrumentation	Core	1	0	0	1
3	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-1-1004	Basic Chemistry for Interdisciplinary sciences:	Optional	1	0	0	1
4	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-1-1005	Introduction to Nanoscience and Nanotechnology	Optional	1	0	0	1
5	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1001	Advanced Inorganic Chemistry	Core	2	0	0	2
6	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1002	Advanced Analytical Chemistry	Elective	2	0	0	2
7	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1003	Advance Materials Characterization Techniques	Elective	2	0	0	2
8	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1004	Sol-gel chemistry	Elective	2	0	0	2
9	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1005	Green chemistry	Elective	2	0	0	2
10	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1006	Environmental Sciences	Elective	2	0	0	2
11	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1007	Environmental Chemistry	Elective	2	0	0	2
12	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1008	Process Chemistry	Elective	1	0	0	1
13	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1009	Separation Science and Technology	Elective	1	0	0	1
14	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1010	Green Chemistry	Elective	1	0	0	1
15	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1011	Soil Sciences	Elective	2	0	0	2
16	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1012	Ground Water and Geochemical Studies	Elective	2	0	0	2
17	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1001	Natural Products and Drug Discovery	Elective	2	0	0	2
18	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1002	Corrosion and Corrosion Protection	Elective	2	0	0	2
19	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1003	Nano Science and Engineering	Elective	2	0	0	2
20	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1004	Functional and Smart Materials	Elective	2	0	0	2
21	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1005	Microfluidics and Microseparation	Elective	2	0	0	2
22	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1006	Unit Operations in Environmental Chemistry	Elective	2	0	0	2
23	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1007	Waste Utilization and Value Addition	Elective	2	0	0	2
24	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1008	Industrial Effluent Treatment & Disposal	Elective	2	0	0	2
25	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1009	Advanced Soil Science	Elective	2	0	0	2
26	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1010	Environment Assessment, Monitoring, Protection and Management	Elective	2	0	0	2
27	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1011	Methods and Techniques for Water resources Development and Manag	Elective	2	0	0	2
28	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-4-1001	Project proposal writing & presentation	Core	0	0	4	2
29	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-4-1002	Review Article	Core	0	0	4	2
30	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-4-1003	CSIR-800 Societal Program	Core	0	0	8	4
31	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-1-1301	Research Methodology	Core	1	0	0	1
32	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-1-1302	Analytical Tools and Instrumentation	Core	1	0	0	1
33	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-1-1304	Basic Chemistry for Interdisciplinary sciences:	Optional	1	0	0	1
34	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-1-1306	Introduction to Chemical Biology	Optional	1	0	0	1
35	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-2-1301	Advanced Organic Chemistry	Compulsory	2	0	0	2
36	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-2-1302	Advanced process chemistry	Elective	2	0	0	2
37	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-2-1303	Advances in Chemical Biology	Elective	2	0	0	2
38	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-2-1304	Natural products	Elective	2	0	0	2
39	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-2-1305	Synthetic methods for organic chemists	Elective	2	0	0	2

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
40	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-2-1306	Organic spectroscopy applications	Elective	2	0	0	2
41	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-3-1301	Molecular modelling and simulation	Elective	2	0	0	2
42	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-3-1302	Asymmetric Synthesis	Elective	1	0	0	1
43	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-3-1303	Chemistry and biology of Heterocycles	Elective	2	0	0	2
44	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-3-1304	Homogeneous Catalysis	Elective	1	0	0	1
45	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-3-1305	Natural products and drug discovery	Elective	2	0	0	2
46	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-3-1306	Green & Sustainable Chemsitry	Elective	2	0	0	2
47	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-4-1301	Project proposal writing & presentation	Core	0	0	4	2
48	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-4-1302	Review Article	Core	0	0	4	2
49	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-4-1303	CSIR-800 Societal Program	Core	0	0	8	4
50	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-1-1401	Research Methodology:	Core	1	0	0	1
51	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-1-1403	Basic mathematics and numerical methods	Core	1	0	0	1
52	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-1-1405	Introduction to Nanoscience and Nanotechnology	Optional	1	0	0	1
53	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-1-1406	Introduction to Chemical Biology	Optional	1	0	0	1
54	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1401	Advanced Physical Chemistry	Elective	2	0	0	2
55	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1402	Advanced Analytical Chemistry	Elective	2	0	0	2
56	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1403	Advanced Electrochemistry	Elective	2	0	0	2
57	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1404	Advanced Materials Science	Elective	2	0	0	2
58	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1405	Advanced Surface Science	Elective	2	0	0	2
59	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1406	Advanced Materials Characterization Techniques:	Elective	2	0	0	2
60	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1407	Advances in Nanoscience and Nanotechnology	Elective	2	0	0	2
61	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1408	Advanced Biomaterials	Elective	2	0	0	2
62	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1409	Ionic liquids	Elective	1	0	0	1
63	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1410	Physical organic chemistry	Elective	2	0	0	2
64	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1411	Surface characterization techniques	Elective	2	0	0	2
65	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1401	Computational materials design	Elective	2	0	0	2
66	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1402	Supramolecular chemistry	Elective	2	0	0	2
67	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1403	Corrosion science	Elective	2	0	0	2
68	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1404	Materials and devices for energy conversion	Elective	2	0	0	2
69	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1405	Organic electrochemistry	Elective	2	0	0	2
70	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1406	Electrochemical power sources	Elective	2	0	0	2
71	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1407	Alternate energy materials	Elective	2	0	0	2
72	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1408	Photoinduced electron and Energy transfer	Elective	2	0	0	2
73	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1409	Hydrogen generation and storage	Elective	2	0	0	2
74	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1410	Polymers for membrane applications	Elective	2	0	0	2
75	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1411	Conducting polymers	Elective	1	0	0	1
76	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1412	Nanobiotechnology	Elective	1	0	0	1
77	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1413	Polymer Electrolyte Fuel Cell	Elective	2	0	0	2
78	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1414	Advanced Lithium Batteries	Elective	2	0	0	2
79	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1415	Functional Materials	Elective	2	0	0	2
80	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1416	Electrochemical Technology	Elective	2	0	0	2
81	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1417	Advanced Corrosion Technology	Elective	2	0	0	2

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
82	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1418	Electrochemical Remediation	Elective	2	0	0	2
83	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-4-1401	Project proposal writing & presentation	Core	0	0	4	2
84	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-4-1402	Review Article	Core	0	0	4	2
85	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-4-1403	CSIR-800 Societal Program	Core	0	0	8	4
86	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-1-1801	Research Methodology, Communication/ethics/safety	Compulsory	1	0	0	1
87	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-1-1802	Fundamentals of Chemical Sciences	Compulsory	1	0	0	1
88	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-1-1803	Computer Applications and Tools in Chemistry and Biology	Compulsory	1	0	0	1
89	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-1-1804	Basic Instrumentation and Statistical Analysis	Optional	1	0	0	1
90	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1801	Analytical Techniques and Instrumentation		2	0	0	2
91	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1802	Advances in Natural Products Chemistry		2	0	0	2
92	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1803	Green Chemistry		2	0	0	2
93	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1804	Chromatographic Techniques		2	0	0	2
94	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1805	Structure Elucidation of Organic Molecules		2	0	0	2
95	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1806	Frontiers in Pharmaceutical Chemistry		2	0	0	2
96	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1807	Advances in Essential Oil Chemistry		2	0	0	2
97	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1808	Advances in Extraction and Processing Technologies		2	0	0	2
98	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1809	Synthetic applications in Natural Product Chemistry		2	0	0	2
99	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1810	Fundamentals of Environmental Chemistry		2	0	0	2
100	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1811	Intellectual Property Management		2	0	0	2
101	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1801	Isolation and Characterization of New Chemical Entities (NCEs)	Elective	2	0	0	2
102	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1802	Frontiers in Synthetic Chemistry-Basic principles and Name reactions	Elective	2	0	0	2
103	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1803	Reagents in Organic Synthesis	Elective	2	0	0	2
104	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1804	Frontiers in Organic Spectroscopy	Elective	2	0	0	2
105	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1805	Techniques in Natural Products Up Scaling	Elective	2	0	0	2
106	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1806	Applied, Industrial and Environmental Chemistry	Elective	2	0	0	2
107	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1807	Quality assurance of Herbs and Herbal Products	Elective	2	0	0	2
108	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1808	Chemistry of Renewable Energy	Elective	2	0	0	2
109	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1809	Frontiers in Drug discovery and development	Elective	2	0	0	2
110	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1810	Frontiers in Nanomaterial and Nanoscience	Elective	2	0	0	2
111	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1811	Advances in Essential Oil Chemistry and Analysis	Elective	2	0	0	2
112	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-4-1801	Project proposal writing & presentation	Compulsory	0	0	4	2
113	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-4-1802	Review Article	Compulsory	0	0	4	2
114	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-4-1803	CSIR-800 Societal Program	Compulsory	0	0	8	4
115	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-1-1901	Research Methodology	core	1	0	0	1
116	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-1-1902	Analytical Tools and Instrumentation	core	1	0	0	1
117	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-1-1903	Basic mathematics and numerical methods	core	1	0	0	1
118	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-1-1904	Basic Chemistry for Interdisciplinary sciences:	Optional	1	0	0	1
119	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-2-1901	Advanced Organic Chemistry		2	0	0	2

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
120	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-2-1902	Advanced Coal Science	Elective	2	0	0	2
121	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-2-1903	Environmental Chemistry	Elective	1	0	2	2
122	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1901	Coal Geology and Organic Petrology	Elective	1	0	2	2
123	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1902	Analytical Techniques for Coal and Derivatives	Elective	1	0	2	2
124	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1903	Coal Beneficiation	Elective	2	0	2	3
125	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1904	Combustion Science and Technology	Elective	2	0	2	3
126	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1905	Coal Gasification	Elective	2	0	2	3
127	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1906	Coal to Liquid (CTL) Technology	Elective	2	0	2	3
128	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1907	Coal Carbonization	Elective	2	0	2	3
129	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1908	Coal Biotechnology	Elective	1	0	2	2
130	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1909	Environmental Management in Coal Industry	Elective	2	0	0	2
131	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1910	Management of Soil, Water & Air Pollution in Coal Industry	Elective	1	0	2	2
132	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1911	GHG Emission and Clean Development Strategies	Elective	2	0	0	2
133	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-4-1901	Project proposal writing & presentation	Core	0	0	4	2
134	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-4-1902	Review Article	Core	0	0	4	2
135	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-4-1903	CSIR-800 Societal Program	Core	0	0	8	4
136	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-1-2001	Research Methodology	Core	1	0	0	1
137	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-1-2002	Analytical Tools and Instrumentation	Core	1	0	0	1
138	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-1-2003	Basic mathematics and numerical methods	Core	1	0	0	1
139	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-1-2004	Basic Chemistry for Interdisciplinary sciences	Optional	1	0	0	1
140	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-1-2005	Introduction to Nanoscience and Nanotechnology	Optional	1	0	0	1
141	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-1-2006	Introduction to Chemical Biology	Optional	1	0	0	1
142	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2001	Advanced Physical Chemistry	Elective	2	0	0	2
143	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2002	Advanced Inorganic Chemistry	Elective	2	0	0	2
144	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2003	Advanced Organic Chemistry	Elective	2	0	0	2
145	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2004	Advanced Analytical Chemistry	Elective	2	0	0	2
146	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2005	Advanced Quantum Mechanics	Elective	2	0	0	2
147	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2006	Advanced Organometallic Chemistry	Elective	2	0	0	2
148	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2007	Advanced Coordination Chemistry	Elective	2	0	0	2
149	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2008	Advanced Photochemistry	Elective	2	0	0	2
150	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2009	Advanced Polymer Chemistry	Elective	2	0	0	2
151	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2010	Advanced Electrochemistry	Elective	2	0	0	2
152	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2011	Advances in Bioinorganic chemistry	Elective	2	0	0	2
153	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2012	Advances in hydrocarbon chemistry	Elective	2	0	0	2
154	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2013	Advanced process chemistry	Elective	2	0	0	2
155	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2014	Advanced Materials Science	Elective	2	0	0	2
156	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2015	Advanced Catalysis	Elective	2	0	0	2
157	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2016	Advanced Surface Science	Elective	2	0	0	2
158	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2017	Advanced Separation Science and Technology:	Elective	2	0	0	2
159	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2018	Advanced Materials Characterization Techniques:	Elective	2	0	0	2
160	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2019	Advances in Nanoscience and Nanotechnology	Elective	2	0	0	2
161	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2020	Advances in soft matter chemistry	Elective	2	0	0	2
162	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2021	Advances in Chemical Biology	Elective	2	0	0	2
163	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2022	Advanced Biomaterials	Elective	2	0	0	2
164	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2023	Rare Earth Chemistry	Elective	2	0	0	2
165	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2024	Sol-gel chemistry	Elective	2	0	0	2
166	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2025	Combinatorial chemistry	Elective	1	0	0	1

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
167	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2026	Green chemistry	Elective	1	0	0	1
168	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2027	Natural products	Elective	2	0	0	2
169	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2028	Ionic liquids	Elective	1	0	0	1
170	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2029	Synthetic methods for organic chemists	Elective	2	0	0	2
171	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2030	Organic reaction mechanisms	Elective	2	0	0	2
172	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2031	Dyes and pigments	Elective	1	0	0	1
173	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2032	Physical organic chemistry	Elective	2	0	0	2
174	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2033	Thermodynamics and Statistical Mechanics	Elective	2	0	0	2
175	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2034	Composite materials	Elective	2	0	0	2
176	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2035	Organic spectroscopy applications	Elective	2	0	0	2
177	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2036	Surface characterization techniques	Elective	2	0	0	2
178	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2001	Mathematical Methods	Elective	2	0	0	2
179	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2002	Numerical Methods	Elective	2	0	0	2
180	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2003	Electronic structure theory	Elective	2	0	0	2
181	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2004	Molecular modeling and simulation	Elective	2	0	0	2
182	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2005	Computer aided drug design	Elective	2	0	0	2
183	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2006	Computational materials design	Elective	2	0	0	2
184	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2007	Multiphase reaction kinetics	Elective	1	0	0	1
185	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2008	Carbohydrate chemistry	Elective	2	0	0	2
186	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2009	Biophysical chemistry	Elective	2	0	0	2
187	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2010	Physics and chemistry of collagen	Elective	2	0	0	2
188	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2011	Marine Natural products	Elective	2	0	0	2
189	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2012	Supramolecular chemistry	Elective	2	0	0	2
190	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2013	Total Synthesis	Elective	1	0	0	1
191	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2014	Asymmetric Synthesis	Elective	1	0	0	1
192	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2015	Chemistry and biology of Heterocycles	Elective	2	0	0	2
193	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2016	Agrochemicals	Elective	2	0	0	2
194	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2017	Fluoro organic chemistry	Elective	2	0	0	2
195	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2018	Corrosion science	Elective	2	0	0	2
196	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2019	Nutraceuticals:	Elective	2	0	0	2
197	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2020	Ionic liquids for lubricants	Elective	1	0	0	1
198	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2021	Applications of ionic liquids	Elective	1	0	0	1
199	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2022	Homogeneous Catalysis	Elective	1	0	0	1
200	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2023	Catalysis for organic synthesis	Elective	1	0	0	1
201	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2024	Materials and devices for energy conversion	Elective	2	0	0	2
202	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2025	Functional Ceramics	Elective	1	0	0	1
203	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2026	Porous structures	Elective	2	0	0	2
204	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2027	Biomaterials for targeted therapeutics	Elective	2	0	0	2
205	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2028	Organic electrochemistry	Elective	2	0	0	2
206	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2029	Photoinduced electron and Energy transfer	Elective	2	0	0	2
207	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2030	Thermochemical Conversion of Biomass	Elective	1	0	0	1
208	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2031	Block copolymers	Elective	2	0	0	2
209	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2032	Polymers for membrane applications	Elective	2	0	0	2
210	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2033	Ion exchange polymers	Elective	1	0	0	1
211	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2034	Conducting polymers	Elective	1	0	0	1
212	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2035	Polymers and Colloidal Solutions	Elective	2	0	0	2

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
213	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2036	Biodegradable polymers	Elective	2	0	0	2
214	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2037	Controlled Radical/Living Polymerizations and Macromolecular Architect	Elective	2	0	0	2
215	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2038	Pi-conjugated polymers	Elective	2	0	0	2
216	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2039	Liquid Crystals	Elective	2	0	0	2
217	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2040	X-Ray Diffraction and Structure of Solids	Elective	2	0	0	2
218	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2041	NMR spectroscopy	Elective	2	0	0	2
219	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2042	Mass spectrometry applications	Elective	2	0	0	2
220	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2043	Ultrafast processes and spectroscopy	Elective	2	0	0	2
221	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2044	Small Angle Scattering Techniques	Elective	2	0	0	2
222	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2045	Natural products and drug discovery	Elective	2	0	0	2
223	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2046	Lipid science & technology	Elective	2	0	0	2
224	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2047	Photobiology	Elective	2	0	0	2
225	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2048	Nanobiotechnology	Elective	1	0	0	1
226	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-4-2001	Project proposal writing & presentation	Core	0	0	4	2
227	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-4-2002	Review Article	Core	0	0	4	2
228	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-4-2003	CSIR-800 Societal Program	Core	0	0	8	4
229	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-1-2101	Research Methodology:	Core	1	0	0	1
230	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-1-2102	Analytical Tools and Instrumentation	Core	1	0	0	1
231	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-1-2104	Basic Chemistry for Interdisciplinary sciences	Optional	1	0	0	1
232	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-1-2105	Introduction to Nanoscience and Nanotechnology	Optional	1	0	0	1
233	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-2-2101	Advanced Physical Chemistry	Elective	2	0	0	2
234	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-2-2102	Advanced Inorganic Chemistry	Elective	2	0	0	2
235	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-2-2103	Advanced Organic Chemistry	Elective	2	0	0	2
236	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-2-2104	Advanced Coordination Chemistry	Elective	2	0	0	2
237	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-2-2105	Advances in Bioinorganic chemistry	Elective	2	0	0	2
238	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-2-2106	Advanced Materials Science	Elective	2	0	0	2
239	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-2-2107	Advanced Catalysis	Elective	2	0	0	2
240	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-2-2108	Advanced Surface Science	Elective	2	0	0	2
241	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-3-2101	Functional Ceramics	Elective	1	0	0	1
242	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-3-2102	Modern Magnetic Materials	Elective	1	0	0	1
243	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-3-2103	Porous structures	Elective	2	0	0	2
244	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-4-2101	Project proposal writing & presentation	Core	0	0	4	2
245	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-4-2102	Review Article	Core	0	0	4	2
246	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-4-2103	CSIR-800 Societal Program	Core	0	0	8	4
247	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-1-2501	Research Methodology:	Core	1	0	0	1
248	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-1-2502	Analytical Tools and Instrumentation	Core	1	0	0	1
249	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-1-2503	Basic mathematics and numerical methods	core	1	0	0	1
250	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-1-2504	Basic Chemistry for Interdisciplinary sciences	Optional	1	0	0	1
251	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-1-2505	Introduction to Nanoscience and Nanotechnology	Optional	1	0	0	1
252	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2501	Advanced Physical Chemistry	Elective	2	0	0	2

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
253	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2502	Advanced Inorganic Chemistry	Elective	2	0	0	2
254	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2503	Advanced Organic Chemistry	elective	2	0	0	2
255	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2504	Advanced Analytical Chemistry	Elective	2	0	0	2
256	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2505	Advanced Quantum Mechanics	Elective	2	0	0	2
257	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2506	Advanced Coordination Chemistry	Elective	2	0	0	2
258	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2507	Advanced Polymer Chemistry	Elective	2	0	0	2
259	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2508	Advanced Electrochemistry	Elective	2	0	0	2
260	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2509	Advanced process chemistry	Elective	2	0	0	2
261	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2510	Advanced Materials Science	Elective	2	0	0	2
262	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2511	Advanced Catalysis	Elective	2	0	0	2
263	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2512	Advanced Surface Science	Elective	2	0	0	2
264	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2513	Advanced Separation Science and Technology	Elective	2	0	0	2
265	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2514	Advanced Materials Characterization Techniques	Elective	2	0	0	2
266	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2515	Advances in Nanoscience and Nanotechnology	Elective	2	0	0	2
267	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2516	Green chemistry	Elective	1	0	0	1
268	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2517	Natural products	Elective	2	0	0	2
269	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2518	Ionic liquids	Elective	1	0	0	1
270	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2519	Organic reaction mechanisms	Elective	2	0	0	2
271	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2501	Molecular modeling and simulation	Elective	2	0	0	2
272	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2502	Marine Natural products	Elective	2	0	0	2
273	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2503	Supramolecular chemistry	Elective	2	0	0	2
274	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2504	Asymmetric Synthesis	Elective	1	0	0	1
275	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2505	Salts from marine resources	Elective	2	0	0	2
276	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2506	Applications of ionic liquids	Elective	1	0	0	1
277	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2507	Homogeneous Catalysis	Elective	1	0	0	1
278	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2508	Catalysis for organic synthesis	Elective	1	0	0	1
279	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2509	Catalysis for biomass refining	Elective	1	0	0	1
280	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2510	Porous structures	Elective	2	0	0	2
281	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2511	Electrochemical power sources	Elective	2	0	0	2
282	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2512	Alternate energy materials	Elective	2	0	0	2
283	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2513	Photoinduced electron and Energy transfer	Elective	2	0	0	2
284	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2514	Thermochemical Conversion of Biomass	Elective	1	0	0	1
285	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2515	CO2 sequestration and conversion	Elective	2	0	0	2
286	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2516	Block copolymers	Elective	2	0	0	2
287	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2517	Polymers for membrane applications	Elective	2	0	0	2
288	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2518	Ion exchange polymers	Elective	1	0	0	1
289	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2519	Conducting polymers	Elective	1	0	0	1
290	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2520	X-Ray Diffraction and Structure of Solids	Elective	2	0	0	2
291	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2521	NMR spectroscopy	Elective	2	0	0	2
292	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-4-2501	Project proposal writing & presentation	Compulsory	0	0	4	2
293	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-4-2502	Review Article	Compulsory	0	0	4	2

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
294	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-4-2503	CSIR-800 Societal Program	Compulsory	0	0	8	4
295	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-1-2701	Research Methodology:	Core	1	0	0	1
296	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-1-2702	Analytical Chromatographic Techniques	Core	1	0	0	1
297	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-1-2703	Organic Spectroscopy Techniques	Optional	1	0	0	1
298	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-2-2701	Advanced Organic Synthesis	Elective	2	0	0	2
299	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-2-2702	Advances in Oxidation and Reduction Reactions	Elective	2	0	0	2
300	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-2-2703	Advances in Natural Products: Traditional methods and Terpenoids	Elective	2	0	0	2
301	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-2-2704	Advances in Natural Products: Alkaloids and Polyphenols	Elective	2	0	0	2
302	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-3-2701	Green Chemistry	Elective	2	0	0	2
303	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-3-2702	Advances in Catalyst and Reagent Chemistry	Elective	2	0	0	2
304	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-3-2703	Advances in Natural Products: Extraction and Isolation Techniques	Elective	2	0	0	2
305	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-3-2704	NMR Spectroscopy and its Applications in Organic Chemistry	Elective	2	0	0	2
306	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-4-2701	Project proposal writing & presentation	Core	0	0	4	2
307	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-4-2702	Review Article	Core	0	0	4	2
308	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-4-2703	CSIR-800 Societal Program	Core	0	0	8	4
309	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-1-2901	Research Methodology (communication & writing skill)	Core	1	0	0	1
310	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-1-2902	Analytical Tools and Instrumentation	Core	1	0	0	1
311	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-1-2905	Introduction to Nanoscience and Nanotechnology	Optional	1	0	0	1
312	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2901	Advanced Physical Chemistry	Elective	2	0	0	2
313	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2902	Advanced Organic Chemistry	Elective	2	0	0	2
314	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2903	Advanced Analytical Chemistry	Elective	2	0	0	2
315	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2904	Advanced Polymer Chemistry	Elective	2	0	0	2
316	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2905	Advanced Catalysis	Elective	2	0	0	2
317	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2906	Advanced Separation Science and Technology:	Elective	2	0	0	2
318	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2907	Advances in Nanoscience and Nanotechnology	Elective	2	0	0	2
319	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2908	Advances in soft matter chemistry	Elective	2	0	0	2
320	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2909	Green chemistry	Elective	2	0	0	2
321	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2910	Dyes and pigments	Elective	1	0	0	1
322	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2911	Composite materials	Elective	2	0	0	2
323	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2912	Advanced NMR Spectroscopic Method	Elective	2	0	0	2
324	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2901	Supramolecular chemistry	Elective	2	0	0	2
325	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2902	Total Synthesis	Elective	1	0	0	1
326	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2903	Asymmetric Synthesis	Elective	1	0	0	1
327	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2904	Agrochemicals	Elective	2	0	0	2
328	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2905	Fluoro organic chemistry	Elective	2	0	0	2
329	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2906	Corrosion science	Elective	2	0	0	2
330	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2907	Catalysis for biomass refining	Elective	1	0	0	1
331	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2908	Materials and devices for energy conversion	Elective	2	0	0	2



Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
332	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2909	Electrochemical power sources	Elective	2	0	0	2
333	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2910	Hydrogen generation and storage	Elective	2	0	0	2
334	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2911	CO2 sequestration and conversion	Elective	2	0	0	2
335	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2912	Block copolymers	Elective	2	0	0	2
336	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2913	Conducting polymers	Elective	1	0	0	1
337	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2914	Polymers and Colloidal Solutions	Elective	2	0	0	2
338	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2915	Controlled Radical/Living Polymerizations and Macromolecular Architect	Elective	2	0	0	2
339	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2916	Pi-conjugated polymers	Elective	2	0	0	2
340	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2917	Liquid Crystals	Elective	2	0	0	2
341	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2918	X-Ray Diffraction and Structure of Solids	Elective	2	0	0	2
342	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2919	NMR spectroscopy	Elective	2	0	0	2
343	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2920	Mass spectrometry applications	Elective	2	0	0	2
344	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-4-2901	Project proposal writing & presentation	Compulsory	0	0	4	2
345	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-4-2902	Review Article	Compulsory	0	0	4	2
346	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-4-2903	CSIR-800 Societal Program	Compulsory	0	0	8	4
347	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-1-3001	Research Methodology:	Core	1	0	0	1
348	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-1-3002	Analytical Tools and Instrumentation	Core	1	0	0	1
349	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-1-3004	Basic Chemistry for Interdisciplinary sciences	Optional	1	0	0	1
350	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-1-3006	Basic Biology for interdisciplinary sciences	Optional	1	0	0	1
351	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-2-3001	Advanced Organic Chemistry	Core	2	0	0	2
352	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-2-3002	Natural Product	Elective	2	0	0	2
353	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-2-3003	Drug Discovery	Elective	2	0	0	2
354	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-2-3004	Molecular Modelling and Simulation	Elective	2	0	0	2
355	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-3-3001	Medicinal Chemistry (Oncology/Infection), Isolations and Synthesis	Elective	3	0	0	3
356	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-3-3002	Seminar for individual	Elective	1	0	0	1
357	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-4-3001	Project proposal writing & presentation	Core	0	0	4	2
358	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-4-3002	Review Article	Core	0	0	4	2
359	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-4-3003	CSIR-800 Societal Program	Core	0	0	8	4
360	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-1-3101	Research Methodology	Core	1	0	0	1
361	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-1-3102	Analytical Tools and Instrumentation	Core	1	0	0	1
362	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-2-3101	Advanced Organic Chemistry	Core	2	0	0	2
363	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-2-3102	Advanced Analytical Chemistry	Elective	2	0	0	2
364	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-2-3103	Advances in hydrocarbon chemistry	Elective	2	0	0	2
365	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-2-3104	Advanced Catalysis	Elective	2	0	0	2
366	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-2-3105	Alternative feedstock options for petrochemicals	Elective	2	0	0	2
367	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-3-3101	Multiphase reaction kinetics	Elective	1	0	0	1
368	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-3-3102	Ionic liquids for lubricants	Elective	1	0	0	1
369	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-3-3103	Catalysis in petroleum refining	Elective	2	0	0	2
370	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-3-3104	Biocatalysis in petroleum refining	Elective	1	0	0	1
371	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-3-3105	Thermochemical Conversion of Biomass	Elective	1	0	0	1
372	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-3-3106	CO2 sequestration and conversion	Elective	2	0	0	2
373	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-3-3107	Natural gas to liquid fuels	Elective	2	0	0	2
374	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-3-3108	Gasoline reformulation techniques	Elective	2	0	0	2

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
375	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-4-3101	Project proposal writing & presentation	Compulsory	0	0	4	2
376	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-4-3102	Review Article	Compulsory	0	0	4	2
377	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-4-3103	CSIR-800 Societal Program	Compulsory	0	0	8	4
378	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-1-3201	Research Methodology:	Core	1	0	0	1
379	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-1-3202	Analytical Tools and Instrumentation	Core	1	0	0	1
380	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-2-3201	Advanced Organic Chemistry	Elective	2	0	0	2
381	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-2-3202	Advanced Analytical Chemistry	Elective	2	0	0	2
382	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-2-3203	Advanced Photochemistry	Elective	2	0	0	2
383	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-2-3204	Green chemistry	Elective	1	0	0	1
384	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-2-3205	Ionic liquids	Elective	1	0	0	1
385	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-2-3206	Synthetic methods for organic chemists	Elective	2	0	0	2
386	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-2-3207	Dyes and pigments	Elective	1	0	0	1
387	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-2-3208	Thermodynamics and Statistical Mechanics	Elective	2	0	0	2
388	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-2-3209	Organic Spectroscopy Applications	Elective	2	0	0	2
389	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-3-3201	Applications of ionic liquids	Elective	1	0	0	1
390	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-3-3202	Biodegradable polymers	Elective	2	0	0	2
391	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-3-3203	NMR spectroscopy	Elective	2	0	0	2
392	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-3-3204	Mass spectrometry applications	Elective	2	0	0	2
393	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-3-3205	Natural products and drug discovery	Elective	2	0	0	2
394	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-3-3206	Photobiology	Elective	2	0	0	2
395	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-4-3201	Project proposal writing & presentation	Core	0	0	4	2
396	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-4-3202	Review Article	Core	0	0	4	2
397	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-4-3203	CSIR-800 Societal Program	Core	0	0	8	4
398	Chemical Sciences	CSIR-IMMT, Bhubaneswar	CHE-IMMT-1-3301	Research Methodology		2	0	0	2
399	Chemical Sciences	CSIR-IMMT, Bhubaneswar	CHE-IMMT-1-3302	Materials Characterization Techniques		3	0	2	4
400	Chemical Sciences	CSIR-IMMT, Bhubaneswar	CHE-IMMT-2-3301	Advanced Materials Chemistry		3	0	2	4
401	Chemical Sciences	CSIR-IMMT, Bhubaneswar	CHE-IMMT-2-3302	Environmental Science		3	0	2	4
402	Chemical Sciences	CSIR-IMMT, Bhubaneswar	CHE-IMMT-3-3301	Advanced Chemistry for Hydro & Electrometallurgy		3	0	2	4
403	Chemical Sciences	CSIR-IMMT, Bhubaneswar	CHE-IMMT-3-3302	Advanced Self Study on Special topic 4C		3	0	2	4
404	Chemical Sciences	CSIR-IMMT, Bhubaneswar	CHE-IMMT-4-3301	Project Proposal writing & presentation		0	0	4	2
405	Chemical Sciences	CSIR-IMMT, Bhubaneswar	CHE-IMMT-4-3302	Review Article		0	0	4	2
406	Chemical Sciences	CSIR-IMMT, Bhubaneswar	CHE-IMMT-4-3303	CSIR-800 Societal Program		0	0	8	4
407	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-1-3701	Research Methodology	Compulsory	2	0	0	2
408	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-1-3702	Analytical Tools and Instrumentation	Compulsory	2	0	0	2
409	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-1-3703	Basic mathematics and numerical methods	Compulsory	2	0	0	2
410	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-1-3704	Basic Chemistry for Interdisciplinary sciences:	Optional	1	0	0	1
411	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-1-3705	Introduction to Nanoscience and Nanotechnology	Optional	1	0	0	1
412	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-1-3706	Introduction to Chemical Biology	Optional	1	0	0	1
413	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3701	Advanced Physical Chemistry	Elective	3	0	0	3

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
414	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3702	Advanced Inorganic Chemistry	Elective	3	0	0	3
415	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3703	Advanced Organic Chemistry	Elective	3	0	0	3
416	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3704	Advanced Analytical Chemistry	Elective	3	0	0	3
417	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3705	Advanced Quantum Mechanics	Elective	3	0	0	3
418	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3706	Advanced Organometallic Chemistry	Elective	3	0	0	3
419	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3707	Advanced Photochemistry	Elective	3	0	0	3
420	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3708	Advanced Polymer Chemistry	Elective	3	0	0	3
421	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3709	Advanced Electrochemistry	Elective	2	0	0	2
422	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3710	Advanced Materials Science	Elective	3	0	0	3
423	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3711	Advanced Catalysis	Elective	3	0	0	3
424	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3712	Advanced Surface Science	Elective	2	0	0	2
425	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3713	Advanced Separation Science and Technology:	Elective	2	0	0	2
426	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3714	Advanced Materials Characterization Techniques:	Elective	3	0	0	3
427	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3715	Advances in Nanoscience and Nanotechnology	Elective	3	0	0	3
428	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3716	Advances in Chemical Biology	Elective	3	0	0	3
429	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3717	Advanced Biomaterials	Elective	3	0	0	3
430	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3718	Green chemistry	Elective	3	0	0	3
431	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3719	Organic reaction mechanisms	Elective	3	0	0	3
432	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3720	Thermodynamics and Statistical Mechanics	Elective	3	0	0	3
433	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3721	Composite materials	Elective	2	0	0	2
434	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3722	Carbon allotropes	Elective	1	0	0	1
435	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3723	Organic spectroscopy applications	Elective	3	0	0	3
436	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3724	Surface characterization techniques	Elective	2	0	0	2
437	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3725	Organic Biomolecular Chemistry	Elective	3	0	0	3
438	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3726	Physical Organic Chemistry	Elective	2	0	0	2
439	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3701	Mathematical Methods	Elective	3	0	0	3
440	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3702	Numerical Methods	Elective	3	0	0	3
441	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3703	Electronic structure theory	Elective	2	0	0	2
442	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3704	Molecular modeling and simulation	Elective	2	0	0	2
443	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3705	Computational materials design	Elective	2	0	0	2
444	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3706	Carbohydrate chemistry	Elective	2	0	0	2
445	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3707	Chemistry and biology of Heterocycles	Elective	2	0	0	2
446	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3708	Homogeneous Catalysis	Elective	2	0	0	2
447	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3709	Materials and devices for energy conversion	Elective	2	0	0	2
448	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3710	Functional Ceramics	Elective	1	0	0	1
449	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3711	Modern Magnetic Materials	Elective	1	0	0	1
450	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3712	Porous structures	Elective	2	0	0	2
451	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3713	Electrochemical power sources	Elective	2	0	0	2
452	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3714	Alternate energy materials	Elective	2	0	0	2
453	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3715	Hydrogen generation and storage	Elective	2	0	0	2
454	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3716	Polymers and Colloidal Solutions	Elective	3	0	0	3
455	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3717	Controlled Radical/Living Polymerizations and Macromolecular Architec	Elective	2	0	0	2
456	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3718	X-Ray Diffraction and Structure of Solids	Elective	3	0	0	3
457	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3719	NMR spectroscopy	Elective	3	0	0	3
458	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3720	Mass spectrometry applications	Elective	2	0	0	2
459	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3721	Small Angle Scattering Techniques	Elective	2	0	0	2

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
460	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3722	Operando Surface Techniques	Elective	3	0	0	3
461	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3723	Chromatographic Techniques	Elective	2	0	0	2
462	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3724	Equilibrium and non-equilibrium statistical mechanics for soft matter	Elective	3	0	0	3
463	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3725	Modern Polymerization Methods for Functional Macromolecules	Elective	2	0	0	2
464	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3726	Molecular Self assembly	Elective	3	0	0	3
465	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3727	Total Synthesis	Elective	2	0	0	2
466	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3728	Catalysis in Petroleum Refining	Elective	2	0	0	2
467	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3729	Thermochemical Conversion of Biomass	Elective	2	0	0	2
468	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3701	Project proposal writing & presentation	Compulsory	0	0	4	2
469	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3702	Review Article	Compulsory	0	0	4	2
470	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3703	CSIR-800 Societal Program	Compulsory	0	0	8	4
471	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-1-3901	Research Methodology:	core	1	0	0	1
472	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-1-3902	Analytical Tools and Instrumentation	core	1	0	0	1
473	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-1-3903	Basic mathematics and numerical methods	core	1	0	0	1
474	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-1-3904	Basic Chemistry for Interdisciplinary sciences:	Optional	1	0	0	1
475	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-1-3905	Introduction to Nanoscience and Nanotechnology	Optional	1	0	0	1
476	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-1-3906	Introduction to Chemical Biology	Optional				
477	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3901	Advanced Physical Chemistry	Elective	2	0	0	2
478	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3902	Advanced Inorganic Chemistry	Elective	2	0	0	2
479	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3903	Advanced Organic Chemistry	Elective	2	0	0	2
480	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3904	Advanced Analytical Chemistry	Elective	2	0	0	2
481	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3905	Advanced Organometallic Chemistry	Elective	2	0	0	2
482	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3906	Advanced Coordination Chemistry	Elective	2	0	0	2
483	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3907	Advanced Polymer Chemistry	Elective	2	0	0	2
484	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3908	Advanced Electrochemistry	Elective	2	0	0	2
485	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3909	Advances in Bioinorganic chemistry	Elective	2	0	0	2
486	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3910	Advances in hydrocarbon chemistry	Elective	2	0	0	2
487	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3911	Advanced Catalysis	Elective	2	0	0	2
488	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3912	Advanced Surface Science	Elective	2	0	0	2
489	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3913	Advanced Materials Characterization Techniques	Elective	2	0	0	2
490	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3914	Advances in Nanoscience and Nanotechnology	Elective	2	0	0	2
491	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3915	Advances in Chemical Biology	Elective	2	0	0	2
492	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3916	Sol-gel chemistry	Elective	2	0	0	2
493	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3917	Green chemistry	Elective	1	0	0	1
494	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3918	Coal chemistry	Elective	2	0	0	2
495	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3919	Alternative feedstock options for petrochemicals	Elective	2	0	0	2
496	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3920	Natural products	Elective	2	0	0	2
497	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3921	Ionic liquids	Elective	1	0	0	1
498	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3922	Synthetic methods for organic chemists	Elective	2	0	0	2
499	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3923	Organic reaction mechanisms	Elective	2	0	0	2
500	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3924	Physical organic chemistry	Elective	2	0	0	2
501	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3925	Composite materials	Elective	2	0	0	2
502	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3926	Carbon allotropes	Elective	1	0	0	1
503	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3927	Organic spectroscopy applications	Elective	2	0	0	2
504	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3928	Surface characterization techniques	Elective	2	0	0	2
505	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3929	Oil Field Materials and Operations	Elective	2	0	0	2

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
506	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3901	Computer aided drug design	Elective	2	0	0	2
507	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3902	Carbohydrate chemistry	Elective	2	0	0	2
508	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3903	Total Synthesis	Elective	1	0	0	1
509	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3904	Asymmetric Synthesis	Elective	1	0	0	1
510	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3905	Chemistry and biology of Heterocycles	Elective	2	0	0	2
511	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3906	Fluoro organic chemistry	Elective	2	0	0	2
512	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3907	Nutraceuticals	Elective	2	0	0	2
513	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3908	Homogeneous Catalysis	Elective	1	0	0	1
514	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3909	Catalysis for organic synthesis	Elective	1	0	0	1
515	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3910	Functional Ceramics	Elective	1	0	0	1
516	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3911	Porous structures	Elective	2	0	0	2
517	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3912	Alternate energy materials	Elective	2	0	0	2
518	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3913	Natural gas to liquid fuels	Elective	2	0	0	2
519	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3914	Block copolymers	Elective	2	0	0	2
520	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3915	Conducting polymers	Elective	1	0	0	1
521	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3916	Polymers and Colloidal Solutions	Elective	2	0	0	2
522	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3917	Biodegradable polymers	Elective	2	0	0	2
523	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3918	Controlled Radical/Living Polymerizations and Macromolecular Architectures	Elective	2	0	0	2
524	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3919	X-Ray Diffraction and Structure of Solids	Elective	2	0	0	2
525	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3920	NMR spectroscopy	Elective	2	0	0	2
526	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3921	Natural products and drug discovery	Elective	2	0	0	2
527	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-4-3901	Project proposal writing & presentation	Core	0	0	4	2
528	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-4-3902	Review Article	Core	0	0	4	2
529	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-4-3903	CSIR-800 Societal Program	Core	0	0	8	4
530	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-1-4101	Research Methodology:	core	1	0	0	1
531	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-1-4102	Analytical Tools and Instrumentation	core	1	0	0	1
532	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-1-4103	Basic mathematics and numerical methods	core	1	0	0	1
533	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-1-4104	Basic Chemistry for Interdisciplinary sciences	Optional	1	0	0	1
534	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-1-4105	Introduction to Nanoscience and Nanotechnology	Optional	1	0	0	1
535	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-1-4106	Introduction to Chemical Biology	Optional				
536	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4101	Advanced Inorganic Chemistry	Elective	2	0	0	2
537	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4102	Advanced Organic Chemistry	Elective	2	0	0	2
538	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4103	Advanced Quantum Mechanics	Elective	2	0	0	2
539	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4104	Advanced Organometallic Chemistry	Elective	2	0	0	2
540	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4105	Advanced Coordination Chemistry	Elective	2	0	0	2
541	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4106	Advanced Photochemistry	Elective	2	0	0	2
542	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4107	Advanced Polymer Chemistry	Elective	2	0	0	2
543	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4108	Advanced Materials Science	Elective	2	0	0	2
544	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4109	Advanced Materials Characterization Techniques:	Elective	2	0	0	2
545	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4110	Advances in Nanoscience and Nanotechnology	Elective	2	0	0	2
546	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4111	Rare Earth Chemistry	Elective	2	0	0	2
547	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4112	Sol-gel chemistry	Elective	2	0	0	2
548	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4113	Green chemistry concpets	Elective	1	0	0	1
549	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4114	Natural products	Elective	2	0	0	2
550	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4115	Synthetic methods for organic chemists	Elective	2	0	0	2
551	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4116	Organic reaction mechanisms	Elective	2	0	0	2

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
552	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4117	Composite materials	Elective	2	0	0	2
553	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4118	Organic spectroscopy applications	Elective	2	0	0	2
554	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4119	Surface characterization techniques	Elective	2	0	0	2
555	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4101	Electronic structure theory	Elective	2	0	0	2
556	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4102	Molecular modeling and simulation	Elective	2	0	0	2
557	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4103	Carbohydrate chemistry	Elective	2	0	0	2
558	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4104	Supramolecular chemistry	Elective	2	0	0	2
559	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4105	Total Synthesis	Elective	1	0	0	1
560	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4106	Asymmetric Synthesis	Elective	1	0	0	1
561	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4107	Chemistry and biology of Heterocycles	Elective	2	0	0	2
562	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4108	Homogeneous Catalysis	Elective	1	0	0	1
563	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4109	Catalysis for organic synthesis	Elective	1	0	0	1
564	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4110	Materials and devices for energy conversion	Elective	2	0	0	2
565	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4111	Functional Ceramics	Elective	1	0	0	1
566	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4112	Photoinduced electron and Energy transfer	Elective	2	0	0	2
567	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4113	Block copolymers	Elective	2	0	0	2
568	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4114	Pi-conjugated polymers	Elective	2	0	0	2
569	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4115	Liquid Crystals	Elective	2	0	0	2
570	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4116	Ultrafast processes and spectroscopy	Elective	2	0	0	2
571	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4117	Natural products and drug discovery	Elective	2	0	0	2
572	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4118	Photobiology	Elective	2	0	0	2
573	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4119	Nanobiotechnology	Elective	2	0	0	2
574	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4120	Rare Earth Molecular Materials	Elective	2	0	0	2
575	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4121	Transition Metal Catalysed organic synthesis & Application in total synthesis of natural products, heterocycles and pharmaceutical intermediates	Elective	2	0	0	2
576	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4122	EMI Shielding Materials	Elective	2	0	0	2
577	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4123	Advanced Materials Processing	Elective	2	0	0	2
578	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4124	Advanced Functional Materials	Elective	2	0	0	2
579	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4125	Surface Science and Technology	Elective	2	0	0	2
580	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4126	ADVANCED DYE-REMOVAL TECHNOLOGIES	Elective	1	0	2	2
581	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4127	Nanomaterials Science and Technology	Elective				
582	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4128	Ionic Conductors	Elective	2	0	2	2
583	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4129	Polymeric Hierarchical Structure and Properties	Elective	2	0	2	2
584	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4130	Advanced sol gel processing	Elective	2	0	2	2
585	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4131	Soft nanomaterials & Functional Polymers	Elective	2	0	2	2
586	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4132	Porous structures	Elective	2	0	0	2
587	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-4-4101	Project proposal writing & presentation	Core	0	0	4	2
588	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-4-4102	Review Article	Core	0	0	4	2
589	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-4-4103	CSIR-800 Societal Program	Core	0	0	8	4

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
1	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-1-1001	Research Methodology:	Core	1	0	0	1
2	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-1-1002	Analytical Tools and Instrumentation	Core	1	0	0	1
3	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-1-1004	Basic Chemistry for Interdisciplinary sciences:	Optional	1	0	0	1
4	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-1-1005	Introduction to Nanoscience and Nanotechnology	Optional	1	0	0	1
5	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1001	Advanced Inorganic Chemistry	Core	2	0	0	2
6	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1002	Advanced Analytical Chemistry	Elective	2	0	0	2
7	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1003	Advance Materials Characterization Techniques	Elective	2	0	0	2
8	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1004	Sol-gel chemistry	Elective	2	0	0	2
9	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1005	Green chemistry	Elective	2	0	0	2
10	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1006	Environmental Sciences	Elective	2	0	0	2
11	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1007	Environmental Chemistry	Elective	2	0	0	2
12	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1008	Process Chemistry	Elective	1	0	0	1
13	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1009	Separation Science and Technology	Elective	1	0	0	1
14	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1010	Green Chemistry	Elective	1	0	0	1
15	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1011	Soil Sciences	Elective	2	0	0	2
16	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-2-1012	Ground Water and Geochemical Studies	Elective	2	0	0	2
17	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1001	Natural Products and Drug Discovery	Elective	2	0	0	2
18	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1002	Corrosion and Corrosion Protection	Elective	2	0	0	2
19	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1003	Nano Science and Engineering	Elective	2	0	0	2
20	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1004	Functional and Smart Materials	Elective	2	0	0	2
21	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1005	Microfluidics and Microseparation	Elective	2	0	0	2
22	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1006	Unit Operations in Environmental Chemistry	Elective	2	0	0	2
23	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1007	Waste Utilization and Value Addition	Elective	2	0	0	2
24	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1008	Industrial Effluent Treatment & Disposal	Elective	2	0	0	2
25	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1009	Advanced Soil Science	Elective	2	0	0	2
26	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1010	Environment Assessment, Monitoring, Protection and Management	Elective	2	0	0	2
27	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-3-1011	Methods and Techniques for Water resources Development and Manag	Elective	2	0	0	2
28	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-4-1001	Project proposal writing & presentation	Core	0	0	4	2
29	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-4-1002	Review Article	Core	0	0	4	2
30	Chemical Sciences	CSIR-AMPRI, Bhopal	CHE-AMPRI-4-1003	CSIR-800 Societal Program	Core	0	0	8	4
31	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-1-1301	Research Methodology	Core	1	0	0	1
32	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-1-1302	Analytical Tools and Instrumentation	Core	1	0	0	1
33	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-1-1304	Basic Chemistry for Interdisciplinary sciences:	Optional	1	0	0	1
34	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-1-1306	Introduction to Chemical Biology	Optional	1	0	0	1
35	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-2-1301	Advanced Organic Chemistry	Compulsory	2	0	0	2
36	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-2-1302	Advanced process chemistry	Elective	2	0	0	2
37	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-2-1303	Advances in Chemical Biology	Elective	2	0	0	2
38	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-2-1304	Natural products	Elective	2	0	0	2
39	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-2-1305	Synthetic methods for organic chemists	Elective	2	0	0	2

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
40	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-2-1306	Organic spectroscopy applications	Elective	2	0	0	2
41	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-3-1301	Molecular modelling and simulation	Elective	2	0	0	2
42	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-3-1302	Asymmetric Synthesis	Elective	1	0	0	1
43	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-3-1303	Chemistry and biology of Heterocycles	Elective	2	0	0	2
44	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-3-1304	Homogeneous Catalysis	Elective	1	0	0	1
45	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-3-1305	Natural products and drug discovery	Elective	2	0	0	2
46	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-3-1306	Green & Sustainable Chemsitry	Elective	2	0	0	2
47	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-4-1301	Project proposal writing & presentation	Core	0	0	4	2
48	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-4-1302	Review Article	Core	0	0	4	2
49	Chemical Sciences	CSIR-CDRI, Lucknow	CHE-CDRI-4-1303	CSIR-800 Societal Program	Core	0	0	8	4
50	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-1-1401	Research Methodology:	Core	1	0	0	1
51	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-1-1403	Basic mathematics and numerical methods	Core	1	0	0	1
52	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-1-1405	Introduction to Nanoscience and Nanotechnology	Optional	1	0	0	1
53	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-1-1406	Introduction to Chemical Biology	Optional	1	0	0	1
54	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1401	Advanced Physical Chemistry	Elective	2	0	0	2
55	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1402	Advanced Analytical Chemistry	Elective	2	0	0	2
56	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1403	Advanced Electrochemistry	Elective	2	0	0	2
57	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1404	Advanced Materials Science	Elective	2	0	0	2
58	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1405	Advanced Surface Science	Elective	2	0	0	2
59	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1406	Advanced Materials Characterization Techniques:	Elective	2	0	0	2
60	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1407	Advances in Nanoscience and Nanotechnology	Elective	2	0	0	2
61	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1408	Advanced Biomaterials	Elective	2	0	0	2
62	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1409	Ionic liquids	Elective	1	0	0	1
63	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1410	Physical organic chemistry	Elective	2	0	0	2
64	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-2-1411	Surface characterization techniques	Elective	2	0	0	2
65	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1401	Computational materials design	Elective	2	0	0	2
66	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1402	Supramolecular chemistry	Elective	2	0	0	2
67	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1403	Corrosion science	Elective	2	0	0	2
68	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1404	Materials and devices for energy conversion	Elective	2	0	0	2
69	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1405	Organic electrochemistry	Elective	2	0	0	2
70	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1406	Electrochemical power sources	Elective	2	0	0	2
71	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1407	Alternate energy materials	Elective	2	0	0	2
72	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1408	Photoinduced electron and Energy transfer	Elective	2	0	0	2
73	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1409	Hydrogen generation and storage	Elective	2	0	0	2
74	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1410	Polymers for membrane applications	Elective	2	0	0	2
75	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1411	Conducting polymers	Elective	1	0	0	1
76	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1412	Nanobiotechnology	Elective	1	0	0	1
77	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1413	Polymer Electrolyte Fuel Cell	Elective	2	0	0	2
78	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1414	Advanced Lithium Batteries	Elective	2	0	0	2
79	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1415	Functional Materials	Elective	2	0	0	2
80	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1416	Electrochemical Technology	Elective	2	0	0	2
81	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1417	Advanced Corrosion Technology	Elective	2	0	0	2



Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
82	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-3-1418	Electrochemical Remediation	Elective	2	0	0	2
83	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-4-1401	Project proposal writing & presentation	Core	0	0	4	2
84	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-4-1402	Review Article	Core	0	0	4	2
85	Chemical Sciences	CSIR-CECRI, Karaikudi	CHE-CECRI-4-1403	CSIR-800 Societal Program	Core	0	0	8	4
86	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-1-1801	Research Methodology, Communication/ethics/safety	Compulsory	1	0	0	1
87	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-1-1802	Fundamentals of Chemical Sciences	Compulsory	1	0	0	1
88	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-1-1803	Computer Applications and Tools in Chemistry and Biology	Compulsory	1	0	0	1
89	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-1-1804	Basic Instrumentation and Statistical Analysis	Optional	1	0	0	1
90	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1801	Analytical Techniques and Instrumentation		2	0	0	2
91	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1802	Advances in Natural Products Chemistry		2	0	0	2
92	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1803	Green Chemistry		2	0	0	2
93	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1804	Chromatographic Techniques		2	0	0	2
94	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1805	Structure Elucidation of Organic Molecules		2	0	0	2
95	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1806	Frontiers in Pharmaceutical Chemistry		2	0	0	2
96	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1807	Advances in Essential Oil Chemistry		2	0	0	2
97	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1808	Advances in Extraction and Processing Technologies		2	0	0	2
98	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1809	Synthetic applications in Natural Product Chemistry		2	0	0	2
99	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1810	Fundamentals of Environmental Chemistry		2	0	0	2
100	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-2-1811	Intellectual Property Management		2	0	0	2
101	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1801	Isolation and Characterization of New Chemical Entities (NCEs)	Elective	2	0	0	2
102	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1802	Frontiers in Synthetic Chemistry-Basic principles and Name reactions	Elective	2	0	0	2
103	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1803	Reagents in Organic Synthesis	Elective	2	0	0	2
104	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1804	Frontiers in Organic Spectroscopy	Elective	2	0	0	2
105	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1805	Techniques in Natural Products Up Scaling	Elective	2	0	0	2
106	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1806	Applied, Industrial and Environmental Chemistry	Elective	2	0	0	2
107	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1807	Quality assurance of Herbs and Herbal Products	Elective	2	0	0	2
108	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1808	Chemistry of Renewable Energy	Elective	2	0	0	2
109	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1809	Frontiers in Drug discovery and development	Elective	2	0	0	2
110	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1810	Frontiers in Nanomaterial and Nanoscience	Elective	2	0	0	2
111	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-3-1811	Advances in Essential Oil Chemistry and Analysis	Elective	2	0	0	2
112	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-4-1801	Project proposal writing & presentation	Compulsory	0	0	4	2
113	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-4-1802	Review Article	Compulsory	0	0	4	2
114	Chemical Sciences	CSIR-CIMAP, Lucknow	CHE-CIMAP-4-1803	CSIR-800 Societal Program	Compulsory	0	0	8	4
115	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-1-1901	Research Methodology	core	1	0	0	1
116	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-1-1902	Analytical Tools and Instrumentation	core	1	0	0	1
117	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-1-1903	Basic mathematics and numerical methods	core	1	0	0	1
118	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-1-1904	Basic Chemistry for Interdisciplinary sciences:	Optional	1	0	0	1
119	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-2-1901	Advanced Organic Chemistry		2	0	0	2

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
120	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-2-1902	Advanced Coal Science	Elective	2	0	0	2
121	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-2-1903	Environmental Chemistry	Elective	1	0	2	2
122	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1901	Coal Geology and Organic Petrology	Elective	1	0	2	2
123	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1902	Analytical Techniques for Coal and Derivatives	Elective	1	0	2	2
124	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1903	Coal Beneficiation	Elective	2	0	2	3
125	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1904	Combustion Science and Technology	Elective	2	0	2	3
126	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1905	Coal Gasification	Elective	2	0	2	3
127	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1906	Coal to Liquid (CTL) Technology	Elective	2	0	2	3
128	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1907	Coal Carbonization	Elective	2	0	2	3
129	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1908	Coal Biotechnology	Elective	1	0	2	2
130	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1909	Environmental Management in Coal Industry	Elective	2	0	0	2
131	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1910	Management of Soil, Water & Air Pollution in Coal Industry	Elective	1	0	2	2
132	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-3-1911	GHG Emission and Clean Development Strategies	Elective	2	0	0	2
133	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-4-1901	Project proposal writing & presentation	Core	0	0	4	2
134	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-4-1902	Review Article	Core	0	0	4	2
135	Chemical Sciences	CSIR-CIMFR, Dhanbad	CHE-CIMFR-4-1903	CSIR-800 Societal Program	Core	0	0	8	4
136	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-1-2001	Research Methodology	Core	1	0	0	1
137	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-1-2002	Analytical Tools and Instrumentation	Core	1	0	0	1
138	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-1-2003	Basic mathematics and numerical methods	Core	1	0	0	1
139	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-1-2004	Basic Chemistry for Interdisciplinary sciences	Optional	1	0	0	1
140	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-1-2005	Introduction to Nanoscience and Nanotechnology	Optional	1	0	0	1
141	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-1-2006	Introduction to Chemical Biology	Optional	1	0	0	1
142	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2001	Advanced Physical Chemistry	Elective	2	0	0	2
143	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2002	Advanced Inorganic Chemistry	Elective	2	0	0	2
144	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2003	Advanced Organic Chemistry	Elective	2	0	0	2
145	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2004	Advanced Analytical Chemistry	Elective	2	0	0	2
146	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2005	Advanced Quantum Mechanics	Elective	2	0	0	2
147	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2006	Advanced Organometallic Chemistry	Elective	2	0	0	2
148	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2007	Advanced Coordination Chemistry	Elective	2	0	0	2
149	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2008	Advanced Photochemistry	Elective	2	0	0	2
150	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2009	Advanced Polymer Chemistry	Elective	2	0	0	2
151	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2010	Advanced Electrochemistry	Elective	2	0	0	2
152	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2011	Advances in Bioinorganic chemistry	Elective	2	0	0	2
153	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2012	Advances in hydrocarbon chemistry	Elective	2	0	0	2
154	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2013	Advanced process chemistry	Elective	2	0	0	2
155	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2014	Advanced Materials Science	Elective	2	0	0	2
156	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2015	Advanced Catalysis	Elective	2	0	0	2
157	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2016	Advanced Surface Science	Elective	2	0	0	2
158	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2017	Advanced Separation Science and Technology:	Elective	2	0	0	2
159	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2018	Advanced Materials Characterization Techniques:	Elective	2	0	0	2
160	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2019	Advances in Nanoscience and Nanotechnology	Elective	2	0	0	2
161	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2020	Advances in soft matter chemistry	Elective	2	0	0	2
162	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2021	Advances in Chemical Biology	Elective	2	0	0	2
163	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2022	Advanced Biomaterials	Elective	2	0	0	2
164	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2023	Rare Earth Chemistry	Elective	2	0	0	2
165	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2024	Sol-gel chemistry	Elective	2	0	0	2
166	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2025	Combinatorial chemistry	Elective	1	0	0	1

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
167	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2026	Green chemistry	Elective	1	0	0	1
168	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2027	Natural products	Elective	2	0	0	2
169	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2028	Ionic liquids	Elective	1	0	0	1
170	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2029	Synthetic methods for organic chemists	Elective	2	0	0	2
171	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2030	Organic reaction mechanisms	Elective	2	0	0	2
172	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2031	Dyes and pigments	Elective	1	0	0	1
173	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2032	Physical organic chemistry	Elective	2	0	0	2
174	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2033	Thermodynamics and Statistical Mechanics	Elective	2	0	0	2
175	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2034	Composite materials	Elective	2	0	0	2
176	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2035	Organic spectroscopy applications	Elective	2	0	0	2
177	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-2-2036	Surface characterization techniques	Elective	2	0	0	2
178	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2001	Mathematical Methods	Elective	2	0	0	2
179	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2002	Numerical Methods	Elective	2	0	0	2
180	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2003	Electronic structure theory	Elective	2	0	0	2
181	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2004	Molecular modeling and simulation	Elective	2	0	0	2
182	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2005	Computer aided drug design	Elective	2	0	0	2
183	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2006	Computational materials design	Elective	2	0	0	2
184	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2007	Multiphase reaction kinetics	Elective	1	0	0	1
185	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2008	Carbohydrate chemistry	Elective	2	0	0	2
186	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2009	Biophysical chemistry	Elective	2	0	0	2
187	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2010	Physics and chemistry of collagen	Elective	2	0	0	2
188	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2011	Marine Natural products	Elective	2	0	0	2
189	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2012	Supramolecular chemistry	Elective	2	0	0	2
190	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2013	Total Synthesis	Elective	1	0	0	1
191	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2014	Asymmetric Synthesis	Elective	1	0	0	1
192	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2015	Chemistry and biology of Heterocycles	Elective	2	0	0	2
193	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2016	Agrochemicals	Elective	2	0	0	2
194	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2017	Fluoro organic chemistry	Elective	2	0	0	2
195	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2018	Corrosion science	Elective	2	0	0	2
196	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2019	Nutraceuticals:	Elective	2	0	0	2
197	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2020	Ionic liquids for lubricants	Elective	1	0	0	1
198	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2021	Applications of ionic liquids	Elective	1	0	0	1
199	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2022	Homogeneous Catalysis	Elective	1	0	0	1
200	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2023	Catalysis for organic synthesis	Elective	1	0	0	1
201	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2024	Materials and devices for energy conversion	Elective	2	0	0	2
202	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2025	Functional Ceramics	Elective	1	0	0	1
203	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2026	Porous structures	Elective	2	0	0	2
204	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2027	Biomaterials for targeted therapeutics	Elective	2	0	0	2
205	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2028	Organic electrochemistry	Elective	2	0	0	2
206	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2029	Photoinduced electron and Energy transfer	Elective	2	0	0	2
207	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2030	Thermochemical Conversion of Biomass	Elective	1	0	0	1
208	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2031	Block copolymers	Elective	2	0	0	2
209	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2032	Polymers for membrane applications	Elective	2	0	0	2
210	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2033	Ion exchange polymers	Elective	1	0	0	1
211	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2034	Conducting polymers	Elective	1	0	0	1
212	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2035	Polymers and Colloidal Solutions	Elective	2	0	0	2

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
213	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2036	Biodegradable polymers	Elective	2	0	0	2
214	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2037	Controlled Radical/Living Polymerizations and Macromolecular Architect	Elective	2	0	0	2
215	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2038	Pi-conjugated polymers	Elective	2	0	0	2
216	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2039	Liquid Crystals	Elective	2	0	0	2
217	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2040	X-Ray Diffraction and Structure of Solids	Elective	2	0	0	2
218	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2041	NMR spectroscopy	Elective	2	0	0	2
219	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2042	Mass spectrometry applications	Elective	2	0	0	2
220	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2043	Ultrafast processes and spectroscopy	Elective	2	0	0	2
221	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2044	Small Angle Scattering Techniques	Elective	2	0	0	2
222	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2045	Natural products and drug discovery	Elective	2	0	0	2
223	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2046	Lipid science & technology	Elective	2	0	0	2
224	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2047	Photobiology	Elective	2	0	0	2
225	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-3-2048	Nanobiotechnology	Elective	1	0	0	1
226	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-4-2001	Project proposal writing & presentation	Core	0	0	4	2
227	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-4-2002	Review Article	Core	0	0	4	2
228	Chemical Sciences	CSIR-CLRI, Chennai	CHE-CLRI-4-2003	CSIR-800 Societal Program	Core	0	0	8	4
229	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-1-2101	Research Methodology:	Core	1	0	0	1
230	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-1-2102	Analytical Tools and Instrumentation	Core	1	0	0	1
231	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-1-2104	Basic Chemistry for Interdisciplinary sciences	Optional	1	0	0	1
232	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-1-2105	Introduction to Nanoscience and Nanotechnology	Optional	1	0	0	1
233	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-2-2101	Advanced Physical Chemistry	Elective	2	0	0	2
234	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-2-2102	Advanced Inorganic Chemistry	Elective	2	0	0	2
235	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-2-2103	Advanced Organic Chemistry	Elective	2	0	0	2
236	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-2-2104	Advanced Coordination Chemistry	Elective	2	0	0	2
237	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-2-2105	Advances in Bioinorganic chemistry	Elective	2	0	0	2
238	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-2-2106	Advanced Materials Science	Elective	2	0	0	2
239	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-2-2107	Advanced Catalysis	Elective	2	0	0	2
240	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-2-2108	Advanced Surface Science	Elective	2	0	0	2
241	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-3-2101	Functional Ceramics	Elective	1	0	0	1
242	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-3-2102	Modern Magnetic Materials	Elective	1	0	0	1
243	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-3-2103	Porous structures	Elective	2	0	0	2
244	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-4-2101	Project proposal writing & presentation	Core	0	0	4	2
245	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-4-2102	Review Article	Core	0	0	4	2
246	Chemical Sciences	CSIR-CMERI, Durgapur	CHE-CMERI-4-2103	CSIR-800 Societal Program	Core	0	0	8	4
247	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-1-2501	Research Methodology:	Core	1	0	0	1
248	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-1-2502	Analytical Tools and Instrumentation	Core	1	0	0	1
249	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-1-2503	Basic mathematics and numerical methods	core	1	0	0	1
250	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-1-2504	Basic Chemistry for Interdisciplinary sciences	Optional	1	0	0	1
251	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-1-2505	Introduction to Nanoscience and Nanotechnology	Optional	1	0	0	1
252	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2501	Advanced Physical Chemistry	Elective	2	0	0	2

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
253	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2502	Advanced Inorganic Chemistry	Elective	2	0	0	2
254	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2503	Advanced Organic Chemistry	elective	2	0	0	2
255	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2504	Advanced Analytical Chemistry	Elective	2	0	0	2
256	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2505	Advanced Quantum Mechanics	Elective	2	0	0	2
257	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2506	Advanced Coordination Chemistry	Elective	2	0	0	2
258	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2507	Advanced Polymer Chemistry	Elective	2	0	0	2
259	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2508	Advanced Electrochemistry	Elective	2	0	0	2
260	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2509	Advanced process chemistry	Elective	2	0	0	2
261	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2510	Advanced Materials Science	Elective	2	0	0	2
262	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2511	Advanced Catalysis	Elective	2	0	0	2
263	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2512	Advanced Surface Science	Elective	2	0	0	2
264	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2513	Advanced Separation Science and Technology	Elective	2	0	0	2
265	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2514	Advanced Materials Characterization Techniques	Elective	2	0	0	2
266	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2515	Advances in Nanoscience and Nanotechnology	Elective	2	0	0	2
267	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2516	Green chemistry	Elective	1	0	0	1
268	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2517	Natural products	Elective	2	0	0	2
269	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2518	Ionic liquids	Elective	1	0	0	1
270	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-2-2519	Organic reaction mechanisms	Elective	2	0	0	2
271	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2501	Molecular modeling and simulation	Elective	2	0	0	2
272	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2502	Marine Natural products	Elective	2	0	0	2
273	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2503	Supramolecular chemistry	Elective	2	0	0	2
274	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2504	Asymmetric Synthesis	Elective	1	0	0	1
275	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2505	Salts from marine resources	Elective	2	0	0	2
276	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2506	Applications of ionic liquids	Elective	1	0	0	1
277	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2507	Homogeneous Catalysis	Elective	1	0	0	1
278	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2508	Catalysis for organic synthesis	Elective	1	0	0	1
279	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2509	Catalysis for biomass refining	Elective	1	0	0	1
280	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2510	Porous structures	Elective	2	0	0	2
281	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2511	Electrochemical power sources	Elective	2	0	0	2
282	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2512	Alternate energy materials	Elective	2	0	0	2
283	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2513	Photoinduced electron and Energy transfer	Elective	2	0	0	2
284	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2514	Thermochemical Conversion of Biomass	Elective	1	0	0	1
285	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2515	CO2 sequestration and conversion	Elective	2	0	0	2
286	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2516	Block copolymers	Elective	2	0	0	2
287	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2517	Polymers for membrane applications	Elective	2	0	0	2
288	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2518	Ion exchange polymers	Elective	1	0	0	1
289	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2519	Conducting polymers	Elective	1	0	0	1
290	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2520	X-Ray Diffraction and Structure of Solids	Elective	2	0	0	2
291	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-3-2521	NMR spectroscopy	Elective	2	0	0	2
292	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-4-2501	Project proposal writing & presentation	Compulsory	0	0	4	2
293	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-4-2502	Review Article	Compulsory	0	0	4	2

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
294	Chemical Sciences	CSIR-CSMCRI, Bhavnagar	CHE-CSMCRI-4-2503	CSIR-800 Societal Program	Compulsory	0	0	8	4
295	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-1-2701	Research Methodology:	Core	1	0	0	1
296	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-1-2702	Analytical Chromatographic Techniques	Core	1	0	0	1
297	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-1-2703	Organic Spectroscopy Techniques	Optional	1	0	0	1
298	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-2-2701	Advanced Organic Synthesis	Elective	2	0	0	2
299	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-2-2702	Advances in Oxidation and Reduction Reactions	Elective	2	0	0	2
300	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-2-2703	Advances in Natural Products: Traditional methods and Terpenoids	Elective	2	0	0	2
301	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-2-2704	Advances in Natural Products: Alkaloids and Polyphenols	Elective	2	0	0	2
302	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-3-2701	Green Chemistry	Elective	2	0	0	2
303	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-3-2702	Advances in Catalyst and Reagent Chemistry	Elective	2	0	0	2
304	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-3-2703	Advances in Natural Products: Extraction and Isolation Techniques	Elective	2	0	0	2
305	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-3-2704	NMR Spectroscopy and its Applications in Organic Chemistry	Elective	2	0	0	2
306	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-4-2701	Project proposal writing & presentation	Core	0	0	4	2
307	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-4-2702	Review Article	Core	0	0	4	2
308	Chemical Sciences	CSIR-IHBT, Palampur	CHE-IHBT-4-2703	CSIR-800 Societal Program	Core	0	0	8	4
309	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-1-2901	Research Methodology (communication & writing skill)	Core	1	0	0	1
310	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-1-2902	Analytical Tools and Instrumentation	Core	1	0	0	1
311	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-1-2905	Introduction to Nanoscience and Nanotechnology	Optional	1	0	0	1
312	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2901	Advanced Physical Chemistry	Elective	2	0	0	2
313	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2902	Advanced Organic Chemistry	Elective	2	0	0	2
314	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2903	Advanced Analytical Chemistry	Elective	2	0	0	2
315	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2904	Advanced Polymer Chemistry	Elective	2	0	0	2
316	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2905	Advanced Catalysis	Elective	2	0	0	2
317	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2906	Advanced Separation Science and Technology:	Elective	2	0	0	2
318	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2907	Advances in Nanoscience and Nanotechnology	Elective	2	0	0	2
319	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2908	Advances in soft matter chemistry	Elective	2	0	0	2
320	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2909	Green chemistry	Elective	2	0	0	2
321	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2910	Dyes and pigments	Elective	1	0	0	1
322	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2911	Composite materials	Elective	2	0	0	2
323	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-2-2912	Advanced NMR Spectroscopic Method	Elective	2	0	0	2
324	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2901	Supramolecular chemistry	Elective	2	0	0	2
325	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2902	Total Synthesis	Elective	1	0	0	1
326	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2903	Asymmetric Synthesis	Elective	1	0	0	1
327	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2904	Agrochemicals	Elective	2	0	0	2
328	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2905	Fluoro organic chemistry	Elective	2	0	0	2
329	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2906	Corrosion science	Elective	2	0	0	2
330	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2907	Catalysis for biomass refining	Elective	1	0	0	1
331	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2908	Materials and devices for energy conversion	Elective	2	0	0	2

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
332	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2909	Electrochemical power sources	Elective	2	0	0	2
333	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2910	Hydrogen generation and storage	Elective	2	0	0	2
334	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2911	CO2 sequestration and conversion	Elective	2	0	0	2
335	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2912	Block copolymers	Elective	2	0	0	2
336	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2913	Conducting polymers	Elective	1	0	0	1
337	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2914	Polymers and Colloidal Solutions	Elective	2	0	0	2
338	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2915	Controlled Radical/Living Polymerizations and Macromolecular Architect	Elective	2	0	0	2
339	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2916	Pi-conjugated polymers	Elective	2	0	0	2
340	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2917	Liquid Crystals	Elective	2	0	0	2
341	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2918	X-Ray Diffraction and Structure of Solids	Elective	2	0	0	2
342	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2919	NMR spectroscopy	Elective	2	0	0	2
343	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-3-2920	Mass spectrometry applications	Elective	2	0	0	2
344	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-4-2901	Project proposal writing & presentation	Compulsory	0	0	4	2
345	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-4-2902	Review Article	Compulsory	0	0	4	2
346	Chemical Sciences	CSIR-IICT, Hyderabad	CHE-IICT-4-2903	CSIR-800 Societal Program	Compulsory	0	0	8	4
347	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-1-3001	Research Methodology:	Core	1	0	0	1
348	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-1-3002	Analytical Tools and Instrumentation	Core	1	0	0	1
349	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-1-3004	Basic Chemistry for Interdisciplinary sciences	Optional	1	0	0	1
350	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-1-3006	Basic Biology for interdisciplinary sciences	Optional	1	0	0	1
351	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-2-3001	Advanced Organic Chemistry	Core	2	0	0	2
352	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-2-3002	Natural Product	Elective	2	0	0	2
353	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-2-3003	Drug Discovery	Elective	2	0	0	2
354	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-2-3004	Molecular Modelling and Simulation	Elective	2	0	0	2
355	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-3-3001	Medicinal Chemistry (Oncology/Infection), Isolations and Synthesis	Elective	3	0	0	3
356	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-3-3002	Seminar for individual	Elective	1	0	0	1
357	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-4-3001	Project proposal writing & presentation	Core	0	0	4	2
358	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-4-3002	Review Article	Core	0	0	4	2
359	Chemical Sciences	CSIR-IIIM, Jammu	CHE-IIIM-4-3003	CSIR-800 Societal Program	Core	0	0	8	4
360	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-1-3101	Research Methodology	Core	1	0	0	1
361	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-1-3102	Analytical Tools and Instrumentation	Core	1	0	0	1
362	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-2-3101	Advanced Organic Chemistry	Core	2	0	0	2
363	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-2-3102	Advanced Analytical Chemistry	Elective	2	0	0	2
364	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-2-3103	Advances in hydrocarbon chemistry	Elective	2	0	0	2
365	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-2-3104	Advanced Catalysis	Elective	2	0	0	2
366	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-2-3105	Alternative feedstock options for petrochemicals	Elective	2	0	0	2
367	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-3-3101	Multiphase reaction kinetics	Elective	1	0	0	1
368	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-3-3102	Ionic liquids for lubricants	Elective	1	0	0	1
369	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-3-3103	Catalysis in petroleum refining	Elective	2	0	0	2
370	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-3-3104	Biocatalysis in petroleum refining	Elective	1	0	0	1
371	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-3-3105	Thermochemical Conversion of Biomass	Elective	1	0	0	1
372	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-3-3106	CO2 sequestration and conversion	Elective	2	0	0	2
373	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-3-3107	Natural gas to liquid fuels	Elective	2	0	0	2
374	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-3-3108	Gasoline reformulation techniques	Elective	2	0	0	2

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
375	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-4-3101	Project proposal writing & presentation	Compulsory	0	0	4	2
376	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-4-3102	Review Article	Compulsory	0	0	4	2
377	Chemical Sciences	CSIR-IIP, Dehradun	CHE-IIP-4-3103	CSIR-800 Societal Program	Compulsory	0	0	8	4
378	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-1-3201	Research Methodology:	Core	1	0	0	1
379	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-1-3202	Analytical Tools and Instrumentation	Core	1	0	0	1
380	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-2-3201	Advanced Organic Chemistry	Elective	2	0	0	2
381	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-2-3202	Advanced Analytical Chemistry	Elective	2	0	0	2
382	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-2-3203	Advanced Photochemistry	Elective	2	0	0	2
383	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-2-3204	Green chemistry	Elective	1	0	0	1
384	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-2-3205	Ionic liquids	Elective	1	0	0	1
385	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-2-3206	Synthetic methods for organic chemists	Elective	2	0	0	2
386	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-2-3207	Dyes and pigments	Elective	1	0	0	1
387	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-2-3208	Thermodynamics and Statistical Mechanics	Elective	2	0	0	2
388	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-2-3209	Organic Spectroscopy Applications	Elective	2	0	0	2
389	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-3-3201	Applications of ionic liquids	Elective	1	0	0	1
390	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-3-3202	Biodegradable polymers	Elective	2	0	0	2
391	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-3-3203	NMR spectroscopy	Elective	2	0	0	2
392	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-3-3204	Mass spectrometry applications	Elective	2	0	0	2
393	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-3-3205	Natural products and drug discovery	Elective	2	0	0	2
394	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-3-3206	Photobiology	Elective	2	0	0	2
395	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-4-3201	Project proposal writing & presentation	Core	0	0	4	2
396	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-4-3202	Review Article	Core	0	0	4	2
397	Chemical Sciences	CSIR-IITR, Lucknow	CHE-IITR-4-3203	CSIR-800 Societal Program	Core	0	0	8	4
398	Chemical Sciences	CSIR-IMMT, Bhubaneswar	CHE-IMMT-1-3301	Research Methodology		2	0	0	2
399	Chemical Sciences	CSIR-IMMT, Bhubaneswar	CHE-IMMT-1-3302	Materials Characterization Techniques		3	0	2	4
400	Chemical Sciences	CSIR-IMMT, Bhubaneswar	CHE-IMMT-2-3301	Advanced Materials Chemistry		3	0	2	4
401	Chemical Sciences	CSIR-IMMT, Bhubaneswar	CHE-IMMT-2-3302	Environmental Science		3	0	2	4
402	Chemical Sciences	CSIR-IMMT, Bhubaneswar	CHE-IMMT-3-3301	Advanced Chemistry for Hydro & Electrometallurgy		3	0	2	4
403	Chemical Sciences	CSIR-IMMT, Bhubaneswar	CHE-IMMT-3-3302	Advanced Self Study on Special topic 4C		3	0	2	4
404	Chemical Sciences	CSIR-IMMT, Bhubaneswar	CHE-IMMT-4-3301	Project Proposal writing & presentation		0	0	4	2
405	Chemical Sciences	CSIR-IMMT, Bhubaneswar	CHE-IMMT-4-3302	Review Article		0	0	4	2
406	Chemical Sciences	CSIR-IMMT, Bhubaneswar	CHE-IMMT-4-3303	CSIR-800 Societal Program		0	0	8	4
407	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-1-3701	Research Methodology	Compulsory	2	0	0	2
408	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-1-3702	Analytical Tools and Instrumentation	Compulsory	2	0	0	2
409	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-1-3703	Basic mathematics and numerical methods	Compulsory	2	0	0	2
410	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-1-3704	Basic Chemistry for Interdisciplinary sciences:	Optional	1	0	0	1
411	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-1-3705	Introduction to Nanoscience and Nanotechnology	Optional	1	0	0	1
412	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-1-3706	Introduction to Chemical Biology	Optional	1	0	0	1
413	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3701	Advanced Physical Chemistry	Elective	3	0	0	3



Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
414	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3702	Advanced Inorganic Chemistry	Elective	3	0	0	3
415	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3703	Advanced Organic Chemistry	Elective	3	0	0	3
416	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3704	Advanced Analytical Chemistry	Elective	3	0	0	3
417	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3705	Advanced Quantum Mechanics	Elective	3	0	0	3
418	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3706	Advanced Organometallic Chemistry	Elective	3	0	0	3
419	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3707	Advanced Photochemistry	Elective	3	0	0	3
420	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3708	Advanced Polymer Chemistry	Elective	3	0	0	3
421	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3709	Advanced Electrochemistry	Elective	2	0	0	2
422	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3710	Advanced Materials Science	Elective	3	0	0	3
423	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3711	Advanced Catalysis	Elective	3	0	0	3
424	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3712	Advanced Surface Science	Elective	2	0	0	2
425	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3713	Advanced Separation Science and Technology:	Elective	2	0	0	2
426	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3714	Advanced Materials Characterization Techniques:	Elective	3	0	0	3
427	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3715	Advances in Nanoscience and Nanotechnology	Elective	3	0	0	3
428	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3716	Advances in Chemical Biology	Elective	3	0	0	3
429	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3717	Advanced Biomaterials	Elective	3	0	0	3
430	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3718	Green chemistry	Elective	3	0	0	3
431	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3719	Organic reaction mechanisms	Elective	3	0	0	3
432	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3720	Thermodynamics and Statistical Mechanics	Elective	3	0	0	3
433	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3721	Composite materials	Elective	2	0	0	2
434	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3722	Carbon allotropes	Elective	1	0	0	1
435	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3723	Organic spectroscopy applications	Elective	3	0	0	3
436	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3724	Surface characterization techniques	Elective	2	0	0	2
437	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3725	Organic Biomolecular Chemistry	Elective	3	0	0	3
438	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-2-3726	Physical Organic Chemistry	Elective	2	0	0	2
439	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3701	Mathematical Methods	Elective	3	0	0	3
440	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3702	Numerical Methods	Elective	3	0	0	3
441	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3703	Electronic structure theory	Elective	2	0	0	2
442	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3704	Molecular modeling and simulation	Elective	2	0	0	2
443	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3705	Computational materials design	Elective	2	0	0	2
444	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3706	Carbohydrate chemistry	Elective	2	0	0	2
445	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3707	Chemistry and biology of Heterocycles	Elective	2	0	0	2
446	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3708	Homogeneous Catalysis	Elective	2	0	0	2
447	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3709	Materials and devices for energy conversion	Elective	2	0	0	2
448	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3710	Functional Ceramics	Elective	1	0	0	1
449	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3711	Modern Magnetic Materials	Elective	1	0	0	1
450	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3712	Porous structures	Elective	2	0	0	2
451	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3713	Electrochemical power sources	Elective	2	0	0	2
452	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3714	Alternate energy materials	Elective	2	0	0	2
453	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3715	Hydrogen generation and storage	Elective	2	0	0	2
454	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3716	Polymers and Colloidal Solutions	Elective	3	0	0	3
455	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3717	Controlled Radical/Living Polymerizations and Macromolecular Architec	Elective	2	0	0	2
456	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3718	X-Ray Diffraction and Structure of Solids	Elective	3	0	0	3
457	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3719	NMR spectroscopy	Elective	3	0	0	3
458	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3720	Mass spectrometry applications	Elective	2	0	0	2
459	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3721	Small Angle Scattering Techniques	Elective	2	0	0	2

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
460	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3722	Operando Surface Techniques	Elective	3	0	0	3
461	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3723	Chromatographic Techniques	Elective	2	0	0	2
462	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3724	Equilibrium and non-equilibrium statistical mechanics for soft matter	Elective	3	0	0	3
463	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3725	Modern Polymerization Methods for Functional Macromolecules	Elective	2	0	0	2
464	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3726	Molecular Self assembly	Elective	3	0	0	3
465	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3727	Total Synthesis	Elective	2	0	0	2
466	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3728	Catalysis in Petroleum Refining	Elective	2	0	0	2
467	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3729	Thermochemical Conversion of Biomass	Elective	2	0	0	2
468	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3701	Project proposal writing & presentation	Compulsory	0	0	4	2
469	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3702	Review Article	Compulsory	0	0	4	2
470	Chemical Sciences	CSIR-NCL, Pune	CHE-NCL-3-3703	CSIR-800 Societal Program	Compulsory	0	0	8	4
471	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-1-3901	Research Methodology:	core	1	0	0	1
472	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-1-3902	Analytical Tools and Instrumentation	core	1	0	0	1
473	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-1-3903	Basic mathematics and numerical methods	core	1	0	0	1
474	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-1-3904	Basic Chemistry for Interdisciplinary sciences:	Optional	1	0	0	1
475	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-1-3905	Introduction to Nanoscience and Nanotechnology	Optional	1	0	0	1
476	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-1-3906	Introduction to Chemical Biology	Optional				
477	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3901	Advanced Physical Chemistry	Elective	2	0	0	2
478	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3902	Advanced Inorganic Chemistry	Elective	2	0	0	2
479	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3903	Advanced Organic Chemistry	Elective	2	0	0	2
480	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3904	Advanced Analytical Chemistry	Elective	2	0	0	2
481	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3905	Advanced Organometallic Chemistry	Elective	2	0	0	2
482	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3906	Advanced Coordination Chemistry	Elective	2	0	0	2
483	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3907	Advanced Polymer Chemistry	Elective	2	0	0	2
484	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3908	Advanced Electrochemistry	Elective	2	0	0	2
485	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3909	Advances in Bioinorganic chemistry	Elective	2	0	0	2
486	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3910	Advances in hydrocarbon chemistry	Elective	2	0	0	2
487	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3911	Advanced Catalysis	Elective	2	0	0	2
488	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3912	Advanced Surface Science	Elective	2	0	0	2
489	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3913	Advanced Materials Characterization Techniques	Elective	2	0	0	2
490	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3914	Advances in Nanoscience and Nanotechnology	Elective	2	0	0	2
491	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3915	Advances in Chemical Biology	Elective	2	0	0	2
492	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3916	Sol-gel chemistry	Elective	2	0	0	2
493	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3917	Green chemistry	Elective	1	0	0	1
494	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3918	Coal chemistry	Elective	2	0	0	2
495	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3919	Alternative feedstock options for petrochemicals	Elective	2	0	0	2
496	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3920	Natural products	Elective	2	0	0	2
497	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3921	Ionic liquids	Elective	1	0	0	1
498	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3922	Synthetic methods for organic chemists	Elective	2	0	0	2
499	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3923	Organic reaction mechanisms	Elective	2	0	0	2
500	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3924	Physical organic chemistry	Elective	2	0	0	2
501	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3925	Composite materials	Elective	2	0	0	2
502	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3926	Carbon allotropes	Elective	1	0	0	1
503	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3927	Organic spectroscopy applications	Elective	2	0	0	2
504	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3928	Surface characterization techniques	Elective	2	0	0	2
505	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-2-3929	Oil Field Materials and Operations	Elective	2	0	0	2

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
506	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3901	Computer aided drug design	Elective	2	0	0	2
507	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3902	Carbohydrate chemistry	Elective	2	0	0	2
508	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3903	Total Synthesis	Elective	1	0	0	1
509	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3904	Asymmetric Synthesis	Elective	1	0	0	1
510	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3905	Chemistry and biology of Heterocycles	Elective	2	0	0	2
511	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3906	Fluoro organic chemistry	Elective	2	0	0	2
512	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3907	Nutraceuticals	Elective	2	0	0	2
513	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3908	Homogeneous Catalysis	Elective	1	0	0	1
514	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3909	Catalysis for organic synthesis	Elective	1	0	0	1
515	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3910	Functional Ceramics	Elective	1	0	0	1
516	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3911	Porous structures	Elective	2	0	0	2
517	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3912	Alternate energy materials	Elective	2	0	0	2
518	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3913	Natural gas to liquid fuels	Elective	2	0	0	2
519	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3914	Block copolymers	Elective	2	0	0	2
520	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3915	Conducting polymers	Elective	1	0	0	1
521	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3916	Polymers and Colloidal Solutions	Elective	2	0	0	2
522	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3917	Biodegradable polymers	Elective	2	0	0	2
523	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3918	Controlled Radical/Living Polymerizations and Macromolecular Architectures	Elective	2	0	0	2
524	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3919	X-Ray Diffraction and Structure of Solids	Elective	2	0	0	2
525	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3920	NMR spectroscopy	Elective	2	0	0	2
526	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-3-3921	Natural products and drug discovery	Elective	2	0	0	2
527	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-4-3901	Project proposal writing & presentation	Core	0	0	4	2
528	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-4-3902	Review Article	Core	0	0	4	2
529	Chemical Sciences	CSIR-NEIST, Jorhat	CHE-NEIST-4-3903	CSIR-800 Societal Program	Core	0	0	8	4
530	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-1-4101	Research Methodology:	core	1	0	0	1
531	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-1-4102	Analytical Tools and Instrumentation	core	1	0	0	1
532	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-1-4103	Basic mathematics and numerical methods	core	1	0	0	1
533	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-1-4104	Basic Chemistry for Interdisciplinary sciences	Optional	1	0	0	1
534	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-1-4105	Introduction to Nanoscience and Nanotechnology	Optional	1	0	0	1
535	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-1-4106	Introduction to Chemical Biology	Optional				
536	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4101	Advanced Inorganic Chemistry	Elective	2	0	0	2
537	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4102	Advanced Organic Chemistry	Elective	2	0	0	2
538	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4103	Advanced Quantum Mechanics	Elective	2	0	0	2
539	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4104	Advanced Organometallic Chemistry	Elective	2	0	0	2
540	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4105	Advanced Coordination Chemistry	Elective	2	0	0	2
541	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4106	Advanced Photochemistry	Elective	2	0	0	2
542	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4107	Advanced Polymer Chemistry	Elective	2	0	0	2
543	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4108	Advanced Materials Science	Elective	2	0	0	2
544	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4109	Advanced Materials Characterization Techniques:	Elective	2	0	0	2
545	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4110	Advances in Nanoscience and Nanotechnology	Elective	2	0	0	2
546	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4111	Rare Earth Chemistry	Elective	2	0	0	2
547	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4112	Sol-gel chemistry	Elective	2	0	0	2
548	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4113	Green chemistry concpets	Elective	1	0	0	1
549	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4114	Natural products	Elective	2	0	0	2
550	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4115	Synthetic methods for organic chemists	Elective	2	0	0	2
551	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4116	Organic reaction mechanisms	Elective	2	0	0	2

Sl. No.	Faculty	Lab_Name	Revised_Nomenclature	Course_Title	Core/ Elective	L	T	P	C
552	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4117	Composite materials	Elective	2	0	0	2
553	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4118	Organic spectroscopy applications	Elective	2	0	0	2
554	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-2-4119	Surface characterization techniques	Elective	2	0	0	2
555	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4101	Electronic structure theory	Elective	2	0	0	2
556	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4102	Molecular modeling and simulation	Elective	2	0	0	2
557	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4103	Carbohydrate chemistry	Elective	2	0	0	2
558	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4104	Supramolecular chemistry	Elective	2	0	0	2
559	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4105	Total Synthesis	Elective	1	0	0	1
560	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4106	Asymmetric Synthesis	Elective	1	0	0	1
561	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4107	Chemistry and biology of Heterocycles	Elective	2	0	0	2
562	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4108	Homogeneous Catalysis	Elective	1	0	0	1
563	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4109	Catalysis for organic synthesis	Elective	1	0	0	1
564	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4110	Materials and devices for energy conversion	Elective	2	0	0	2
565	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4111	Functional Ceramics	Elective	1	0	0	1
566	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4112	Photoinduced electron and Energy transfer	Elective	2	0	0	2
567	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4113	Block copolymers	Elective	2	0	0	2
568	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4114	Pi-conjugated polymers	Elective	2	0	0	2
569	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4115	Liquid Crystals	Elective	2	0	0	2
570	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4116	Ultrafast processes and spectroscopy	Elective	2	0	0	2
571	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4117	Natural products and drug discovery	Elective	2	0	0	2
572	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4118	Photobiology	Elective	2	0	0	2
573	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4119	Nanobiotechnology	Elective	2	0	0	2
574	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4120	Rare Earth Molecular Materials	Elective	2	0	0	2
575	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4121	Transition Metal Catalysed organic synthesis & Application in total synthesis of natural products, heterocycles and pharmaceutical intermediates	Elective	2	0	0	2
576	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4122	EMI Shielding Materials	Elective	2	0	0	2
577	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4123	Advanced Materials Processing	Elective	2	0	0	2
578	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4124	Advanced Functional Materials	Elective	2	0	0	2
579	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4125	Surface Science and Technology	Elective	2	0	0	2
580	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4126	ADVANCED DYE-REMOVAL TECHNOLOGIES	Elective	1	0	2	2
581	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4127	Nanomaterials Science and Technology	Elective				
582	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4128	Ionic Conductors	Elective	2	0	2	2
583	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4129	Polymeric Hierarchical Structure and Properties	Elective	2	0	2	2
584	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4130	Advanced sol gel processing	Elective	2	0	2	2
585	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4131	Soft nanomaterials & Functional Polymers	Elective	2	0	2	2
586	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-3-4132	Porous structures	Elective	2	0	0	2
587	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-4-4101	Project proposal writing & presentation	Core	0	0	4	2
588	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-4-4102	Review Article	Core	0	0	4	2
589	Chemical Sciences	CSIR-NIIST, Thiruvananthapuram	CHE-NIIST-4-4103	CSIR-800 Societal Program	Core	0	0	8	4

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-1-1001			
Course Title	Research Methodology:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Good laboratory practices, Safety in the laboratory, First Aid in the laboratory, Maintenance of laboratory records, Scientific literature management, Communication skills (scientific writing and presentation), Intellectual property management & planning, Ethics in Science, Computer applications and tools, Statistical methods & Data analysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-1-1002			
Course Title	Analytical Tools and Instrumentation			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Thermal methods (TG, DTG, DTA, TMA, DSC), X-ray methods (XRD, XRF, SAXS), NMR (<sup>1</sup>H, <sup>13</sup>C) and other Spectroscopic methods (EPR, IR, UV, Fluorescence), Chromatographic methods (TLC, GC, LC), Mass spectroscopy, Electron Microscopy (SEM, TEM), Electron Probe Micro Analysis (EDS, WDS), Quantitative Analysis (AAS, ICP, CHN)

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-1-1004			
Course Title	Basic Chemistry for Interdisciplinary sciences:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

Basics of inorganic, organic, physical and biochemistry, Nomenclature (IUPAC), molarity, molality and normality, types of bonding, Ionic, covalent and non-bonding interactions, Acids and bases, Atomic structure, periodic table and periodic properties, stoichiometry, chemical reactions and kinetics, solvent effects, functional groups in organic compounds, general named reactions and reaction mechanisms, carbohydrates, lipids, proteins, nucleotides, enzymes, photosynthesis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-1-1005			
Course Title	Introduction to Nanoscience and Nanotechnology			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

General considerations, Introduction, definitions, consequences of size reduction, Properties: structural, thermodynamic, optical, electrical and magnetic properties, Methods of synthesis, Surface modifications, factors governing the stability and assembly, Characterization of nanomaterials, Applications of Nanomaterials



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-2-1001			
Course Title	Advanced Inorganic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Core			

### Course Description:

Structure & Bonding in Inorganic Compounds, Chemistry of Coordination Compounds, Symmetry in Chemistry & Group Theory, Main group chemistry, Organometallic chemistry, Electronic Spectra of Transition Metal Compounds, Magneto Chemistry, Metal Cluster Compounds, Inorganic Reaction Mechanism, Electron Transfer Reactions in Metal Complexes, Bioinorganic Chemistry (Metalloenzymes, Metal complexes as oxygen carriers, Photosynthesis), Metal Complexes in Medicinal Chemistry, Catalysis by Inorganic Complexes.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-2-1002			
Course Title	Advanced Analytical Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Analytical instrumentation, signal and noise, Overview of optical methods of analysis: Components of optical instruments, atomic and molecular spectrometry based on absorption, emission and scattering, Electroanalytical techniques (basic electrochemistry, voltammetry, potentiometry), Analytical separations and introduction to chromatographic methods, GC, LC, Mass spectrometry, electromigration techniques, hyphenated techniques, detectors, Analytical tools for petroleum refining.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-2-1003			
Course Title	Advance Materials Characterization Techniques			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Optical Microscopy, Electron microscopy: TEM, HRTEM, SEM, STEM, EDX, FIB, e-beam lithography, Scanning probe microscopy: AFM, STM, MFM, confocal, etc, Raman spectroscopy/microscopy, Thermal analysis techniques, Magnetic measurements, Electrical measurements, Spectroscopic ellipsometry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-2-1004			
Course Title	Sol-gel chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction, Hydrolysis and condensation reactions, Solution chemistry and physics of intermediates, Role of the anion on the hydrolysis and condensation reactions, Kinetics of Hydrolysis and Condensation, Non-Hydrolytic Sol-Gel Processing, Gelation, Ageing, Drying, Densification, Characterization, Chemistry of Sol-Gel Silicates, Solution chemistry of transition metal alkoxide precursors, Sol-gel synthesis and characterization of important materials, structure-property relationships

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-2-1005			
Course Title	Green chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Green chemistry concepts: Basic understanding, scope and interdisciplinary nature of green chemistry; Environmental factors; Carbon credit, Energy efficiency and atom economy, Catalysis and green chemistry, Alternate reaction media and reaction systems, ionic liquids,

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-2-1006			
Course Title	Environmental Sciences			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction to industrial wastes, their definition, classification, sources and characteristics. hazardous wastes, their classification and characteristics. treatment and disposal of industrial wastes, physico-chemical processes, solidification & stabilisation. air pollutants, their sources and types, global warming, green house gases and their capture, air quality monitoring, air pollution control devices. environmental analysis & parameters - air, noise, water, and soil pollution. environmental impact & risk assessment, ambient air quality monitoring & modelling, industrial disaster modelling, its regulations and framework

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-2-1007			
Course Title	Environmental Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Environmental chemistry: introduction; Water: properties; acid-base reactions, electrochemistry, pH; Eh; Chemical methods in treating water and wastewater; water disinfection. Thermodynamics and kinetics of air pollutants; chemical and photochemical reactions in atmosphere. Soil chemistry: nature and importance; acid-base and ion-exchange reactions in soils; colloidal chemistry of inorganic constituents, clays, organic matter and soil humus; adsorption desorption reactions, ion exchange, degradation of pesticides and hazardous substances in soil.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-2-1008			
Course Title	Process Chemistry			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Evaluation of rate equations, unit processes, mass transfer, mass balance, energy balance, fluid flow, design of homogeneous systems, different types of reactors, green chemistry



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-2-1009			
Course Title	Separation Science and Technology			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Absorption and adsorption, adsorption isotherms, chemical and physical adsorbents, cost effective adsorbents for toxic metal ion removal, ion-exchange membranes and their applications

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-2-1010			
Course Title	Green Chemistry			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Green chemistry concepts: Basic understanding, scope and interdisciplinary nature of green chemistry; Environmental factors; Carbon credit, Energy efficiency and atom economy, Catalysis and green chemistry, Alternate reaction media and reaction systems, ionic liquids, supercritical fluids, solventless chemistry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-2-1011			
Course Title	Soil Sciences			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Geomorphology, pedogenesis of soils and components of soil, role of soils in agriculture, environment and conservation of natural resources, bulk density, particle density, porosity, particle size distribution (texture), water holding capacity, soil water potential, plant water available capacity (PAWC), soil-water movement - hydraulic conductivity and infiltration, soil reactivity (pH), electrical conductivity, soil fertility, organic matter/organic carbon, major nutrients (N, P, K, S, Ca, Mg) and micronutrients (Cu, Zn, Mn, Fe, Cl, Mo, B) of soil (total & available- DTPA / EDTA extractable) and their role in agriculture and environment, role of cation exchange capacity (CEC) and sodium absorption ratio (SAR) etc of soils in plant life. Biogeochemistry of trace and heavy metals (Cd, Cr, Co, Ni, Pb, Hg, Se, As etc) in agro-ecosystem / environment, permeability hydraulic gradient and seepage in soils, their effect in land development, foundations and constructions

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-2-1012			
Course Title	Ground Water and Geochemical Studies			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Classification of rocks with respect to water bearing characteristics, geological structures favouring groundwater occurrence, geomorphic units and their influence on occurrence and movement of water resources, hydrological properties of rocks, aquifer and its classification, surface and subsurface water sources, hydrological cycle, Darcy's law, groundwater movement, water table, aquifer test, draw down, flow nets, geomorphic processes and land forms, definition and importance of structural geology with reference to water resources management, groundwater exploration, geochemical studies, chemical parameters of water

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-3-1001			
Course Title	Natural Products and Drug Discovery			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Natural products: Importance, lead, clinical trials in drug discovery research, Case studies of marketed natural product drugs, Synthetic Biology and Genetic engineering in the production of natural product, A brief overview of drug discovery approach, Cause of diseases, Target identification, Target validation, Modeling, Synthesis and SAR, Drug Delivery, Clinical Trials, Etiology, pathogenesis, prevention, drug targets and chemotherapy, drug resistance and remedies of tropical infectious diseases, Etiology and remedies of diseases developed through metabolic disorders.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-3-1002			
Course Title	Corrosion and Corrosion Protection			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Basics of corrosion including electrochemical mechanism, polarization, potential-pH diagram, electrochemical series, galvanic series, electrochemical polarization, different forms of corrosion including stress corrosion cracking, different corrosion tests like weight loss, Tafel plots, polarization resistance, testing methods and impedance measurement as per ASTM and NACE standards, electrochemical polarization (potentiodynamic and potentiostatic), chronoamperometry, chronopotentiometry, electrochemical impedance spectroscopy, noise analysis, cyclic voltammetry etc., electrochemical testing of corrosion (sample preparation, corrosion testing, effect of heat treatment on microstructural changes and corrosion behaviour, effects of pH, dissolved oxygen, Cl<sup>-</sup> on corrosion), passivity, corrosion of metallic materials (iron, steels, Al-, Mg-, Cu-, Ni-, Pb-, Ti-, Ta- based alloys, metal matrix composites), cathodic protection (passivation, oxidation and tarnishing, coating, inhibitors), corrosion in dry condition (formation of oxides, sulphides etc.)

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-3-1003			
Course Title	Nano Science and Engineering			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Basic concept and approach, introduction to nanomaterials (definition and classification, top-down and bottom-up approaches, synthesis methodologies, processing and characterization techniques, functionalization and applications), fundamental properties of various primary material classes (metals, ceramics and polymers), size dependent properties, challenges in processing bulk ceramic nanomaterials, processing-structure-properties of important bulk nanomaterials, mechanical, thermal, tribological and biological properties, critical issues related to understanding properties of nanomaterials, application potential of bulk nanomaterials, nano coatings, nano-composites, nano-metal powders, nano-medicines, nano-tribology

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-3-1004			
Course Title	Functional and Smart Materials			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Basic concept and approach, stimuli, shape memory effect, response to thermal, magnetic, electrical, piezoelectric, and others effects, creation of functional and smart materials with preset properties, generation of shape memory effect, structure, phase transformation and properties, specific property characterization, interpretation of information, smart materials (shape memory alloys and polymers, piezoelectric, strictive, pH-sensitive, halochromic, chromogenic, surface active & biomimetic materials, ferrofluids, electro and magneto rheological material etc.), material development, application potential (energy sector, information technology, health, lab-on-a-chip etc.), principles of ferrofluids, synthesis, characterization, properties and applications.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-3-1005			
Course Title	Microfluidics and Microseparation			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Solvent extraction (fundamentals & principles, classification, factors favouring extraction, extraction equilibria, applications), solid phase micro extraction and single drop micro extraction (selection of solid and liquid phase for extraction, principles and applications), chemical derivatization in liquid and gas chromatography (pre, post and on column derivatization, functional groups and reaction with derivatizing agents for fluorescence, electrochemical and UV-Vis detection), electrochemical methods of analysis (potentiometry, polarography, cyclic voltametry, amperimetric determination, and coulometry, basic principles and applications), electrochemical bio sensors (principle and applications in clinical diagnostics), chromatographic techniques (principles of separation and application of column, paper, thin layer and gas chromatography, GPC, HPLC, HPTLC, size exclusion chromatography, affinity chromatography, electrophoresis. preparative and micropore columns, reverse phase columns, mobile phase selection and detectors in separation techniques), capillary electrophoresis (principle, classification, instrumentation and applications in qualitative and quantitative analysis), microfabrication techniques (principle, instrumentation and applications for fabrication of miniaturized devices), integration of microfluidic channels with pump, valve, detector etc., lab-on-a-chip.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-3-1006			
Course Title	Unit Operations in Environmental Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Separation techniques (crushing, grinding, size analysis, separation based on density difference, gravity separation, magnetic separation, froth flotation), chemical processes (absorption, adsorption, membranes, cryogenic distillation, order, and rate of reaction), different isotherms ((Langmuir, Freundlich etc.) and their applicability to adsorption process, removal of air pollutants, carbon dioxide capture and storage (different types of CCS, CO<sub>2</sub> sequestration and its role in making clean environment, pre and post combustion CO<sub>2</sub> capture, carbon capture at the source of generation, different methods of carbon capture, packed bed towers/ columns and their design), removal of water pollutants (different processes/ methods of removal of toxic/ heavy metals, impure water/ effluent treatment using different separation techniques, packed bed towers / columns and their design), adsorbents (commercial adsorbents and their application, role of industrial wastes in synthesis and characterization of cost-effective adsorbents, their application for effluent treatment, water purification and CO<sub>2</sub> capture, zero-waste concept)

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-3-1007			
Course Title	Waste Utilization and Value Addition			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Industrial wastes (red mud, fly ash, slag, low grade minerals, stone dust etc.), different category of wastes, their source of generation and their methods of handling, environmental impact, audit, acts and regulations, global policy, regulation, waste management, municipal solid wastes, management and disposal, processes/ methods of waste utilization for different environmental applications such as decontamination of ground water, recycling, solidification/ stabilisation, immobilisation, detoxification, vitrification of toxic waste, management of hazardous and toxic waste, natural products, renewable resources, biodegradable polymers, conversion of wastes into value added materials, application potential (land use planning by reclamation of wastelands, overburden areas/mine spoil dumps, ash-back haul regions, etc for agriculture, horticulture, forestry, and other useful purposes, agriculture, construction, transportation, general engineering etc.) Introduction to industrial wastes, types, sources and characteristics, different rules and acts, classification of hazardous waste, its characteristics, waste recycle & reuse, solidification and stabilisation, waste to material approach using industrial waste, disposal of industrial wastes, chemistry of silica and silicon, ceramic, geopolymers and their applications, theory and principles of synthesis, characterization and applications of radiation shielding materials

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-3-1008			
Course Title	Industrial Effluent Treatment & Disposal			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Industrial effluents, their types, sources, measurement and characteristics, environmental pollution monitoring and control – DO, BOD, COD, oxygen sag curve, Streeter-Phelps' equation and steadystate surface water quality modelling, primary, secondary and tertiary treatment methods such as physical and chemical including design aspects, disposal of industrial effluents, treated effluents recycle & reuse, different rules and standards and their environmental benefits.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-3-1009			
Course Title	Advanced Soil Science			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Pedogenesis of soils, components of soil and soil as a resource material. Physical properties of soil - bulk density, particle density, porosity, texture, water holding capacity, plant available water capacity, soil-water movement (hydraulic conductivity and infiltration). Soil reactivity, electrical conductivity, cation exchange capacity and sodium absorption ratio. Techniques of soil survey, taxonomy of soils, land evaluation, land capability and soil-site suitability criteria for agriculture, forestry and engineering applications. Soil fertility management - organic matter, major and micro nutrients in soil and their role in sustainable agriculture and environment. Manures, fertilisers, pesticides / insecticides and herbicides in soil-crop system – relevance, application, pathways, fate and safety. Water-logging in soils, saline and sodic soils, soil buffering, lime requirement, phyto-remediation and application of soil amendments. Soil pollution, bio-geochemistry of trace and heavy metals in soil, agro-ecosystem and environment. Soil erosion, soil loss and soil conservation for agriculture, environment and watershed management, and sustainable techniques of soil conservation.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-3-1010			
Course Title	Environment Assessment, Monitoring, Protection and Management			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Concept and significance, environmental impact studies, rules and acts, water and air pollution (effluents, groundwater contamination, air pollutants, greenhouse gases, global warming, estimation/modelling & prevention), air and water quality monitoring and modelling, scope of error and precautions, air pollution control devices, industrial effluents and treatments, environmental issues, soil quality analysis, types and characteristics, secured landfills, treatment, storage, principles of mathematical modelling and numerical methods in environmental assessment/studies, soil and ground water contamination due to industrial and agricultural practices, disposal and utilization of municipal solid wastes and medical wastes, incineration of wastes

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-3-1011			
Course Title	Methods and Techniques for Water resources Development and Management			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Recharge mechanisms, groundwater recharging techniques for rejuvenation of water resources, watershed development and management, water resources mapping, monitoring and management, water resources contamination, groundwater modelling (procedures, software, applications of modflow, SWAT, GMS, AGPNS, rockworks etc.), tracking the possible migration pathway of groundwater contamination, long term prediction of the effect of future groundwater withdrawals on groundwater levels and contaminants transport movement.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-4-1001			
Course Title	Project proposal writing & presentation			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Formulation of a project proposal by selecting topics of high relevance and novelty and will have state-of-the-art review, methodologies, recommendations etc. in specified format in a holistic manner preferably candidate's own research work suitable for submission to appropriate funding agencies.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-4-1002			
Course Title	Review Article			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Preparation of one review article on specific research area of the student.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-AMPRI, Bhopal			
Course Nomenclature	CHE-AMPRI-4-1003			
Course Title	CSIR-800 Societal Program			
Credit Distribution (L-T-P-C)	0	0	8	4
Core/Elective	Core			

### Course Description:

The students have to undertake a project in rural areas for 6-8 weeks in the line with CSIR-800 programme which is primarily prepared at empowering 800 million Indians by way of S&T inventions. The theme for the project may be chosen from CSIR-800 documents and as per expertise available in the laboratory. Students will select the topics in consultation with Doctoral Advisory Committee (DAC).

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CDRI, Lucknow			
Course Nomenclature	CHE-CDRI-1-1301			
Course Title	Research Methodology:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Good laboratory practices, Safety in the laboratory, First Aid in the laboratory, Maintenance of laboratory records, Scientific literature management, Communication skills (scientific writing and presentation), Intellectual property management & planning, Ethics in Science, Computer applications and tools, Statistical methods & Data analysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CDRI, Lucknow			
Course Nomenclature	CHE-CDRI-1-1302			
Course Title	Analytical Tools and Instrumentation			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Thermal methods (TG, DTG, DTA, TMA, DSC), X-ray methods (XRD, XRF, SAXS), NMR (<sup>1</sup>H, <sup>13</sup>C) and other Spectroscopic methods (EPR, IR, UV, Fluorescence), Chromatographic methods (TLC, GC, LC), Mass spectroscopy, Electron Microscopy (SEM, TEM), Electron Probe Micro Analysis (EDS, WDS), Quantitative Analysis (AAS, ICP, CHN)

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CDRI, Lucknow			
Course Nomenclature	CHE-CDRI-1-1304			
Course Title	Basic Chemistry for Interdisciplinary sciences:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

Basics of inorganic, organic, physical and biochemistry, Nomenclature (IUPAC), molarity, molality and normality, types of bonding, Ionic, covalent and non-bonding interactions, Acids and bases, Atomic structure, periodic table and periodic properties, stoichiometry, chemical reactions and kinetics, solvent effects, functional groups in organic compounds, general named reactions and reaction mechanisms, carbohydrates, lipids, proteins, nucleotides, enzymes, photosynthesis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CDRI, Lucknow			
Course Nomenclature	CHE-CDRI-1-1306			
Course Title	Introduction to Chemical Biology			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

chemical biology/synthetic biology, Structure, function and chemistry of biological macromolecules including amino acids, proteins, nucleic acids and carbohydrates, Chemical kinetics and thermodynamics in biology, Chemical reactions and chemical diversity in Biology The Chemistry of Enzymes, Lipids, Fats & Steroids, Drug discovery, Drugs from Nature, Drug interaction

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CDRI, Lucknow			
Course Nomenclature	CHE-CDRI-2-1301			
Course Title	Advanced Organic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Compulsory			

### Course Description:

Stereochemistry, reaction mechanism, C-C and C-X bond formations, Retrosynthetic analysis, photochemistry, pericyclic reactions, reactive intermediates, Methods of asymmetric synthesis and their application in total synthesis, oxidation-reduction reactions, organocatalysis, metathesis reactions.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CDRI, Lucknow			
Course Nomenclature	CHE-CDRI-2-1302			
Course Title	Advanced process chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Integral and Differential analysis; Evaluation of rate equations, unit processes, mass transfer, mass balance, energy balance, fluid flow, Design of homogeneous systems, different types of reactors, green chemistry



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CDRI, Lucknow			
Course Nomenclature	CHE-CDRI-2-1303			
Course Title	Advances in Chemical Biology			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Amino Acids, Peptides & Proteins, Design of poly peptides, Peptide hormones and their pharmaceutical significance, Peptide mimetics as therapeutics, Chemistry of Carbohydrates, Nucleic acids, Structure & function of DNA and RNA, Nucleic acid mimetics & their therapeutic applications, Chemistry of Enzymes, Lipids, Fats & Steroids, Drug discovery, Basic principles of medicinal chemistry, Drugs from Nature, Natural products based drug discovery, Kinetics and thermodynamics of biological process, Enzyme Catalysis, consecutive, parallel and competitive reactions in biological systems, Thermodynamics, allosteric effect in biology, types of bonds, hydration and their specific contribution towards specific thermodynamic parameters, enthalpy or entropy, Scatchard analysis, hill plot analysis.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CDRI, Lucknow			
Course Nomenclature	CHE-CDRI-2-1304			
Course Title	Natural products			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Carbohydrates and polysaccharides, Structure and functions of important derivatives of monosaccharides, Classification and nomenclature and synthesis of some simple Alkaloids; Terpenoids and Steroids such as pinene; Camphor and Cadenine;  $\alpha$ -vetinone; Hirsutene and Abietic acid (Terpenoids); Cholesterol; Testosterone and Andestrone (Steroids) etc. isolation and characterization, elucidation of structure-property relationships. Biosynthesis of steroids, terpenoids, fatty acids, alkaloids and polysaccharides, biosynthesis of natural products

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CDRI, Lucknow			
Course Nomenclature	CHE-CDRI-2-1305			
Course Title	Synthetic methods for organic chemists			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Formation of carbon-carbon bond employing various kinds of organometallic reagents, C-C double bonds through different reactions, oxidation, reduction through various kinds of reagents, functional group interconversion, by substitution including protection and deprotection, alkylation of enolates, and other carbon nucleophiles, reaction of carbon nucleophiles with carbonyl compounds, electrophilic addition to C-C multiple bonds, reactions of C-C multiple bonds, Retrosynthesis, disconnection, synthons, linear and convergent synthesis, umpolung of reactivity and protecting groups.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CDRI, Lucknow			
Course Nomenclature	CHE-CDRI-2-1306			
Course Title	Organic spectroscopy applications			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Mass spectroscopy, IR spectroscopy, Proton magnetic resonance spectroscopy, Structural assignment by employing NMR techniques, Carbon-13 NMR spectroscopy, Introduction COSY, HSQC, HMBC, NOESY, ROESY, Structural elucidation using 2D-NMR methods

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CDRI, Lucknow			
Course Nomenclature	CHE-CDRI-3-1301			
Course Title	Molecular modelling and simulation			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Molecular Mechanics: Features of molecular mechanics - Force Fields: Bonds structure and bending angles, Electrostatic Vander Waals and non-bonded interactions, Hydrogen bonding - Derivatives of molecular mechanics energy function - Calculating thermodynamic properties - Force Field for inorganic systems - Energy minimization, Molecular Dynamics Simulation: Molecular Dynamics using simple models, Molecular Dynamics with continuous potentials, Solvent effects, Conformational changes, Thermostats, Barostats, Lincs and shake algorithms, Monte Carlo simulation Methods, sorption, Applications of Molecular Modeling

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CDRI, Lucknow			
Course Nomenclature	CHE-CDRI-3-1302			
Course Title	Asymmetric Synthesis			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Strategies for the preparation of optically pure compounds; Stereoselective, Enantioselective and Diastereoselective reactions; Stoichiometric asymmetric synthesis-chiral auxiliaries, Evans Alsdol and modified versions; Catalytic asymmetric synthesis; Asymmetric Dihydroxylation; Asymmetric Aminohydroxylation; Asymmetric Hydrogenation; Asymmetric allylation, propargylation, and alkylation; Chiral Organocatalysis; Cascade reactions by organocatalysis; Transition Metal based catalysis; Asymmetric amplification and autocatalysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CDRI, Lucknow			
Course Nomenclature	CHE-CDRI-3-1303			
Course Title	Chemistry and biology of Heterocycles			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Privileged heterocycles, Electronic properties, reactivity (electrophilicity and nucleophilicity), Synthetic methodologies, Biological properties of Natural products and drug candidates, Biosynthesis, Dimeric compounds and related stereochemistry

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CDRI, Lucknow			
Course Nomenclature	CHE-CDRI-3-1304			
Course Title	Homogeneous Catalysis			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Organometallic Catalysis, Applications in organic synthesis: Olefin Isomerization, C-C Coupling reactions: Heck, Suzuki, Stille and Sonogashira reactions, Alkene and Alkyne Metathesis, C-Heteroatom coupling: Hydroamination, Olefin Oxidation, C-H activation, Oxidation reactions, hydrogenation of Alkenes, Industrial Applications.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CDRI, Lucknow			
Course Nomenclature	CHE-CDRI-3-1305			
Course Title	Natural products and drug discovery			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Natural products: Importance, lead, clinical trials in drug discovery research, Case studies of marketed natural product drugs, Synthetic Biology and Genetic engineering in the production of natural product, A brief overview of drug discovery approach, Cause of diseases, Target identification, Target validation, Modeling, Synthesis and SAR, Drug Delivery, Clinical Trials, Etiology, pathogenesis, prevention, drug targets and chemotherapy, drug resistance and remedies of tropical infectious diseases, Etiology and remedies of diseases developed through metabolic disorders.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CDRI, Lucknow			
Course Nomenclature	CHE-CDRI-3-1306			
Course Title	Green & Sustainable Chemsitry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction to green chemistry (Concept of Atom Economy), Principles, plans and benefit, Tools of green chemistry, Name reactions using green chemistry concept, Asymmetric green chemistry, Raw materials diversification, Energy production, Waste reduction at source, Direct and Indirect utilisation of CO<sub>2</sub>, Biomass exploitation

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CDRI, Lucknow			
Course Nomenclature	CHE-CDRI-4-1301			
Course Title	Project proposal writing & presentation			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Formulation of a project proposal by selecting topics of high relevance and novelty and will have state-of-the-art review, methodologies, recommendations etc. in specified format in a holistic manner preferably candidate's own research work suitable for submission to appropriate funding agencies.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CDRI, Lucknow			
Course Nomenclature	CHE-CDRI-4-1302			
Course Title	Review Article			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Preparation of one review article on specific research area of the student.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CDRI, Lucknow			
Course Nomenclature	CHE-CDRI-4-1303			
Course Title	CSIR-800 Societal Program			
Credit Distribution (L-T-P-C)	0	0	8	4
Core/Elective	Core			

### Course Description:

The students have to undertake a project in rural areas for 6-8 weeks in the line with CSIR-800 programme which is primarily prepared at empowering 800 million Indians by way of S&T inventions. The theme for the project may be chosen from CSIR-800 documents and as per expertise available in the laboratory. Students will select the topics in consultation with Doctoral Advisory Committee (DAC).

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-1-1401			
Course Title	Research Methodology:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Good laboratory practices, Safety in the laboratory, First Aid in the laboratory, Maintenance of laboratory records, Scientific literature management, Communication skills (scientific writing and presentation), Intellectual property management & planning, Ethics in Science, Computer applications and tools, Statistical methods & Data analysis

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-1-1403			
Course Title	Basic mathematics and numerical methods			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Determinants and Matrices, Complex Variables, Vector analysis, Infinite Series, Special Functions, Differential Equations, Interpolation and Approximation, Numerical differentiation and Integration, Basic Linux, Introduction to Algorithms, basic programming, Shell and Shell Scripting, Network Computing and Parallel Computing, Matlab/Scilab/Octave/Gnuplot Algorithms, basic programming, Shell and Shell Scripting, Network Computing and Parallel Computing, Matlab/Scilab/Octave/Gnuplot

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-1-1405			
Course Title	Introduction to Nanoscience and Nanotechnology			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

General considerations, Introduction, definitions, consequences of size reduction, Properties: structural, thermodynamic, optical, electrical and magnetic properties, Methods of synthesis, Surface modifications, factors governing the stability and assembly, Characterization of nanomaterials, Applications of Nanomaterials



## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-1-1406			
Course Title	Introduction to Chemical Biology			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

chemical biology/synthetic biology, Structure, function and chemistry of biological macromolecules including amino acids, proteins, nucleic acids and carbohydrates, Chemical kinetics and thermodynamics in biology, Chemical reactions and chemical diversity in Biology The Chemistry of Enzymes, Lipids, Fats & Steroids, Drug discovery, Drugs from Nature, Drug interaction

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-2-1401			
Course Title	Advanced Physical Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Thermodynamics and chemical kinetics, Quantum Mechanics, Atomic structure and spectroscopy, Chemical bonding in diatomics, Chemical applications of group theory, Colloids and Surface science, surfactants, Interface and Interfacial properties, Electrochemistry.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-2-1402			
Course Title	Advanced Analytical Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Analytical instrumentation, signal and noise, Overview of optical methods of analysis: Components of optical instruments, atomic and molecular spectrometry based on absorption, emission and scattering, Electroanalytical techniques (basic electrochemistry, voltammetry, potentiometry), Analytical separations and introduction to chromatographic methods, GC, LC, Mass spectrometry, electromigration techniques, hyphenated techniques, detectors, Analytical tools for petroleum refining.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-2-1403			
Course Title	Advanced Electrochemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Basic electrochemistry concepts, Reference electrodes, Electrochemical Thermodynamics, Kinetics of electron transfer, the Taft equation, Diffusion, Double Layers, electrode Kinetics, the Gibbs adsorption isotherm, the Lippmann equation, infinitely dilute solutions and thermal balance, Electro capillary phenomena, Faradaic vs. capacitive currents, transport properties, potential theory, Electrochemical Techniques, Voltammetry, Reversible and irreversible reactions, Mass transport by convection, rotating electrodes, Equivalent circuits, A.C. voltammetry, Electrolysis methods, Adsorption, Thin layer cells, Electrochemistry of polymers and inorganic solids, Spectroelectrochemistry, Applications.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-2-1404			
Course Title	Advanced Materials Science			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Crystal systems and space groups, Close packing and various simple structure types like AB, AB<sub>2</sub>, AB<sub>3</sub> and complex structural types ABX<sub>3</sub>, AB<sub>2</sub>X<sub>4</sub>, etc. Factors affecting crystal structures, Common preparative methods; X-ray diffraction and Electron microscopy, Defect structures, colour centers, reciprocal lattices, Properties of solids – Band theory, metals, insulators, semiconductors, dielectric and ferroelectric properties, magnetic properties, optical properties, ionic conduction; structure-processing-property correlations.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-2-1405			
Course Title	Advanced Surface Science			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction to Surface Science - Surface phenomena - Adsorption, Desorption, Adsorption Models, Special properties of surfaces and interfaces, Electronic structure of surfaces, Surface modification and its applications, Nanoscale catalysis and applications, Surface spectroscopy and microscopy tools for nanocatalysis

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-2-1406			
Course Title	Advanced Materials Characterization Techniques:			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Optical Microscopy, Electron microscopy: TEM, HRTEM, SEM, STEM, EDX, FIB, e-beam lithography, Scanning probe microscopy: AFM, STM, MFM, confocal, etc, Raman spectroscopy/microscopy, Thermal analysis techniques, Magnetic measurements, Electrical measurements, Spectroscopic ellipsometry.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-2-1407			
Course Title	Advances in Nanoscience and Nanotechnology			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Low-dimensional structures: Quantum wells, Quantum wires, and Quantum dots, Nano clusters & Nano crystals, fullerenes, carbon nano tubes and graphene, Nano Composites, synthesis and characterization techniques, Properties at Nano Scales and comparison with bulk materials, fabrication techniques, general applications, nanomaterials in biology.



## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-2-1408			
Course Title	Advanced Biomaterials			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Definition of biomaterials, Surface property requirements of biomaterials, Types of materials used in medicine, Synthesis and surface characterization, Biology of wound healing, foreign body response and tissue remodeling, Molecular and cellular interactions of materials with biological environment, Degradation and long term fate of materials used in medicine, Requirements of biomaterials for biomedical implants, surface coatings, wound dressings, sutures, cardiovascular devices, ophthalmology, dentistry, orthopedics and cosmetic surgeries, Applications in drug delivery and tissue engineering, Standard protocols for testing the efficacy and efficiency of biomaterials, The regulatory environment for biomaterials, Some concepts for design development of common biomaterials.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-2-1409			
Course Title	Ionic liquids			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Introduction to ionic liquids, ionic liquids vs. molecular solvents/ionic salts (solids), ionic liquids vs. eutectic mixtures, solvent polarities using different spectral techniques (parameters), physicochemical properties of ionic liquids, effect of functional groups on the properties of ionic liquids, surface active ionic liquids, aggregation behavior of ionic liquids, interaction of ionic liquids with different molecular solvents, interaction of ionic liquids with biopolymers, thermodynamics of the binary mixtures of ionic liquids, structure property relationship in ionic liquids.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-2-1410			
Course Title	Physical organic chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Hammett concepts-Quantitative structure activity relationships, linear free energy relationships, Molecular mechanics, Semi-empirical and ab initio molecular theory, Pericyclic Reactions; Substituent Effects; Frontier Molecular Orbitals, HOMO-LUMO Interactions, Aromaticity, Odd and Even Alternant Hydrocarbons, Pericyclic Reactions The Woodward-Hoffman Rules. Free Energy Changes, Transition State Theory, The Eyring Equation, The Mechanistic Significance of Kinetic versus Thermodynamic Control of Organic Reactions, The Hammond Postulate, The Curtin-Hammett Principle; Kinetic Isotope Effects, The Reactivity-Selectivity Principle, Substituent Effects, Absorption of Light by Organic Molecules, Jablonsky Diagrams, Morse Potential Energy Curves, Common Photochemical Reactions, Photocycloadditions.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-2-1411			
Course Title	Surface characterization techniques			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

XPS, LEED, XAS, SEM, AFM, TEM, NSOM, SPR, SERS, static and dynamic contact angle measurements, Ellipsometry.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-3-1401			
Course Title	Computational materials design			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Solids, Drude and Sommerfield theories of metals, Kronig-Penning model, Tight-Binding approximation, band structure, density of states, prediction of electrical and magnetic properties, Prediction of properties of organic molecules and polymers, Introduction to Multiscale Modeling and simulations and applications. Monte Carlo simulation in various ensembles, Gas sensing properties of various porous materials using grand canonical Monte Carlo method, Dissipative particle dynamics, Mesoscale dynamics and applications.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-3-1402			
Course Title	Supramolecular chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Nature of supramolecular interactions, role of various non-covalent interactions, multiple hydrogen bonding motifs, Stability of H-bonds, Jorgensen model for H-bonding, supramolecular synthons , dimensions of supramolecular chemistry, Janus molecules. Photoresponsive molecules and self-assembly, Molecular recognition, classification of supramolecular host-guest complexes, supramolecular self-assembly, supramolecular polymers, molecular capsules, self- assembled dendrimers, self-assembled nanotubes, low molecular weight organogels. Characterization techniques of self-assemblies, supramolecular sensors.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-3-1403			
Course Title	Corrosion science			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Basic aspects, Forms of corrosion, Atmospheric corrosion and protective coatings, Immersion corrosion and electrochemical protection, Corrosion monitoring, impedance spectroscopy, harmonics and NDT techniques.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-3-1404			
Course Title	Materials and devices for energy conversion			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Design of organic and Inorganic semiconductors, Approaches to process organic semiconductors by covalent and non covalent modifications , band edges and band gaps, Modulation of charge transport properties, kinetics of electron transfer, Design of small molecule dyes for DSSC, Electron transfer at interfaces, Transistors and solar cells, Fabrication of Devices, Device characterisation using dark current, IV curves under illumination, IPCE, Calculation of Voc, Jsc, Vpp, Ipp, FF and Pmax. hybrid solar cells



## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-3-1405			
Course Title	Organic electrochemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Cathodic reactions of organic compounds, Anodic reactions of organic compounds, Classifications of electrode reactions, Stereochemistry of electrochemical processes, Applications of organic electrochemistry.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-3-1406			
Course Title	Electrochemical power sources			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Energy scenario, emissions and global warming, fuel cells, Thermodynamic potentials, electrochemical processes and electrode kinetics, Proton exchange membranes, proton conducting mechanisms, recent advances, Operating conditions, overview of characterization techniques, technical aspects, advantages, materials, significances and challenges, Materials for supercapacitor applications, recent advances in the system development, battery vs. supercapacitor, modern technologies, challenges and prospects.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-3-1407			
Course Title	Alternate energy materials			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Energy scenario, Non-renewable and renewable energy sources; description of renewable sources and their importance. Technologies for biomass energy conversion, Solar energy, Wind Turbines, Geothermal Technologies; Applications; Sustainable sources of hydrogen; Fuel cell technologies; Hydrogen storage and distribution; Applications and feasibility assessment; Science, technology and policy of energy conservation; Strategies for enhancing role of renewable energy.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-3-1408			
Course Title	Photoinduced electron and Energy transfer			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Thermodynamic aspects, Calculation of free energy change from redox potentials, Weller equation, Kinetic aspects, concept of reorganization energy, Marcus theory, Inverted region kinetics, Back electron transfer, circumventing back electron transfer, Applications of photoinduced electron and energy transfer, Reaction centre and photoinduced electron transfer processes in photosynthetic bacteria, Solar water splitting, Dye-sensitized solar cells, Organic photovoltaics, Few organic reactions initiated by PET, Photo-remediation of organic waste materials, Mechanisms and dynamics of fluorescence quenching, Fluorescence anisotropy, Energy transfer to single and multiple acceptors, Resonance energy transfer and its implication, Sensors based on photoinduced processes.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-3-1409			
Course Title	Hydrogen generation and storage			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Sustainable sources of hydrogen; Fuel cell technologies; Hydrogen storage and distribution; Applications and feasibility assessment; Science, technology and policy of energy conservation; Strategies for enhancing role of renewable energy.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-3-1410			
Course Title	Polymers for membrane applications			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Polymers as membrane materials, functional polymers containing styrene and its derivatives; Functionalized poly(arylene ether)s, Nafion and other Poly(perfluorosulfonic acid) Membranes, Post functionalized polymeric membranes, random and block copolymers; functional poly(imide)s; functional polyphosphazene; functionalized bio- polymers, design of new functional polymers; Glassy and rubbery polymers, characterization of polymer membranes, transport phenomena, polymer nanocomposites for membranes in the separation of gases and liquids, membrane fouling.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-3-1411			
Course Title	Conducting polymers			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Synthesis and characterization, electrical transport properties, theory of conductivity, doping, electrochromic properties, Classification and types of organic conductors, Structure and properties of conducting charge-transfer salts, Conducting polymers based on organometallic compounds, Applications of conducting polymers, EMI shielding, supercapacitors, sensors

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-3-1412			
Course Title	Nanobiotechnology			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Concept of hybrid systems, signaling and signaling responses; biological systems as transducers, Biology at the nano-interface, fluorescent nanoparticles for life sciences, applications, DNA based particles used as building blocks, micelles, Nucleic Acid, Engineering using DNA as Nano materials, Cells & Microfabricated Devices, Nanomaterials for drug delivery, imaging, diagnostics, therapy, separation, Biosensors



## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-3-1413			
Course Title	Polymer Electrolyte Fuel Cell			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction - Polymer electrolyte membrane fuel cell components - materials, properties and processes - experimental methods in PEM Fuel Cell - transport Processes in PEM Fuel Cells - Design & modelling of PEM fuel cells.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-3-1414			
Course Title	Advanced Lithium Batteries			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction – historical perspective–battery performance and thermal management – lithium availability – alternatives to lithium – applications. Battery -active materials – anode-active materials – carbonaceous anodes – other alternative anodes – cathode - active materials – modified cathode - surface, electronically modified cathodes and solid solutions–synthesis and characterization. Electrolytes and separators – aprotic organic electrolytes – functional electrolytes – solid electrolyte interphase – polymer electrolytes – polymer membranes – ionic liquids –separators–shutdown separators – membrane preparation methods. Instrumental methods in battery research – x-ray diffraction – microscopy – thermal methods–NMR – cyclic voltammetry – EIS – GITT. Safety – assembly - testing and modeling – safety tests and protocols – assembly and testing – recycling – atomic modelling.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-3-1415			
Course Title	Functional Materials			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction - surface properties and functionalization - nanomaterials – design of functional materials – characterization techniques – functional materials for energy applications – biomaterials - materials for solar energy - magnetic materials– thermoelectric materials - smart materials - organic materials for electronics application - computational materials science - modelling of nanomaterials -electronic and band structures.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-3-1416			
Course Title	Electrochemical Technology			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Electrochemical process engineering and optimization of electrochemical parameters - technologies on electrochemicals including processes developed at CSIR-CECRI - metal finishing technologies - corrosion control processes - electrometallurgy includes aqueous - non-aqueous and high temperature metallurgical processes.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-3-1417			
Course Title	Advanced Corrosion Technology			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Functional Coatings - types and application - cathodic protection (CP)- electrochemical theory of cathodic protection—design - reinforcement corrosion- environmental conditions - transport mechanisms - admixtures to concrete - coatings to concrete surface- high performance concrete - corrosion resistant rebars - smart and greener concrete - nano composite materials for construction industries - flow and biocorrosion - fluid flow fields - flow corrosion testing methods - bacterial enumeration - mechanism - microbial corrosion on active/passive alloys - selection of biocides/inhibitors against Microbiologically Influenced Corrosion (MIC ) - relationship between CP and MIC.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-3-1418			
Course Title	Electrochemical Remediation			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Overview of electrochemical remediation technologies- electro chemical transport and transformation – basics – electrokinetic (Ek) removal of chlorinated organic compounds – lasagna technology – remediation of heavy metals and other inorganic pollutants – Ek removal of nitrate and fluoride – Ek remediation of mixed metal contaminants – electrokinetics/biofences – bioremediation and applied aspects – mathematical modeling.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-4-1401			
Course Title	Project proposal writing & presentation			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Formulation of a project proposal by selecting topics of high relevance and novelty and will have state-of-the-art review, methodologies, recommendations etc. in specified format in a holistic manner preferably candidate's own research work suitable for submission to appropriate funding agencies.

## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-4-1402			
Course Title	Review Article			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Preparation of one review article on specific research area of the student.



## Chemical Sciences Coursework PhD

Faculty	Chemical SciencesM			
Lab Name	CSIR-CECRI, Karaikudi			
Course Nomenclature	CHE-CECRI-4-1403			
Course Title	CSIR-800 Societal Program			
Credit Distribution (L-T-P-C)	0	0	8	4
Core/Elective	Core			

### Course Description:

The students have to undertake a project in rural areas for 6-8 weeks in the line with CSIR-800 programme which is primarily prepared at empowering 800 million Indians by way of S&T inventions. The theme for the project may be chosen from CSIR-800 documents and as per expertise available in the laboratory. Students will select the topics in consultation with Doctoral Advisory Committee (DAC).

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-1-1801			
Course Title	Research Methodology, Communication/ethics/safety			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Compulsory			

### Course Description:

Essential elements of scientific method [objective (identify problem), hypothesis; experiment design (procedures), literature search, data observation, interpretation, and conclusion, protect IPR/ publish]; prior art mining using several databases, maintenance of lab records, Ethical behaviour considerations: Research subjects, Researcher and Research sponsors; Writing scientific manuscript; The Menace of Plagiarism, safety in the laboratory, first aid.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-1-1802			
Course Title	Fundamentals of Chemical Sciences			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Compulsory			

### Course Description:

Basic chemistry for biologist: Acid-base equilibria (pH, buffer solutions, indicators, etc), redox reactions; Aliphatic and aromatic compounds; Bonding in organic compounds (electronic structure, bonding in methane, ethene, benzene and carbonyl compounds, electronegativity and bond polarity); Organic chemistry conventions (name and draw organic compounds, and the use of curly arrows in reaction mechanisms); Isomerism in organic compounds (structural isomerism and stereoisomerism both geometric and optical); Organic acids and bases (acid strengths of carboxylic acids, phenols and alcohols, and the base strengths of primary amines); Instrumental analysis-sample preparation and applications-UV-Vis, IR, Mass, NMR and chromatography.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-1-1803			
Course Title	Computer Applications and Tools in Chemistry and Biology			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Compulsory			

### Course Description:

Tools for structure and reaction mining, 2D and 3D molecular structures-representation and manipulation; molecular descriptors; Computational models-QSAR; Selection of diverse set of compounds; Analysis of high throughput screening data-visualization and mining; Virtual screening-drug-likeness, protein-ligand docking and ADMET.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-1-1804			
Course Title	Basic Instrumentation and Statistical Analysis			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

Principles of IR & NIR; Principles of UV spectroscopy; Principles of Mass spectrometry; Principles of GC & GC-MS; Principles of NMR; Principles of HPLC; Principles of HPTLC; Principles of optical rotation; Data analysis: error; mean; Standard deviation; Relative standard deviation-.Coefficient of variation; Confidence limits of a measurement; Propagation of errors-random and systematic.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-2-1801			
Course Title	Analytical Techniques and Instrumentation			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective				

### Course Description:

Principles of IR & NIR; Principles of UV spectroscopy; Principles of Mass spectrometry; Principles of GC & GC-MS; Principles of NMR; Principles of HPLC; Principles of HPTLC; Principles of optical rotation; Data analysis: error; mean; Standard deviation; Relative standard deviation-.Coefficient of variation; Confidence limits of a measurement; Propagation of errors-random and systematic.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-2-1802			
Course Title	Advances in Natural Products Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective				

Course Description:

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-2-1803			
Course Title	Green Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective				

### Course Description:

Green chemistry concepts: Basic understanding, scope and interdisciplinary nature of green chemistry; Environmental factors; Carbon credit, Energy efficiency and atom economy, Catalysis and green chemistry, Alternate reaction media and reaction systems, ionic liquids, supercritical fluids, solventless chemistry.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-2-1804			
Course Title	Chromatographic Techniques			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective				

### Course Description:

High Performance Liquid Chromatography: Principles and methods in Natural Products; Modern Thin-Layer Chromatography: Practical Aspects and applications; Measuring Diffusion with PFG's; Enantioselective GC in flavor and fragrance Analysis: Strategies for Identification of Plant Volatiles; GC-MS: Applications in Plant Volatile Identification; Analysis of Natural Products by LC-MS; Analysis of Natural Products by LC-MS/MS; Centrifugal Accelerated Radial TLC (Cromotron): Principles and its Applications in Natural Product Separation.; Vacuum Liquid Chromatography: Principles and its Applications in Natural Product Separation.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-2-1805			
Course Title	Structure Elucidation of Organic Molecules			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective				

### Course Description:

Unsaturation and functional group identification by UV/IR.; Structure elucidation by NMR; Molecular weight determination by Mass spectrometry; Structural confirmation of- Terpenoids, Alkaloids, Flavonoids, Carbohydrates, Steroids.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-2-1806			
Course Title	Frontiers in Pharmaceutical Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective				

### Course Description:

Fundamentals of Medicinal chemistry: Drugs history, mechanism of drug action, drug discovery process, modern drug designing, Lead identification, lead optimization, receptor theories, agonists and antagonists, Pharmacokinetics and pharmacodynamics, ADME, Lipinski's Rule, Drug efficacy, half life of drug, soft drug design, Drug testing and clinical phases; Chemistry and biology of some anticancer leads from plants: Camptothecin, Podophyllotoxin, Taxol, Combretastatin A4; Chemistry and biology of antimalarial drugs, Chemistry and biology of anti tubercular drugs

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-2-1807			
Course Title	Advances in Essential Oil Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective				

### Course Description:

Terpenoids, chemistry of essential oils, isoprene rule, classification of terpenes, structures of mono-, sesqui- and diterpenes, occurrence of terpenes and phenylpropanoids and their isolation/ distillation, preparation of concrete and absolute, phenylpropanoids C6-C3, physico-chemical parameters of essential oils: specific gravity, refractive index, optical rotation, solubility; Method development for quality separation of essential oils in one dimensional GC and GC-MS; analysis and fingerprint generation of commercially important plant *Mentha* as an example.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-2-1808			
Course Title	Advances in Extraction and Processing Technologies			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective				

### Course Description:

Techniques of distillation; maceration and extraction with volatile solvents; Supercritical extraction;; Hydrofluorocarbon extraction; Ultrasonication and Microwave extraction; Fractional distillation of essential oils, etc.; Processing technologies of MAPs; Counter Current Chromatography: Principle and its application in Natural Product Separation; Centrifugal Partition Chromatography: Principle and its application in Natural Product separation.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-2-1809			
Course Title	Synthetic applications in Natural Product Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective				

### Course Description:

Synthetic approach for structure elucidation, analogue synthesis, Hit & Trial method, logical modification, modifications for enhanced bioavailability, modification for detoxification, total and partial synthesis.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-2-1810			
Course Title	Fundamentals of Environmental Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective				

### Course Description:

Fundamental principles of chemistry to gain an understanding of the source, fate, and reactivity of compounds in natural and polluted environments. Environmental implications of energy utilization and on the chemistry of the atmosphere, hydrosphere, and lithosphere. Effects on biota, Chemical, photochemical, photosensitized reactions in the atmosphere. Photochemical smog- mechanisms of smog formation. Effects of smog, thermal inversion. Global environmental concerns: Anthropogenic change in the atmosphere, Greenhouse gases and Global warming, Acid rain, Ozone layer destruction, Nuclear winter, El nino, Asian Brown Haze, pollution and treatment of water sources, and the effect of insecticide and herbicide residues.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-2-1811			
Course Title	Intellectual Property Management			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective				

### Course Description:

General Principles of Intellectual Property: Copyright, Trademark, Patents: need of patents, major types of patents, patent offices in India, US and Europe, International registration of patents, how patents are obtained for drugs and their impact on pharmaceutical industry and patients, patent term and extension The Patents Act, 1970 – salient features, trade related aspects (TRIPS), international & regional agreements. Geo indicator, Aroma Industry.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-3-1801			
Course Title	Isolation and Characterization of New Chemical Entities (NCEs)			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Extraction and isolation of Plants Secondary Metabolites (PSM); Column chromatographic techniques and various adsorbents used in the purification of PSM; Activity guided fractionation, isolation and characterization of leads from natural products; Principles and applications of Flash, Low pressure, Medium pressure and High pressure liquid chromatography, <sup>13</sup>CNMR Spectroscopy; 2D NMR; Structure elucidation of natural products by EI/CI-MS, FAB-MS; Hybrid Instruments for Structure elucidation of natural products by LC-MS and LC-MS/MS; Resolution of enantiomeric mixtures; Separation methods in carbohydrates

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-3-1802			
Course Title	Frontiers in Synthetic Chemistry-Basic principles and Name reactions			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-3-1803			
Course Title	Reagents in Organic Synthesis			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Reagents for Oxidation: Jones reagent, Pyridine chlorochromate, Collins reagent, Serette's reagent, Corey's reagent, Selenium dioxide, m-Chloroperbenzoic acid, Swern oxidation, Osmium tetroxide etc.; Reagents for Reduction: Catalytic hydrogenation, Pd-C, Raney Nickel, Lindlar's catalyst, Wilkinson' catalyst, Sodium borohydride, Lithium aluminium hydride, DiBAL, Sodium cyanoborohydride, Na-NH<sub>3</sub>, Clemmensen reduction, Wolff-Kishner reduction. Miscellaneous reagents: Diazomethane, poly phosphoric acid, Gilman reagents, Lithium diisopropylamide (LDA), DABCO, Butyl lithium, DCC, EDC, HOBt, Potassium t-butoxide, Phase transfer catalysis, Crown ethers, Baker's yeast, p-TSA, Diazomethane, N-bromo succinimide, PPA, DBU, DDQ, Trifluoroacetic acid etc.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-3-1804			
Course Title	Frontiers in Organic Spectroscopy			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

Course Description:

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-3-1805			
Course Title	Techniques in Natural Products Up Scaling			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Bench scale, pilot plant scale, industrial scale, liquid-liquid extraction; solid-liquid extraction techniques, green solvents in chemical industry, Analytical to prep TLC; HPLC-Isolation from analytical to prep to industrial scale; supercritical extraction; process control and purity profile; Techno-economical feasibility report; fundamentals of scale up, economics of chemical engineering; process safety; basics of renewable energy & energy management in chemical process.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-3-1806			
Course Title	Applied, Industrial and Environmental Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Organic carbon; organic carbon budget, natural polymers- cellulose and chitosans; Chemical modifications in natural polymers and their applications; Conversion of natural polymers to nano-composites and their industrial utilization

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-3-1807			
Course Title	Quality assurance of Herbs and Herbal Products			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Chemical analysis of crude drug & finished product, de-replication technique in isolation, impurity profiling, bio-analysis of drug molecules, quality standards, herbals in IP

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-3-1808			
Course Title	Chemistry of Renewable Energy			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Renewable energy sources - hydro, wind, solar; Energy resources of plant origin, bioenergy, bio-fuel and bio chars; chemistry and processes of biofuel; by-products of biofuel processes.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-3-1809			
Course Title	Frontiers in Drug discovery and development			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Overview of drug discovery approach, causes of disease, target identification & validation, modelling and SAR, drug delivery system, pre-clinical and clinical trials, etiology, chemotherapy, drug resistance, remedies of infectious diseases (Microbial, malaria, tuberculosis), diseases of metabolic disorders (diabetes, cancer, osteoporosis, CNS & CVS). Plants as drugs: History, Phyto-molecules as pharmacophores, Approaches for development of drugs from plants, antimalarial, anti-tubercular, anti-infective, anti-hepatoprotective, anti-cancer, Immunomodulatory & anti-inflammatory molecules from plants.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-3-1810			
Course Title	Frontiers in Nanomaterial and Nanoscience			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Importance and properties of nanomaterials, advantages & disadvantages, nano composites, synthesis, characterisation, processing and applications of nano-tubes, topographical characteristics of nano material, chemical character of nano composites.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-3-1811			
Course Title	Advances in Essential Oil Chemistry and Analysis			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective				

### Course Description:

Headspace Gas chromatography (HS-GC): theory and practice, Chiral Gas Chromatography, Two Dimensional Gas chromatography techniques (GCxGC): theory and practice, Solid-phase micro-extraction (SPME) technique and its application in analysis of flower volatiles, selection of different polarity SPME fibers, enantiomer separation using chiral SPME-GC, SPME-GC-MS and Headspace techniques.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-4-1801			
Course Title	Project proposal writing & presentation			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Compulsory			

### Course Description:

Formulation of a project proposal by selecting topics of high relevance and novelty and will have state-of-the-art review, methodologies, recommendations etc. in specified format in a holistic manner preferably candidate's own research work suitable for submission to appropriate funding agencies.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-4-1802			
Course Title	Review Article			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Compulsory			

### Course Description:

Preparation of one review article on specific research area of the student.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMAP, Lucknow			
Course Nomenclature	CHE-CIMAP-4-1803			
Course Title	CSIR-800 Societal Program			
Credit Distribution (L-T-P-C)	0	0	8	4
Core/Elective	Compulsory			

### Course Description:

The students have to undertake a project in rural areas for 6-8 weeks in the line with CSIR-800 programme which is primarily prepared at empowering 800 million Indians by way of S&T inventions. The theme for the project may be chosen from CSIR-800 documents and as per expertise available in the laboratory. Students will select the topics in consultation with Doctoral Advisory Committee (DAC).

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMFR, Dhanbad			
Course Nomenclature	CHE-CIMFR-1-1901			
Course Title	Research Methodology:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	core			

### Course Description:

Good laboratory practices, Safety in the laboratory, First Aid in the laboratory, Maintenance of laboratory records, Scientific literature management, Communication skills (scientific writing and presentation), Intellectual property management & planning, Ethics in Science, Computer applications and tools, Statistical methods & Data analysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMFR, Dhanbad			
Course Nomenclature	CHE-CIMFR-1-1902			
Course Title	Analytical Tools and Instrumentation			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	core			

### Course Description:

Thermal methods (TG, DTG, DTA, TMA, DSC), X-ray methods (XRD, XRF, SAXS), NMR (<sup>1</sup>H, <sup>13</sup>C) and other Spectroscopic methods (EPR, IR, UV, Fluorescence), Chromatographic methods (TLC, GC, LC), Mass spectroscopy, Electron Microscopy (SEM, TEM), Electron Probe Micro Analysis (EDS, WDS), Quantitative Analysis (AAS, ICP, CHN)



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMFR, Dhanbad			
Course Nomenclature	CHE-CIMFR-1-1903			
Course Title	Basic mathematics and numerical methods			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	core			

### Course Description:

Determinants and Matrices, Complex Variables, Vector analysis, Infinite Series, Special Functions, Differential Equations, Interpolation and Approximation, Numerical differentiation and Integration, Basic Linux, Introduction to Algorithms, basic programming, Shell and Shell Scripting, Network Computing and Parallel Computing, Matlab/Scilab/Octave/Gnuplot Algorithms, basic programming, Shell and Shell Scripting, Network Computing and Parallel Computing, Matlab/Scilab/Octave/Gnuplot

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMFR, Dhanbad			
Course Nomenclature	CHE-CIMFR-1-1904			
Course Title	Basic Chemistry for Interdisciplinary sciences:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

Basics of inorganic, organic, physical and biochemistry, Nomenclature (IUPAC), molarity, molality and normality, types of bonding, Ionic, covalent and non-bonding interactions, Acids and bases, Atomic structure, periodic table and periodic properties, stoichiometry, chemical reactions and kinetics, solvent effects, functional groups in organic compounds, general named reactions and reaction mechanisms, carbohydrates, lipids, proteins, nucleotides, enzymes, photosynthesis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMFR, Dhanbad			
Course Nomenclature	CHE-CIMFR-2-1901			
Course Title	Advanced Organic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective				

### Course Description:

Stereochemistry, reaction mechanism, C-C and C-X bond formations, Retrosynthetic analysis, photochemistry, pericyclic reactions, reactive intermediates, Methods of asymmetric synthesis and their application in total synthesis, oxidation-reduction reactions, organocatalysis, metathesis reactions.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMFR, Dhanbad			
Course Nomenclature	CHE-CIMFR-2-1902			
Course Title	Advanced Coal Science			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction to coal geology and petrology. Coal classification, physical & chemical structure and properties of coal, macro-molecular structure of coal, structure and behaviour relationship, coal solubilization and structural modification of coal (chemical and thermal), low temperature oxidation of coal including coal weathering and spontaneous combustion, computer aided molecular design (CAMD) of coal including application of different sophisticated instrumental techniques. Introduction to clean coal technology and coal bio- processing. Environmental issues in coal industry and ash utilisation.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMFR, Dhanbad			
Course Nomenclature	CHE-CIMFR-2-1903			
Course Title	Environmental Chemistry			
Credit Distribution (L-T-P-C)	1	0	2	2
Core/Elective	Elective			

### Course Description:

Environmental chemistry: introduction; Water: properties; acid-base reactions, electrochemistry, pH; Eh; Chemical methods in treating water and wastewater; water disinfection. Thermodynamics and kinetics of air pollutants; chemical and photochemical reactions in atmosphere. Soil chemistry: nature and importance; acid-base and ion-exchange reactions in soils; colloidal chemistry of inorganic constituents, clays, organic matter and soil humus; adsorption desorption reactions, ion exchange, degradation of pesticides and hazardous substances in soil.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMFR, Dhanbad			
Course Nomenclature	CHE-CIMFR-3-1901			
Course Title	Coal Geology and Organic Petrology			
Credit Distribution (L-T-P-C)	1	0	2	2
Core/Elective	Elective			

### Course Description:

methods in treating water and wastewater; water disinfection. Thermodynamics and kinetics of air pollutants; chemical and photochemical reactions in atmosphere. Soil chemistry: nature and importance; acid-base and ion-exchange reactions in soils; colloidal chemistry of inorganic constituents, clays, organic matter and soil humus; adsorption desorption reactions, ion exchange, degradation of pesticides and hazardous substances in soil.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMFR, Dhanbad			
Course Nomenclature	CHE-CIMFR-3-1902			
Course Title	Analytical Techniques for Coal and Derivatives			
Credit Distribution (L-T-P-C)	1	0	2	2
Core/Elective	Elective			

### Course Description:

Analytical techniques for analysis of coal, fly ash, minerals, tar. Instrumental analysis: GC; XRD, XRF, DSC/DTA-TG, STA, TPR/ TPO/ TPD/ Pulse chemisorptions, particle size analysis, BET surface area, flame photometry AAS, ICP, CHNS, INAA, MS hyphenated techniques, FTIR, NMR, SEM-EDX, TEM, TMA, CSR/CRI

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMFR, Dhanbad			
Course Nomenclature	CHE-CIMFR-3-1903			
Course Title	Coal Beneficiation			
Credit Distribution (L-T-P-C)	2	0	2	3
Core/Elective	Elective			

### Course Description:

Introduction, sampling and sample preparation, size reduction; screening and classification; Fundamentals of coal washability, development of washability curves, interpretation of washability data, Separation process: dry coal beneficiation, coarse coal beneficiation, fine coal beneficiation, efficiency testing of gravity concentrators, solid- liquid/dewatering separation and types, flocculation, thermal drying; chemicals in coal preparation, process control and instrumentation, materials handling and transportation; blending and homogenization, testing of coal for end users, economics of coal preparation, waste disposal and environmental factors, computer applications-modelling & simulation, development of flow sheet, plant design and layout, process equipment selection, plant performance testing, coal washing practices in India.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMFR, Dhanbad			
Course Nomenclature	CHE-CIMFR-3-1904			
Course Title	Combustion Science and Technology			
Credit Distribution (L-T-P-C)	2	0	2	3
Core/Elective	Elective			

### Course Description:

Principle of coal combustion, oxidation and combustion, combustion process, kinetics of combustion, thermodynamics of combustion process, flame, flame temperature and velocity. Coal combustion technology – conventional and advanced, combustion behaviour of coal – laboratory, bench and pilot scale. Impact of coal quality parameters including petrography on combustion, spontaneous combustion of coal. Oxy fuel combustion, co-combustion, chemical looping combustion, super critical and ultra super critical boiler technology. Combustion products- solids and gases, pollution from coal combustion. Ash deposition characteristics, utilization of fly ash, trace and heavy metals pollution from coal combustion.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMFR, Dhanbad			
Course Nomenclature	CHE-CIMFR-3-1905			
Course Title	Coal Gasification			
Credit Distribution (L-T-P-C)	2	0	2	3
Core/Elective	Elective			

### Course Description:

Introduction: chemistry of gasification; pyrolysis; char gasification; factors affecting gasification and kinetics; gasification processes; coal properties on gasification; fluidization; fluidized bed gasifier design; types of gasifiers; major gasification technologies; gasification of high ash Indian coals; gasification applications; syn gas cleaning; present status of international and national gasification scenario.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMFR, Dhanbad			
Course Nomenclature	CHE-CIMFR-3-1906			
Course Title	Coal to Liquid (CTL) Technology			
Credit Distribution (L-T-P-C)	2	0	2	3
Core/Elective	Elective			

### Course Description:

Basics of catalysis, different types of Fischer-Tropsch (FT) catalysts, design, development and synthesis of FT

catalysts, historical development of CTL Technology, direct liquefaction (Bergius Process); syngas conversions;

Indirect Liquefaction (FT Synthesis); FT reactor design and development, modified FT processes, case studies of

CTL plants, bench & pilot scale investigations.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMFR, Dhanbad			
Course Nomenclature	CHE-CIMFR-3-1907			
Course Title	Coal Carbonization			
Credit Distribution (L-T-P-C)	2	0	2	3
Core/Elective	Elective			

### Course Description:

Caking and coking coals; characteristics; significance of proximate analysis and thermal rheological properties; role of macerals; coal blending for coke making; carbonization at various temperature; thermal characteristics of coal and mechanism of coke formation; design and types of coke oven; cooling / quenching of coke; coke oven by-products; pollution in coke industries and its abatement, operation and troubleshooting in coke oven industries; characterization and evaluation of coke; carbonization technology for future generation and utilization of low grade coal for coke making: stamp charging, partial briquette charging, selective crushing.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMFR, Dhanbad			
Course Nomenclature	CHE-CIMFR-3-1908			
Course Title	Coal Biotechnology			
Credit Distribution (L-T-P-C)	1	0	2	2
Core/Elective	Elective			

### Course Description:

Introduction; structure of low rank coal and biomass (lignin & cellulose, hemicellulose etc), microbial techniques; microbial diversity and characteristic features; microbial classification; extremophiles; bioinstrumentation; fermentation technology; microbial physiology; microbial metabolism; microbial genetics; enzyme technology; bioreactors and application; bio-cleaning, bio-desulphurization of coal, bio-methanation and bio-liquefaction of coal, environmental microbial technology; biostatistics.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMFR, Dhanbad			
Course Nomenclature	CHE-CIMFR-3-1909			
Course Title	Environmental Management in Coal Industry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

microbial diversity and characteristic features; microbial classification; extremophiles; bioinstrumentation; fermentation technology; microbial physiology; microbial metabolism; microbial genetics; enzyme technology; bioreactors and application; bio-cleaning, bio-desulphurization of coal, bio-methanation and bio-liquefaction of coal, environmental microbial technology; biostatistics.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMFR, Dhanbad			
Course Nomenclature	CHE-CIMFR-3-1910			
Course Title	Management of Soil, Water & Air Pollution in Coal Industry			
Credit Distribution (L-T-P-C)	1	0	2	2
Core/Elective	Elective			

### Course Description:

Soil: concept, properties, classification. Soil pollution; soil erosion and conservation; soil quality assessment, reclamation of coal mine spoil. Source and characteristics of wastewater, sampling and analysis, fundamentals of water treatment, physical, chemical and biological processes and design parameters, sludge stabilization, effluent disposal and reuse, Recycling of water in coal washery, recovery of coal fines. Air pollution; sources; abiotic, biotic and gaseous pollutants; air sampling and monitoring techniques; ambient air and stack monitoring; qualitative and quantitative analyses; environmental health hazards; abatement strategies.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMFR, Dhanbad			
Course Nomenclature	CHE-CIMFR-3-1911			
Course Title	GHG Emission and Clean Development Strategies			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Kyoto protocol, national and international protocols and guidelines. Climate change issues. Tire-I, Tire-II and Tier -III, approach for GHG emission estimates. Estimation of GHGs in mining and industrial sectors; flue gas cleaning. Carbon footprints and carbon market, CO<sub>2</sub>-capture & storage. Uncertainties in emission estimates, development of country specific NCV and CEF for different types of coal and lignite. Clean development mechanism (CDM); sectors eligible for CDM; national CDM authority and guidelines.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMFR, Dhanbad			
Course Nomenclature	CHE-CIMFR-4-1901			
Course Title	Project proposal writing & presentation			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Formulation of a project proposal by selecting topics of high relevance and novelty and will have state-of-the-art review, methodologies, recommendations etc. in specified format in a holistic manner preferably candidate's own research work suitable for submission to appropriate funding agencies.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMFR, Dhanbad			
Course Nomenclature	CHE-CIMFR-4-1902			
Course Title	Review Article			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Preparation of one review article on specific research area of the student.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CIMFR, Dhanbad			
Course Nomenclature	CHE-CIMFR-4-1903			
Course Title	CSIR-800 Societal Program			
Credit Distribution (L-T-P-C)	0	0	8	4
Core/Elective	Core			

### Course Description:

The students have to undertake a project in rural areas for 6-8 weeks in the line with CSIR-800 programme which is primarily prepared at empowering 800 million Indians by way of S&T inventions. The theme for the project may be chosen from CSIR-800 documents and as per expertise available in the laboratory. Students will select the topics in consultation with Doctoral Advisory Committee (DAC).

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-1-2001			
Course Title	Research Methodology:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Good laboratory practices, Safety in the laboratory, First Aid in the laboratory, Maintenance of laboratory records, Scientific literature management, Communication skills (scientific writing and presentation), Intellectual property management & planning, Ethics in Science, Computer applications and tools, Statistical methods & Data analysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-1-2002			
Course Title	Analytical Tools and Instrumentation			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Thermal methods (TG, DTG, DTA, TMA, DSC), X-ray methods (XRD, XRF, SAXS), NMR (<sup>1</sup>H, <sup>13</sup>C) and other Spectroscopic methods (EPR, IR, UV, Fluorescence), Chromatographic methods (TLC, GC, LC), Mass spectroscopy, Electron Microscopy (SEM, TEM), Electron Probe Micro Analysis (EDS, WDS), Quantitative Analysis (AAS, ICP, CHN)

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-1-2003			
Course Title	Basic mathematics and numerical methods			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Determinants and Matrices, Complex Variables, Vector analysis, Infinite Series, Special Functions, Differential Equations, Interpolation and Approximation, Numerical differentiation and Integration, Basic Linux, Introduction to Algorithms, basic programming, Shell and Shell Scripting, Network Computing and Parallel Computing, Matlab/Scilab/Octave/Gnuplot Algorithms, basic programming, Shell and Shell Scripting, Network Computing and Parallel Computing, Matlab/Scilab/Octave/Gnuplot

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-1-2004			
Course Title	Basic Chemistry for Interdisciplinary sciences:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

Basics of inorganic, organic, physical and biochemistry, Nomenclature (IUPAC), molarity, molality and normality, types of bonding, Ionic, covalent and non-bonding interactions, Acids and bases, Atomic structure, periodic table and periodic properties, stoichiometry, chemical reactions and kinetics, solvent effects, functional groups in organic compounds, general named reactions and reaction mechanisms, carbohydrates, lipids, proteins, nucleotides, enzymes, photosynthesis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-1-2005			
Course Title	Introduction to Nanoscience and Nanotechnology			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

General considerations, Introduction, definitions, consequences of size reduction, Properties: structural, thermodynamic, optical, electrical and magnetic properties, Methods of synthesis, Surface modifications, factors governing the stability and assembly, Characterization of nanomaterials, Applications of Nanomaterials



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-1-2006			
Course Title	Introduction to Chemical Biology			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

chemical biology/synthetic biology, Structure, function and chemistry of biological macromolecules including amino acids, proteins, nucleic acids and carbohydrates, Chemical kinetics and thermodynamics in biology, Chemical reactions and chemical diversity in Biology The Chemistry of Enzymes, Lipids, Fats & Steroids, Drug discovery, Drugs from Nature, Drug interaction

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2001			
Course Title	Advanced Physical Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Thermodynamics and chemical kinetics, Quantum Mechanics, Atomic structure and spectroscopy, Chemical bonding in diatomics, Chemical applications of group theory, Colloids and Surface science, surfactants, Interface and Interfacial properties, Electrochemistry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2002			
Course Title	Advanced Inorganic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Structure & Bonding in Inorganic Compounds, Chemistry of Coordination Compounds, Symmetry in Chemistry & Group Theory, Main group chemistry, Organometallic chemistry, Electronic Spectra of Transition Metal Compounds, Magneto Chemistry, Metal Cluster Compounds, Inorganic Reaction Mechanism, Electron Transfer Reactions in Metal Complexes, Bioinorganic Chemistry (Metalloenzymes, Metal complexes as oxygen carriers, Photosynthesis), Metal Complexes in Medicinal Chemistry, Catalysis by Inorganic Complexes.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2003			
Course Title	Advanced Organic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Stereochemistry, reaction mechanism, C-C and C-X bond formations, Retrosynthetic analysis, photochemistry, pericyclic reactions, reactive intermediates, Methods of asymmetric synthesis and their application in total synthesis, oxidation-reduction reactions, organocatalysis, metathesis reactions.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2004			
Course Title	Advanced Analytical Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Analytical instrumentation, signal and noise, Overview of optical methods of analysis: Components of optical instruments, atomic and molecular spectrometry based on absorption, emission and scattering, Electroanalytical techniques (basic electrochemistry, voltammetry, potentiometry), Analytical separations and introduction to chromatographic methods, GC, LC, Mass spectrometry, electromigration techniques, hyphenated techniques, detectors, Analytical tools for petroleum refining.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2005			
Course Title	Advanced Quantum Mechanics			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Revision of Hydrogen atom and particle in box (1D and 3D), Approximate methods in quantum mechanics; Non degenerate perturbation ; Perturbation treatment of the Helium atom ground state and first excited state; Variation method for helium atom ground state; Comparison of perturbation and variation method, Structure of many electron wave function, Antisymmetry, Valence bond theory for homo and hetero nuclear diatomic molecules; Molecular orbital theory Comparison of MO and VB theory; Introduction to density functional theory; Hartree Fock theory, Overview of methods beyond Hartree Fock theory; Configuration Interaction; Many body perturbation; Coupled cluster

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2006			
Course Title	Advanced Organometallic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Fundamentals, The 18 Valence Electron Rule; Structure and bonding of organometallic complexes using molecular orbital theory.  $\sigma$ -Donor Ligands: Transition-Metal-Alkyl and -Aryl compounds;  $\sigma$ -Donor/ $\pi$  – Acceptor Ligands: Transition-Metal-Alkenyl, -Aryl and –Alkynyl Complexes, Transition-Metal-Carbenes (Fischer and Schrock Carbenes); Metal Carbonyl; Structure, properties and principal reaction types of the above complexes;  $\sigma$ ,  $\pi$  -Donor/ $\pi$  –Acceptor Ligands: Olefin Complexes; Alkyne, Allyl and Enyl Complexes, Complexes of the cyclic  $C_nH_n$ , Fundamental Mechanism of Organometallic Transformations: Oxidative addition, Migratory Insertion,  $\beta$ -hydride elimination and reductive elimination; Interaction of C-C and C-H  $\sigma$ -bonds with Transition Metals

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2007			
Course Title	Advanced Coordination Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Naming of coordination compounds, classification of ligands, chelate and macrocyclic effect, Theories dealing with the formation of Coordination Compounds, Spectrochemical Series; Splitting of d-orbitals, Jahn–Teller Effect; Stability constants of Transition metal complexes and their determination by Job's Method. Spin–Orbit Coupling, Electronic states and term symbols, Selection rules (Laporte and spin selection rule), Interpretation of electronic spectra of Transition metal complexes, Orgel and Tanabe Sugano diagrams. Charge Transfer spectra, Magnetic Properties of Transition elements, Chemistry of Inner Transition Elements.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2008			
Course Title	Advanced Photochemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction to photochemistry, excited state processes, fluorescence and phosphorescence, quantum yields, charge-transfer spectra, solvatochromism, photochromism, transient absorption techniques, Luminescence emission lifetimes, two- and multiphoton processes, photoinduced energy and electron transfer, FRET, fluorescence polarization, excimers, exciplexes, delayed fluorescence, Photochemistry of Organic chromophores. Photochemistry in organized and confined media.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2009			
Course Title	Advanced Polymer Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Techniques of polymerization, polymer characterization techniques, Stereochemistry of Polymers, polymer nano-architectures, random and block copolymers, Liquid Crystalline Polymers, Conducting Polymers, Non-linear Polymers, Polymer Blends and Composites, polymer rheology, inorganic, bio and supramolecular polymers

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2010			
Course Title	Advanced Electrochemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Basic electrochemistry concepts, Reference electrodes, Electrochemical Thermodynamics, Kinetics of electron transfer, the Taft equation, Diffusion, Double Layers, electrode Kinetics, the Gibbs adsorption isotherm, the Lippmann equation, infinitely dilute solutions and thermal balance, Electro capillary phenomena, Faradaic vs. capacitive currents, transport properties, potential theory, Electrochemical Techniques, Voltammetry, Reversible and irreversible reactions, Mass transport by convection, rotating electrodes, Equivalent circuits, A.C. voltammetry, Electrolysis methods, Adsorption, Thin layer cells, Electrochemistry of polymers and inorganic solids, Spectroelectrochemistry, Applications.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2011			
Course Title	Advances in Bioinorganic chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Metal ions in biology, structure and function of metallo-proteins and enzymes, Communication role for metals in biology. Heme and non-heme systems with one-, two- or multi-metal, photosynthesis and photosystem II; O<sub>2</sub>-binding, reduction to O<sub>2</sub><sup>-</sup>, O<sub>2</sub><sup>2-</sup>, and O<sub>2</sub>-species their utilization in hydroxylation and epoxidation; nitrogen fixation, water-oxidation reactions. Synthetic models, Correlation with structure and function of the natural enzymes, design and synthesis, mechanisms. Metal based drugs, Porphyrins, Corrins, hydroporphyrins.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2012			
Course Title	Advances in hydrocarbon chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Chemistry of crude oil, thermal cracking, visbreaking and coking processes, catalytic cracking, hydro cracking and hydrogen production processes, catalytic reforming process, Chemistry and industrial processes for alkylates, isomerisation processes, Petrochemicals, Basic Building blocks; C1-Chemistry; Petrochemicals from n-paraffins; Petrochemicals from olefins and aromatics; Refinery-Petrochemical Integration, Future Prospects

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2013			
Course Title	Advanced process chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Integral and Differential analysis; Evaluation of rate equations, unit processes, mass transfer, mass balance, energy balance, fluid flow, Design of homogeneous systems, different types of reactors, green chemistry

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2014			
Course Title	Advanced Materials Science			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Crystal systems and space groups, Close packing and various simple structure types like AB, AB<sub>2</sub>, AB<sub>3</sub> and complex structural types ABX<sub>3</sub>, AB<sub>2</sub>X<sub>4</sub>, etc. Factors affecting crystal structures, Common preparative methods; X-ray diffraction and Electron microscopy, Defect structures, colour centers, reciprocal lattices, Properties of solids – Band theory, metals, insulators, semiconductors, dielectric and ferroelectric properties, magnetic properties, optical properties, ionic conduction; structure-processing-property correlations.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2015			
Course Title	Advanced Catalysis			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Homogeneous and heterogeneous catalysis, adsorption, diffusion, kinetics, equilibrium and rate expressions; Chiral catalysis, Surface Science in Catalysis, Catalytic Materials; Supports; Active Components, Classes of reactions and types of reactors; Catalyst preparation methods; Characterization of catalysts; Catalysis in super critical media; Brief introduction of organo and electro-catalysis; Structure-activity-property-stability of catalysts, Catalysts in chemical industry, Catalysis in petroleum refining and petrochemicals; Catalysis in the utilization of renewable feed stocks and concepts of sustainable chemistry.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2016			
Course Title	Advanced Surface Science			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction to Surface Science - Surface phenomena - Adsorption, Desorption, Adsorption Models, Special properties of surfaces and interfaces, Electronic structure of surfaces, Surface modification and its applications, Nanoscale catalysis and applications, Surface spectroscopy and microscopy tools for nanocatalysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2017			
Course Title	Advanced Separation Science and Technology:			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Resins and membranes for separations, Classification of membranes; electromembrane Processes; Ion-exchange membranes and their applications, Electrodialysis and related processes. Polymer electrolyte membrane and their applications for fuel cells; Water electrolyzer for hydrogen production; Reverse electrodialysis for non-renewable energy from concentration gradient, reverse osmosis, nanofiltration, ultrafiltration, pervaporation and gas separation: Membrane fouling, concentration polarization and other limitations of Pressure-driven membrane technologies.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2018			
Course Title	Advanced Materials Characterization Techniques:			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Optical Microscopy, Electron microscopy: TEM, HRTEM, SEM, STEM, EDX, FIB, e-beam lithography, Scanning probe microscopy: AFM, STM, MFM, confocal, etc, Raman spectroscopy/microscopy, Thermal analysis techniques, Magnetic measurements, Electrical measurements, Spectroscopic ellipsometry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2019			
Course Title	Advances in Nanoscience and Nanotechnology			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Low-dimensional structures: Quantum wells, Quantum wires, and Quantum dots, Nano clusters & Nano crystals, fullerenes, carbon nano tubes and graphene, Nano Composites, synthesis and characterization techniques, Properties at Nano Scales and comparison with bulk materials, fabrication techniques, general applications, nanomaterials in biology.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2020			
Course Title	Advances in soft matter chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Condensed Matter, Colloids, Characterization of colloids by light scattering and electric-field based techniques, Micelles, Self-assembled systems, Molecular gels, Lyotropic liquid crystalline phases, One-, Two- and Three-dimensionally ordered phases, Thermotropic Liquid crystals textures and their identification, characterization of mesophases, Description of order parameter, Phase transitions

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2021			
Course Title	Advances in Chemical Biology			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Amino Acids, Peptides & Proteins, Design of poly peptides, Peptide hormones and their pharmaceutical significance, Peptide mimetics as therapeutics, Chemistry of Carbohydrates, Nucleic acids, Structure & function of DNA and RNA, Nucleic acid mimetics & their therapeutic applications, Chemistry of Enzymes, Lipids, Fats & Steroids, Drug discovery, Basic principles of medicinal chemistry, Drugs from Nature, Natural products based drug discovery, Kinetics and thermodynamics of biological process, Enzyme Catalysis, consecutive, parallel and competitive reactions in biological systems, Thermodynamics, allosteric effect in biology, types of bonds, hydration and their specific contribution towards specific thermodynamic parameters, enthalpy or entropy, Scatchard analysis, hill plot analysis.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2022			
Course Title	Advanced Biomaterials			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Definition of biomaterials, Surface property requirements of biomaterials, Types of materials used in medicine, Synthesis and surface characterization, Biology of wound healing, foreign body response and tissue remodeling, Molecular and cellular interactions of materials with biological environment, Degradation and long term fate of materials used in medicine, Requirements of biomaterials for biomedical implants, surface coatings, wound dressings, sutures, cardiovascular devices, ophthalmology, dentistry, orthopedics and cosmetic surgeries, Applications in drug delivery and tissue engineering, Standard protocols for testing the efficacy and efficiency of biomaterials, The regulatory environment for biomaterials, Some concepts for design development of common biomaterials.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2023			
Course Title	Rare Earth Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Lanthanides and actinides, Electronic structure, periodic properties, extraction, separation, solution chemistry, coordination compounds, spectroscopy, luminescence, magnetism, dyes and pigments, trans-uranium elements, nuclear technology, displays and energy related applications.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2024			
Course Title	Sol-gel chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction, Hydrolysis and condensation reactions, Solution chemistry and physics of intermediates, Role of the anion on the hydrolysis and condensation reactions, Kinetics of Hydrolysis and Condensation, Non-Hydrolytic Sol-Gel Processing, Gelation, Ageing, Drying, Densification, Characterization, Chemistry of Sol-Gel Silicates, Solution chemistry of transition metal alkoxide precursors, Sol-gel synthesis and characterization of important materials, structure-property relationships

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2025			
Course Title	Combinatorial chemistry			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Principles and techniques of combinatorial chemistry, Popular organic reactions in combinatorial chemistry. solid-phase organic synthesis, Solution-phase parallel synthesis, mixture-based compound libraries, principles of compound library design, natural product and natural product-like libraries, case studies of combinatorial chemistry in drug discovery

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2026			
Course Title	Green chemistry			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Green chemistry concepts: Basic understanding, scope and interdisciplinary nature of green chemistry; Environmental factors; Carbon credit, Energy efficiency and atom economy, Catalysis and green chemistry, Alternate reaction media and reaction systems, ionic liquids, supercritical fluids, solventless chemistry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2027			
Course Title	Natural products			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Carbohydrates and polysaccharides, Structure and functions of important derivatives of monosaccharides, Classification and nomenclature and synthesis of some simple Alkaloids; Terpenoids and Steroids such as pinene; Camphor and Cadenine;  $\alpha$ -vetinone; Hirsutene and Abietic acid (Terpenoids); Cholesterol; Testosterone and Andestrone (Steroids) etc. isolation and characterization, elucidation of structure-property relationships. Biosynthesis of steroids, terpenoids, fatty acids, alkaloids and polysaccharides, biosynthesis of natural products

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2028			
Course Title	Ionic liquids			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Introduction to ionic liquids, ionic liquids vs. molecular solvents/ionic salts (solids), ionic liquids vs. eutectic mixtures, solvent polarities using different spectral techniques (parameters), physicochemical properties of ionic liquids, effect of functional groups on the properties of ionic liquids, surface active ionic liquids, aggregation behavior of ionic liquids, interaction of ionic liquids with different molecular solvents, interaction of ionic liquids with biopolymers, thermodynamics of the binary mixtures of ionic liquids, structure property relationship in ionic liquids.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2029			
Course Title	Synthetic methods for organic chemists			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Formation of carbon-carbon bond employing various kinds of organometallic reagents, C-C double bonds through different reactions, oxidation, reduction through various kinds of reagents, functional group interconversion, by substitution including protection and deprotection, alkylation of enolates, and other carbon nucleophiles, reaction of carbon nucleophiles with carbonyl compounds, electrophilic addition to C-C multiple bonds, reactions of C-C multiple bonds, Retrosynthesis, disconnection, synthons, linear and convergent synthesis, umpolung of reactivity and protecting groups.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2030			
Course Title	Organic reaction mechanisms			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Basics, The concept of Aromaticity, How to write an organic reaction mechanism?, Popular name reactions, Reactive intermediates: Generation, stability, structures and reactivity of carbocation, carbaion, carbene, radicals, benzyne, nitrene, Types of mechanism: classification, limitations examples of aliphatic nucleophilic substitution - aliphatic electrophilic substitution - aromatic nucleophilic substitution - aromatic electrophilic Substitution - types of radical reactions - molecular rearrangements oxidation and reduction; Electrophilic reactions-Friedel crafts reaction, Rieme r Tiemenn reaction, Beckmann rearrangements; nucleophilic reactions- aldol condensation, perkin reaction, benzoin condensation;free radical reaction-halogenation of alkane, addition of HBr on alkene in presence of peroxide;allylic halogenation - using N-Bromo Succinamide (NBS), thermal halogenation of alkene  $\text{CH}_3 - \text{CH} = \text{CH}_2$

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2031			
Course Title	Dyes and pigments			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Colour and constitution, chromogen and chromophore. Classification of dyes based on structure and mode of dyeing, Chemistry of some important dyes, NIR reflecting dyes, Dyes for solar cells



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2032			
Course Title	Physical organic chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Hammett concepts-Quantitative structure activity relationships, linear free energy relationships, Molecular mechanics, Semi-empirical and ab initio molecular theory, Pericyclic Reactions; Substituent Effects; Frontier Molecular Orbitals, HOMO-LUMO Interactions, Aromaticity, Odd and Even Alternant Hydrocarbons, Pericyclic Reactions The Woodward-Hoffman Rules. Free Energy Changes, Transition State Theory, The Eyring Equation, The Mechanistic Significance of Kinetic versus Thermodynamic Control of Organic Reactions, The Hammond Postulate, The Curtin-Hammett Principle; Kinetic Isotope Effects, The Reactivity-Selectivity Principle, Substituent Effects, Absorption of Light by Organic Molecules, Jablonsky Diagrams, Morse Potential Energy Curves, Common Photochemical Reactions, Photocycloadditions.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2033			
Course Title	Thermodynamics and Statistical Mechanics			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction: Thermodynamics – A Macroscopic Theory of Matter; Laws of Thermodynamics, Ideal Gas Laws, Specific Heat Capacities; Concept of Free Energy, Hamiltonian Mechanics, Equilibrium Distributions and Ergodic Hypothesis, Ensembles, Thermodynamic Functions and the Distribution Function,  $g(r)$ , Imperfect Gases, Kinetic Theory of Gases, Time Dependent Processes, Phase Transitions

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2034			
Course Title	Composite materials			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Concept of Composite materials, Various types of composites, Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites, Reinforcements/Fibers ,Types of fibres, Multiphase fibers, Whiskers and Flakes, Mechanical properties of fibres, Processing of Advanced composites, Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing; Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering; Carbon – Carbon composites: Knitting, Braiding, Weaving; Polymer matrix composites: Preparation of Moulding compounds and prepregs – hand lay up method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding, Processing and characteristics of nanocomposites, hybrid composites, functionally graded composites, smart and functional composites

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2035			
Course Title	Organic spectroscopy applications			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Mass spectroscopy, IR spectroscopy, Proton magnetic resonance spectroscopy, Structural assignment by employing NMR techniques, Carbon-13 NMR spectroscopy, Introduction COSY, HSQC, HMBC, NOESY, ROESY, Structural elucidation using 2D-NMR methods

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-2-2036			
Course Title	Surface characterization techniques			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

XPS, LEED, XAS, SEM, AFM, TEM, NSOM, SPR, SERS, static and dynamic contact angle measurements, Ellipsometry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2001			
Course Title	Mathematical Methods			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Determinants and Matrices : Orthogonal Matrices, Hermitian Matrices, Unitary Matrices, Diagonalisation of Matrices, Vector analysis : Scalar and Vector product, Triple scalar and vector product, Gradient, Divergence, Curl, Vector Integration, Gauss Theorem, Stokes Theorem. Vector Analysis in Curvilinear coordinates and Tensors, Infinite Series: Fundamental Concepts, Convergence tests, Taylor's expansion, Power Series, Special Functions: Gamma Function, The Beta Function, Differential Equations: Series Solution-Frobenius Method, Bessel Functions, Legendre Functions, Hermite Functions, Laguerre Functions, Fourier Series, Applications of Fourier Series, Fourier Transforms

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2002			
Course Title	Numerical Methods			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Fortran and Linux basics, Solution to the linear algebraic equations, Eigen Values problems, Interpolation and extrapolation, Random number and sorting, Minimization and maximization of functions, Modeling of data

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2003			
Course Title	Electronic structure theory			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Post-Hartree-Fock methods: Moller-Plesset perturbation theory (MP2, MP3, and MP4), Configuration Interaction (CI), Coupled-Cluster single double (triple) (CCSD(T))– performance of various methods for the prediction of van der Waal and hydrogen bonding interactions, spectral properties. Density functional theory based methods: Hybrid and Minnesota functional – Application of DFT methods (excitation energy calculations). Density functional methods with Dispersion correction (Grimme's approaches). Car-Parrinello Molecular Dynamics (CPMD) and Born-Oppenheimer Molecular Dynamics (BOMD).



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2004			
Course Title	Molecular modeling and simulation			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Molecular Mechanics: Features of molecular mechanics - Force Fields: Bonds structure and bending angles, Electrostatic Vander Waals and non-bonded interactions, Hydrogen bonding - Derivatives of molecular mechanics energy function - Calculating thermodynamic properties - Force Field for inorganic systems - Energy minimization, Molecular Dynamics Simulation: Molecular Dynamics using simple models, Molecular Dynamics with continuous potentials, Solvent effects, Conformational changes, Thermostats, Barostats, Lincs and shake algorithms, Monte Carlo simulation Methods, sorption, Applications of Molecular Modeling

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2005			
Course Title	Computer aided drug design			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Definition of a drug molecule and factor affecting their biological activity, definition of chemotherapeutic index, therapeutic index, design of a drug molecule and relationship of functional groups, discovery of new drugs: drug discovery without a lead, lead discovery, random screen, non-random screen, concept of absorption, distribution, metabolism, and excretion (ADME), drug receptors, physicochemical properties, mechanism of a drug action, stereochemistry and drug action, synthetic and natural drugs and their modifications to increase oral bioavailability, chirality and drug action, bioisosterism, drug receptor-interactions, topographical and stereo-chemical considerations, concept of drug resistance, drug synergism, enzyme inhibition and activation, molecular modeling and insilico drug design, concept of structure-activity relationship(SAR) and quantitative structure-activity relationship (QSAR), Lipinski rule of five, mechanism of action of some important drug molecules.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2006			
Course Title	Computational materials design			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Solids, Drude and Sommerfield theories of metals, Kronig-Penning model, Tight-Binding approximation, band structure, density of states, prediction of electrical and magnetic properties, Prediction of properties of organic molecules and polymers, Introduction to Multiscale Modeling and Simulations and applications. Monte Carlo simulation in various ensembles, Gas sensing properties of various porous materials using grand canonical Monte Carlo method, Dissipative particle dynamics, Mesoscale dynamics and applications.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2007			
Course Title	Multiphase reaction kinetics			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Mass transfer theories, Multi phase reactors, Multi phase reactors selection criteria; Mass transfer coupled with chemical reaction; measurement of gas-liquid parameters, Reaction in porous catalysts; effective diffusivity and structure of porous catalysts, Important design parameters for gas-liquid and solid reactors, Reactor modeling in petroleum refining industry, Modeling of catalytic sweetening, isomerisation, hydro treating, and FT synthesis.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2008			
Course Title	Carbohydrate chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Mono and disaccharides, polysaccharides, Bacterial polysaccharides, starch and cellulose, derivatives of cellulose, Protecting groups, Glycosylation reactions, Dynamics and interactions, carboxy methyl cellulose and gun cotton, structure, Conformational analyses, glycoconjugates, Immunology of carbohydrates.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2009			
Course Title	Biophysical chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Physico Chemical properties of Water, State of Water in biostructures & its significance, Lipids & Proteins, Membrane organization & stability, Protein lipid interactions, Phase properties of biological membranes, Transport across the membrane, Osmosis, molecular basis of aqueous channels, Structural level of proteins & stabilizing forces, Conformational analysis of polypeptides, Ramachandran plot, Double helical structure of DNA, Conformational parameters of Nucleic acids & their constituents, Types & structure of RNA, mRNA, rRNA, tRNA, Protein-ligand and DNA-protein interactions.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2010			
Course Title	Physics and chemistry of collagen			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Molecular Structure of Collagen, Native collagen fibrils, X-ray Diffraction studies of collagen, Electron microscopic appearance of collagen, synthetic collagen-like polypeptides, Chemistry of Collagen and its Distribution, Biosynthesis of Collagen, Crosslinking, Degradation, Isolation and Characterization of Collagen, Physico-Chemical Techniques for Collagenous Matrices, Microscopy and other Non-invasive methods.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2011			
Course Title	Marine Natural products			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Polysaccharide contents of various seaweeds, Phaeophyceae and Rhodophyceae, Bioactive compounds from halophytic plants and marine algae/seaweeds, Gelling polysaccharides, extraction from natural sources, characterization and properties. Preparation of polysaccharide based biodegradable materials, hybrid composites, stimuli responsive materials. Applications of polysaccharide based materials. Biosynthesis of bioactive polysaccharides, steroids, fatty acid derivatives and alkaloids.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2012			
Course Title	Supramolecular chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Nature of supramolecular interactions, role of various non-covalent interactions, multiple hydrogen bonding motifs, Stability of H-bonds, Jorgensen model for H-bonding, supramolecular synthons , dimensions of supramolecular chemistry, Janus molecules. Photoresponsive molecules and self-assembly, Molecular recognition, classification of supramolecular host-guest complexes, supramolecular self-assembly, supramolecular polymers, molecular capsules, self- assembled dendrimers, self-assembled nanotubes, low molecular weight organogels. Characterization techniques of self-assemblies, supramolecular sensors.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2013			
Course Title	Total Synthesis			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Synthesis of complex organic molecules – planning and execution; Concepts of Retrosynthetic Analysis and Total synthesis of Natural products; Retrosynthesis; Disconnection; Synthons; Linear and Convergent Synthesis; Photochemistry in total synthesis; MCRs in total synthesis; Breakthrough synthesis – past and present.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2014			
Course Title	Asymmetric Synthesis			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Strategies for the preparation of optically pure compounds; Stereoselective, Enantioselective and Diastereoselective reactions; Stoichiometric asymmetric synthesis-chiral auxiliaries, Evans Alsdol and modified versions; Catalytic asymmetric synthesis; Asymmetric Dihydroxylation; Asymmetric Aminohydroxylation; Asymmetric Hydrogenation; Asymmetric allylation, propargylation, and alkylation; Chiral Organocatalysis; Cascade reactions by organocatalysis; Transition Metal based catalysis; Asymmetric amplification and autocatalysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2015			
Course Title	Chemistry and biology of Heterocycles			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Privileged heterocycles, Electronic properties, reactivity (electrophilicity and nucleophilicity), Synthetic methodologies, Biological properties of Natural products and drug candidates, Biosynthesis, Dimeric compounds and related stereochemistry

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2016			
Course Title	Agrochemicals			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Biochemistry in agriculture, Carbohydrates, Proteins, Lipids, Vitamins and Minerals and Enzymes, Soil science, guidelines on agricultural crops micronutrients and fertilizers, Chemistry of pesticides, synthesis, formulations, mode of action, toxicology, resistance and residual analysis, Methodologies for the synthesis of agrochemicals and other relevant organic molecules, chemistry in Integrated Pest Management, Semiochemicals, insect growth regulators, botanical pesticides and other biotechnological approaches, Analysis of agrochemicals and residues - Botanical pesticides, hormones, pheromone, kairomones and plant volatiles

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2017			
Course Title	Fluoro organic chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Importance of fluorine in organic compounds, Strategies to introduce fluorine/ trifluoromethyl group into organic molecules, Preparation of fluorinated reagents, Preparation of fluorinated carbon materials and their uses, Known fluorinated drugs and their mode of action, Overview on CFCs, HCFCs, HFCs, their preparation and applications, Halon susbsitutes, Harmful effects of fluorine and inorganic fluorides

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2018			
Course Title	Corrosion science			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Basic aspects, Forms of corrosion, Atmospheric corrosion and protective coatings, Immersion corrosion and electrochemical protection, Corrosion monitoring, impedance spectroscopy, harmonics and NDT techniques.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2019			
Course Title	Nutraceuticals:			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Raw material preparation, and characterization, extraction of valuable biomolecules, characterization of these molecules with stability study, preparation and formulations for functional foods. Characterization and stability study of nutraceuticals, properties and stability packaging of nutraceuticals.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2020			
Course Title	Ionic liquids for lubricants			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Lubrication by Ionic liquids and its structural correlation, Ionic liquids interaction with surfaces, synthetic oil lubricants, synthesis of lubricating ionic liquids, effect of alkyl chain length and anions, IL lubrication oils at variable temperatures, thin films, heat capacity and thermal properties, viscosity and wetting properties, ionic liquids as additives for lubricants, comparison with conventional hydrocarbon oils, Case studies.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2021			
Course Title	Applications of ionic liquids			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Introduction to task specific ionic liquids, self-assembly of ionic liquids in aqueous/non aqueous media and synthesis of nanomaterials therein, ionic liquids in catalysis, extraction of metal ions, ionic liquids and biopolymers: dissolution, regeneration and ionic-gel formation, processing of lignocellulosic biomass using ionic liquids, clean separation of various fractions of biomass and recovery of valuable chemicals using ionic liquids, application of ionic liquids in electrochemistry, separation of azeotropic mixtures using ionic liquids, organic reactions in ionic liquids.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2022			
Course Title	Homogeneous Catalysis			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Organometallic Catalysis, Applications in organic synthesis: Olefin Isomerization, C-C Coupling reactions: Heck, Suzuki, Stille and Sonogashira reactions, Alkene and Alkyne Metathesis, C-Heteroatom coupling: Hydroamination, Olefin Oxidation, C-H activation, Oxidation reactions, hydrogenation of Alkenes, Industrial Applications.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2023			
Course Title	Catalysis for organic synthesis			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

A background on fine and specialty chemicals in chemical industry; Concept of atom economy; Homogeneous and heterogeneous catalytic reactions: hydrogenation, hydrogenolysis, dehydrogenation, selective oxidation, alkylation & acylation, isomerization and C-C bond forming reactions, Enzyme catalysis in organic synthesis; Reaction mechanisms

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2024			
Course Title	Materials and devices for energy conversion			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Design of organic and Inorganic semiconductors, Approaches to process organic semiconductors by covalent and non covalent modifications , band edges and band gaps, Modulation of charge transport properties, kinetics of electron transfer, Design of small molecule dyes for DSSC, Electron transfer at interfaces, Transistors and solar cells, Fabrication of Devices, Device characterisation using dark current, IV curves under illumination, IPCE, Calculation of Voc, Jsc, Vpp, Ipp, FF and Pmax. hybrid solar cells

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2025			
Course Title	Functional Ceramics			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Advanced Electronic Ceramics, high temperature ceramic super conductors, Dielectric ceramics, microwave ceramics, low k materials, SOFC materials, solid-ionic conductors, phosphor materials, Impedance analysis, varistors, sensors, ceramic magnets, thermal shock resistance and super plastic ceramics.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2026			
Course Title	Porous structures			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Definitions, Micro-Porous and Mesoporous Solids, Structural Chemistry of Zeolite Framework Types, MOFs, COFs, Synthesis, Structure Determination, Role of the Structure-directing Agents, The Chemistry of Microporous Framework Solids, Adsorption and Diffusion, Catalytic Applications, hydrogen storage, separation, CO<sub>2</sub> sequestration, sensors,

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2027			
Course Title	Biomaterials for targeted therapeutics			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Rational design and engineering of lipid-based targeted drug delivery vehicles and their therapeutic applications - Design of polymeric micelles as nano drug carriers - Design of polymer-based nanometric targeted delivery systems and their therapeutic applications - Set-backs and unmet challenges – Cancer and its Hall Marks - Principles of designing anti-cancer therapeutics – Molecular basis of lung, breast, melanoma and prostate cancers – Rationale for selecting leading pathways in cancer therapy – Nuclear hormone receptors as targets in cancer therapy – Rationale for design of cancer therapy against multiple pathways-Concept of designing hybrid molecules as a dual strategy - Use of nanotechnology in cancer therapy - Concept of cancer stem cells and design of cancer stem cell therapeutics.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2028			
Course Title	Organic electrochemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Cathodic reactions of organic compounds, Anodic reactions of organic compounds, Classifications of electrode reactions, Stereochemistry of electrochemical processes, Applications of organic electrochemistry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2029			
Course Title	Photoinduced electron and Energy transfer			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Thermodynamic aspects, Calculation of free energy change from redox potentials, Weller equation, Kinetic aspects, concept of reorganization energy, Marcus theory, Inverted region kinetics, Back electron transfer, circumventing back electron transfer, Applications of photoinduced electron and energy transfer, Reaction centre and photoinduced electron transfer processes in photosynthetic bacteria, Solar water splitting, Dye-sensitized solar cells, Organic photovoltaics, Few organic reactions initiated by PET, Photo-remediation of organic waste materials, Mechanisms and dynamics of fluorescence quenching, Fluorescence anisotropy, Energy transfer to single and multiple acceptors, Resonance energy transfer and its implication, Sensors based on photoinduced processes.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2030			
Course Title	Thermochemical Conversion of Biomass			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Thermochemical conversion technologies for biomass pyrolysis, gasification, combustion, thermal and catalytic conversion of biomass; upgradation of pyrolysis products; bio-refining products and applications; biorefinery concept; Hybrid methods of conversion and effective utilization; Alternative and/or clean fuels, functional and bulk chemicals from biomass; life cycle analysis; carbon and water foot prints; Utilization of products and feasibility assessment; Science, technology and policy of biomass energy; Strategies for Enhancing role of renewable energy and Indian scenario.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2031			
Course Title	Block copolymers			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Chain and controlled block copolymerization, monomer reactivity ratios, Copolymer compositions, molecular architecture, blends, grafts, melts, self assembly and phase separation, phase diagram, range of applicability of copolymerization equation; types of copolymerization; Block copolymers with controlled molecular weight, Living Polymerization, block copolymer synthesis, characterization techniques, block copolymers for biomedical and industrial applications, Amphiphilic block copolymer micelles, Block copolymer thin films.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2032			
Course Title	Polymers for membrane applications			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Polymers as membrane materials, functional polymers containing styrene and its derivatives; Functionalized poly(arylene ether)s, Nafion and other Poly(perfluorosulfonic acid) Membranes, Post functionalized polymeric membranes, random and block copolymers; functional poly(imide)s; functional polyphosphazene; functionalized bio- polymers, design of new functional polymers; Glassy and rubbery polymers, characterization of polymer membranes, transport phenomena, polymer nanocomposites for membranes in the separation of gases and liquids, membrane fouling.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2033			
Course Title	Ion exchange polymers			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Adsorbents and ion exchange resins, Classification of ion exchange resins, Synthesis and characterization of ion-exchange resins and polymers, Water treatment and other applications, fouling, regeneration.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2034			
Course Title	Conducting polymers			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Synthesis and characterization, electrical transport properties, theory of conductivity, doping, electrochromic properties, Classification and types of organic conductors, Structure and properties of conducting charge-transfer salts, Conducting polymers based on organometallic compounds, Applications of conducting polymers, EMI shielding, supercapacitors, sensors

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2035			
Course Title	Polymers and Colloidal Solutions			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Intermolecular forces and potentials, Overview of Statistical physics, DLVO theory, charged colloids, Poisson Boltzmann theory, Debye radius, Bjerrum length, electrophoresis, zeta potential, diffusion, Hydrodynamic interactions. Brief overview of Phase transitions in hard sphere colloids, Random walk, self avoiding random walk, flexible polymers, persistence length, Excluded volume interactions, Polymer solutions in the dilute limit/semi-dilute limit, Entropy of mixing, theta temperature, rubber elasticity, Polyelectrolytes, polymer at surfaces: Brushes, polymer dynamics.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2036			
Course Title	Biodegradable polymers			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Polymers from biomass, microbial production, synthetic polymers, structure and properties, Biodegradation mechanism, measurement techniques, processing techniques, sterilization and storage, global standards, market potential, applications.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2037			
Course Title	Controlled Radical/Living Polymerizations and Macromolecular Architectures			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Controlled or Living Radical Polymerization, TEMPO-mediated polymerization and atom Transfer radical Polymerization (ATRP), Kinetics of ATRP, Reversible Addition Chain Fragmentation Transfer (RAFT), Nitroxide mediated polymerization (NMP), Ring opening Metathesis polymerization (ROMP), living ROP, Macromolecular architectures using controlled living polymerizations

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2038			
Course Title	Pi-conjugated polymers			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Synthesis and characterization, electronic and optical properties, energy band structure, Display Materials: Organic Light Emitting Diodes, Organic thin film transistors, device preparation, working principle, advantages, drawbacks; Organic photovoltaics, OFETs, device preparation and characterization, factors influencing efficiency, stability.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2039			
Course Title	Liquid Crystals			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Liquid crystal phases, classification, Chiral liquid crystalline phases, Ferroelectric liquid crystalline phases, discotic liquid crystalline phases, Characterization techniques, Surface Alignment of Liquid Crystals, Dichroic LCs, Polycatenar mesogenes, Display and photovoltaic applications.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2040			
Course Title	X-Ray Diffraction and Structure of Solids			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction to X-ray crystallography, Crystal growth, evaluation and mounting, Symmetry and space group determination, Background theory for data collection, Data collection using four-circle diffractometers, Area detectors, Crystal lattices, Structure factors, Crystal symmetry, Structure solutions, Structure refinement, An introduction to maximum entropy, Least squares fitting of parameters, Practical aspects of structure refinement, Crystallographic Database, Structure solution from Powder Diffraction Data

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2041			
Course Title	NMR spectroscopy			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Quantum Mechanics of NMR, Multinuclear NMR spectroscopy, Periodic table of NMR, Heteronuclear double resonance experiments, Magnetization transfer and signal enhancement, NMR of diamagnetic and paramagnetic compounds, Multidimensional NMR: 2D NMR, <sup>1</sup>H-<sup>1</sup>H correlations, Heteronuclear Correlation Spectroscopy, 2D Exchange (EXSY), 2D NOESY, ROESY, DOSY Structure elucidation of small molecules, NMR of macromolecules, Multidimensional NMR Spectra, NMR Spectroscopy of Solids, 2D experiments in solids, semi rigid systems: HR MAS, Magnetic Resonance Imaging: In Vivo NMR, Imaging, MRI, functional MRI, NMR imaging of materials.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2042			
Course Title	Mass spectrometry applications			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Applications to analyze molecular, macromolecular and biological samples, Sample Preparation Protocols, Drug Metabolism and Pharmacokinetics (DMPK), Development of Quantitative analytical methods using mass spectrometry, Application to some model drugs, Metabolomics , Proteomics, GC-MS, LC-MS, MALDI-TOF, GC-TOF, TOF/TOF MS, LC-ESI-MS, Protein Database search (MASCOT), Clinical Mass Spectrometry,

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2043			
Course Title	Ultrafast processes and spectroscopy			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Different types of lasers, components and building of lasers and generation of ultrafast lasers. Principles, instrumentation and applications of different types of ultrafast spectroscopy, Conventional and laser flash Photolysis, and Pump-Probe spectroscopy, Steady state and time resolved Raman spectroscopy, Coherent anti-Stokes resonance Raman Spectroscopy, Femtosecond stimulated Raman Spectroscopy Femtosecond vibrational coherence spectroscopy, Transient grating Spectroscopy, Fluorescence up-conversion, Time correlated single photon counting, ultrafast physical, chemical and biological systems.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2044			
Course Title	Small Angle Scattering Techniques			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

SAXS and Fourier Transforms, General Theorems in Small Angle Scattering: Particulate systems: Porod and Guinier regimes, Pair density distribution functions, Single particle form factor for spheres, rods and plates, polydispersity, Structure factors for equilibrium concentrated particulate systems, measured structure factors for systems exhibiting polydispersity, Two phase systems: General Theorems, Detailed analysis of scattering from lamellar systems, relevance to semicrystalline polymers.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2045			
Course Title	Natural products and drug discovery			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Natural products: Importance, lead, clinical trials in drug discovery research, Case studies of marketed natural product drugs, Synthetic Biology and Genetic engineering in the production of natural product, A brief overview of drug discovery approach, Cause of diseases, Target identification, Target validation, Modeling, Synthesis and SAR, Drug Delivery, Clinical Trials, Etiology, pathogenesis, prevention, drug targets and chemotherapy, drug resistance and remedies of tropical infectious diseases, Etiology and remedies of diseases developed through metabolic disorders.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2046			
Course Title	Lipid science & technology			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Chemistry and Biochemistry of Lipids, Lipid Modification for Surfactant Preparation and Oleochemicals, Analytical Techniques for Lipids and Allied Products, Processing, Degumming, Bleaching, Dewaxing, Neutralization & Deodorization, Hydrogenation, By-products of lipids and their Value Addition,

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2047			
Course Title	Photobiology			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Primary processes in photosynthesis, antenna effect, reaction center, primary processes in vision, bio and chemiluminescence and environmental photobiology and UV effects, Phototherapy and photodynamic therapy, sensitizers, structures of porphyrinic and non-porphyrinic sensitizers, type I and type II mechanisms, advantages and disadvantages of light in medicine.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-3-2048			
Course Title	Nanobiotechnology			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Concept of hybrid systems, signaling and signaling responses; biological systems as transducers, Biology at the nano-interface, fluorescent nanoparticles for life sciences, applications, DNA based particles used as building blocks, micelles, Nucleic Acid, Engineering using DNA as Nano materials, Cells & Microfabricated Devices, Nanomaterials for drug delivery, imaging, diagnostics, therapy, separation, Biosensors

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-4-2001			
Course Title	Project proposal writing & presentation			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Formulation of a project proposal by selecting topics of high relevance and novelty and will have state-of-the-art review, methodologies, recommendations etc. in specified format in a holistic manner preferably candidate's own research work suitable for submission to appropriate funding agencies.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-4-2002			
Course Title	Review Article			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Preparation of one review article on specific research area of the student.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CLRI, Chennai			
Course Nomenclature	CHE-CLRI-4-2003			
Course Title	CSIR-800 Societal Program			
Credit Distribution (L-T-P-C)	0	0	8	4
Core/Elective	Core			

### Course Description:

The students have to undertake a project in rural areas for 6-8 weeks in the line with CSIR-800 programme which is primarily prepared at empowering 800 million Indians by way of S&T inventions. The theme for the project may be chosen from CSIR-800 documents and as per expertise available in the laboratory. Students will select the topics in consultation with Doctoral Advisory Committee (DAC).



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CMERI, Durgapur			
Course Nomenclature	CHE-CMERI-1-2101			
Course Title	Research Methodology:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Good laboratory practices, Safety in the laboratory, First Aid in the laboratory, Maintenance of laboratory records, Scientific literature management, Communication skills (scientific writing and presentation), Intellectual property management & planning, Ethics in Science, Computer applications and tools, Statistical methods & Data analysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CMERI, Durgapur			
Course Nomenclature	CHE-CMERI-1-2102			
Course Title	Analytical Tools and Instrumentation			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Thermal methods (TG, DTG, DTA, TMA, DSC), X-ray methods (XRD, XRF, SAXS), NMR (<sup>1</sup>H, <sup>13</sup>C) and other Spectroscopic methods (EPR, IR, UV, Fluorescence), Chromatographic methods (TLC, GC, LC), Mass spectroscopy, Electron Microscopy (SEM, TEM), Electron Probe Micro Analysis (EDS, WDS), Quantitative Analysis (AAS, ICP, CHN)

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CMERI, Durgapur			
Course Nomenclature	CHE-CMERI-1-2104			
Course Title	Basic Chemistry for Interdisciplinary sciences:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

Basics of inorganic, organic, physical and biochemistry, Nomenclature (IUPAC), molarity, molality and normality, types of bonding, Ionic, covalent and non-bonding interactions, Acids and bases, Atomic structure, periodic table and periodic properties, stoichiometry, chemical reactions and kinetics, solvent effects, functional groups in organic compounds, general named reactions and reaction mechanisms, carbohydrates, lipids, proteins, nucleotides, enzymes, photosynthesis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CMERI, Durgapur			
Course Nomenclature	CHE-CMERI-1-2105			
Course Title	Introduction to Nanoscience and Nanotechnology			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

General considerations, Introduction, definitions, consequences of size reduction, Properties: structural, thermodynamic, optical, electrical and magnetic properties, Methods of synthesis, Surface modifications, factors governing the stability and assembly, Characterization of nanomaterials, Applications of Nanomaterials

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CMERI, Durgapur			
Course Nomenclature	CHE-CMERI-2-2101			
Course Title	Advanced Physical Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Thermodynamics and chemical kinetics, Quantum Mechanics, Atomic structure and spectroscopy, Chemical bonding in diatomics, Chemical applications of group theory, Colloids and Surface science, surfactants, Interface and Interfacial properties, Electrochemistry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CMERI, Durgapur			
Course Nomenclature	CHE-CMERI-2-2102			
Course Title	Advanced Inorganic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Structure & Bonding in Inorganic Compounds, Chemistry of Coordination Compounds, Symmetry in Chemistry & Group Theory, Main group chemistry, Organometallic chemistry, Electronic Spectra of Transition Metal Compounds, Magneto Chemistry, Metal Cluster Compounds, Inorganic Reaction Mechanism, Electron Transfer Reactions in Metal Complexes, Bioinorganic Chemistry (Metalloenzymes, Metal complexes as oxygen carriers, Photosynthesis), Metal Complexes in Medicinal Chemistry, Catalysis by Inorganic Complexes.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CMERI, Durgapur			
Course Nomenclature	CHE-CMERI-2-2103			
Course Title	Advanced Organic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Stereochemistry, reaction mechanism, C-C and C-X bond formations, Retrosynthetic analysis, photochemistry, pericyclic reactions, reactive intermediates, Methods of asymmetric synthesis and their application in total synthesis, oxidation-reduction reactions, organocatalysis, metathesis reactions.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CMERI, Durgapur			
Course Nomenclature	CHE-CMERI-2-2104			
Course Title	Advanced Coordination Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Naming of coordination compounds, classification of ligands, chelate and macrocyclic effect, Theories dealing with the formation of Coordination Compounds, Spectrochemical Series; Splitting of d-orbitals, Jahn–Teller Effect; Stability constants of Transition metal complexes and their determination by Job's Method. Spin–Orbit Coupling, Electronic states and term symbols, Selection rules (Laporte and spin selection rule), Interpretation of electronic spectra of Transition metal complexes, Orgel and Tanabe Sugano diagrams. Charge Transfer spectra, Magnetic Properties of Transition elements, Chemistry of Inner Transition Elements.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CMERI, Durgapur			
Course Nomenclature	CHE-CMERI-2-2105			
Course Title	Advances in Bioinorganic chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Metal ions in biology, structure and function of metallo-proteins and enzymes, Communication role for metals in biology. Heme and non-heme systems with one-, two- or multi-metal, photosynthesis and photosystem II; O<sub>2</sub>-binding, reduction to O<sub>2</sub><sup>-</sup>, O<sub>2</sub><sup>2-</sup>, and O<sub>2</sub>-species their utilization in hydroxylation and epoxidation; nitrogen fixation, water-oxidation reactions. Synthetic models, Correlation with structure and function of the natural enzymes, design and synthesis, mechanisms. Metal based drugs, Porphyrins, Corrins, hydroporphyrins.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CMERI, Durgapur			
Course Nomenclature	CHE-CMERI-2-2106			
Course Title	Advanced Materials Science			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Crystal systems and space groups, Close packing and various simple structure types like AB, AB<sub>2</sub>, AB<sub>3</sub> and complex structural types ABX<sub>3</sub>, AB<sub>2</sub>X<sub>4</sub>, etc. Factors affecting crystal structures, Common preparative methods; X-ray diffraction and Electron microscopy, Defect structures, colour centers, reciprocal lattices, Properties of solids – Band theory, metals, insulators, semiconductors, dielectric and ferroelectric properties, magnetic properties, optical properties, ionic conduction; structure-processing-property correlations.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CMERI, Durgapur			
Course Nomenclature	CHE-CMERI-2-2107			
Course Title	Advanced Catalysis			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Homogeneous and heterogeneous catalysis, adsorption, diffusion, kinetics, equilibrium and rate expressions; Chiral catalysis, Surface Science in Catalysis, Catalytic Materials; Supports; Active Components, Classes of reactions and types of reactors; Catalyst preparation methods; Characterization of catalysts; Catalysis in super critical media; Brief introduction of organo and electro-catalysis; Structure-activity-property-stability of catalysts, Catalysts in chemical industry, Catalysis in petroleum refining and petrochemicals; Catalysis in the utilization of renewable feed stocks and concepts of sustainable chemistry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CMERI, Durgapur			
Course Nomenclature	CHE-CMERI-2-2108			
Course Title	Advanced Surface Science			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction to Surface Science - Surface phenomena - Adsorption, Desorption, Adsorption Models, Special properties of surfaces and interfaces, Electronic structure of surfaces, Surface modification and its applications, Nanoscale catalysis and applications, Surface spectroscopy and microscopy tools for nanocatalysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CMERI, Durgapur			
Course Nomenclature	CHE-CMERI-3-2101			
Course Title	Functional Ceramics			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Advanced Electronic Ceramics, high temperature ceramic super conductors, Dielectric ceramics, microwave ceramics, low k materials, SOFC materials, solid-ionic conductors, phosphor materials, Impedance analysis, varistors, sensors, ceramic magnets, thermal shock resistance and super plastic ceramics.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CMERI, Durgapur			
Course Nomenclature	CHE-CMERI-3-2102			
Course Title	Modern Magnetic Materials			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Types of magnetism, molecular field theory, measurement techniques, magnetoresistance (AMR, GMR, CMR, TMR), hard and soft magnets, New magnetic materials, applications.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CMERI, Durgapur			
Course Nomenclature	CHE-CMERI-3-2103			
Course Title	Porous structures			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Definitions, Micro-Porous and Mesoporous Solids, Structural Chemistry of Zeolite Framework Types, MOFs, COFs, Synthesis, Structure Determination, Role of the Structure-directing Agents, The Chemistry of Microporous Framework Solids, Adsorption and Diffusion, Catalytic Applications, hydrogen storage, separation, CO<sub>2</sub> sequestration, sensors,

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CMERI, Durgapur			
Course Nomenclature	CHE-CMERI-4-2101			
Course Title	Project proposal writing & presentation			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Formulation of a project proposal by selecting topics of high relevance and novelty and will have state-of-the-art review, methodologies, recommendations etc. in specified format in a holistic manner preferably candidate's own research work suitable for submission to appropriate funding agencies.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CMERI, Durgapur			
Course Nomenclature	CHE-CMERI-4-2102			
Course Title	Review Article			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Preparation of one review article on specific research area of the student.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CMERI, Durgapur			
Course Nomenclature	CHE-CMERI-4-2103			
Course Title	CSIR-800 Societal Program			
Credit Distribution (L-T-P-C)	0	0	8	4
Core/Elective	Core			

### Course Description:

The students have to undertake a project in rural areas for 6-8 weeks in the line with CSIR-800 programme which is primarily prepared at empowering 800 million Indians by way of S&T inventions. The theme for the project may be chosen from CSIR-800 documents and as per expertise available in the laboratory. Students will select the topics in consultation with Doctoral Advisory Committee (DAC).

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-1-2501			
Course Title	Research Methodology:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Good laboratory practices, Safety in the laboratory, First Aid in the laboratory, Maintenance of laboratory records, Scientific literature management, Communication skills (scientific writing and presentation), Intellectual property management & planning, Ethics in Science, Computer applications and tools, Statistical methods & Data analysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-1-2502			
Course Title	Analytical Tools and Instrumentation			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Thermal methods (TG, DTG, DTA, TMA, DSC), X-ray methods (XRD, XRF, SAXS), NMR (<sup>1</sup>H, <sup>13</sup>C) and other Spectroscopic methods (EPR, IR, UV, Fluorescence), Chromatographic methods (TLC, GC, LC), Mass spectroscopy, Electron Microscopy (SEM, TEM), Electron Probe Micro Analysis (EDS, WDS), Quantitative Analysis (AAS, ICP, CHN)

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-1-2503			
Course Title	Basic mathematics and numerical methods			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	core			

### Course Description:

Determinants and Matrices, Complex Variables, Vector analysis, Infinite Series, Special Functions, Differential Equations, Interpolation and Approximation, Numerical differentiation and Integration, Basic Linux, Introduction to Algorithms, basic programming, Shell and Shell Scripting, Network Computing and Parallel Computing, Matlab/Scilab/Octave/Gnuplot Algorithms, basic programming, Shell and Shell Scripting, Network Computing and Parallel Computing, Matlab/Scilab/Octave/Gnuplot

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-1-2504			
Course Title	Basic Chemistry for Interdisciplinary sciences:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

Basics of inorganic, organic, physical and biochemistry, Nomenclature (IUPAC), molarity, molality and normality, types of bonding, Ionic, covalent and non-bonding interactions, Acids and bases, Atomic structure, periodic table and periodic properties, stoichiometry, chemical reactions and kinetics, solvent effects, functional groups in organic compounds, general named reactions and reaction mechanisms, carbohydrates, lipids, proteins, nucleotides, enzymes, photosynthesis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-1-2505			
Course Title	Introduction to Nanoscience and Nanotechnology			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

General considerations, Introduction, definitions, consequences of size reduction, Properties: structural, thermodynamic, optical, electrical and magnetic properties, Methods of synthesis, Surface modifications, factors governing the stability and assembly, Characterization of nanomaterials, Applications of Nanomaterials

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-2-2501			
Course Title	Advanced Physical Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Thermodynamics and chemical kinetics, Quantum Mechanics, Atomic structure and spectroscopy, Chemical bonding in diatomics, Chemical applications of group theory, Colloids and Surface science, surfactants, Interface and Interfacial properties, Electrochemistry.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-2-2502			
Course Title	Advanced Inorganic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Structure & Bonding in Inorganic Compounds, Chemistry of Coordination Compounds, Symmetry in Chemistry & Group Theory, Main group chemistry, Organometallic chemistry, Electronic Spectra of Transition Metal Compounds, Magneto Chemistry, Metal Cluster Compounds, Inorganic Reaction Mechanism, Electron Transfer Reactions in Metal Complexes, Bioinorganic Chemistry (Metalloenzymes, Metal complexes as oxygen carriers, Photosynthesis), Metal Complexes in Medicinal Chemistry, Catalysis by Inorganic Complexes.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-2-2503			
Course Title	Advanced Organic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	elective			

### Course Description:

Stereochemistry, reaction mechanism, C-C and C-X bond formations, Retrosynthetic analysis, photochemistry, pericyclic reactions, reactive intermediates, Methods of asymmetric synthesis and their application in total synthesis, oxidation-reduction reactions, organocatalysis, metathesis reactions.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-2-2504			
Course Title	Advanced Analytical Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Analytical instrumentation, signal and noise, Overview of optical methods of analysis: Components of optical instruments, atomic and molecular spectrometry based on absorption, emission and scattering, Electroanalytical techniques (basic electrochemistry, voltammetry, potentiometry), Analytical separations and introduction to chromatographic methods, GC, LC, Mass spectrometry, electromigration techniques, hyphenated techniques, detectors, Analytical tools for petroleum refining.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-2-2505			
Course Title	Advanced Quantum Mechanics			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Revision of Hydrogen atom and particle in box (1D and 3D), Approximate methods in quantum mechanics; Non degenerate perturbation ; Perturbation treatment of the Helium atom ground state and first excited state; Variation method for helium atom ground state; Comparison of perturbation and variation method, Structure of many electron wave function, Antisymmetry, Valence bond theory for homo and hetero nuclear diatomic molecules; Molecular orbital theory Comparison of MO and VB theory; Introduction to density functional theory; Hartree Fock theory, Overview of methods beyond Hartree Fock theory; Configuration Interaction; Many body perturbation; Coupled cluster

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-2-2506			
Course Title	Advanced Coordination Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Naming of coordination compounds, classification of ligands, chelate and macrocyclic effect, Theories dealing with the formation of Coordination Compounds, Spectrochemical Series; Splitting of d-orbitals, Jahn–Teller Effect; Stability constants of Transition metal complexes and their determination by Job's Method. Spin–Orbit Coupling, Electronic states and term symbols, Selection rules (Laporte and spin selection rule), Interpretation of electronic spectra of Transition metal complexes, Orgel and Tanabe Sugano diagrams. Charge Transfer spectra, Magnetic Properties of Transition elements, Chemistry of Inner Transition Elements.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-2-2507			
Course Title	Advanced Polymer Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Techniques of polymerization, polymer characterization techniques, Stereochemistry of Polymers, polymer nano-architectures, random and block copolymers, Liquid Crystalline Polymers, Conducting Polymers, Non-linear Polymers, Polymer Blends and Composites, polymer rheology, inorganic, bio and supramolecular polymers

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-2-2508			
Course Title	Advanced Electrochemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Basic electrochemistry concepts, Reference electrodes, Electrochemical Thermodynamics, Kinetics of electron transfer, the Taft equation, Diffusion, Double Layers, electrode Kinetics, the Gibbs adsorption isotherm, the Lippmann equation, infinitely dilute solutions and thermal balance, Electro capillary phenomena, Faradaic vs. capacitive currents, transport properties, potential theory, Electrochemical Techniques, Voltammetry, Reversible and irreversible reactions, Mass transport by convection, rotating electrodes, Equivalent circuits, A.C. voltammetry, Electrolysis methods, Adsorption, Thin layer cells, Electrochemistry of polymers and inorganic solids, Spectroelectrochemistry, Applications.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-2-2509			
Course Title	Advanced process chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Integral and Differential analysis; Evaluation of rate equations, unit processes, mass transfer, mass balance, energy balance, fluid flow, Design of homogeneous systems, different types of reactors, green chemistry



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-2-2510			
Course Title	Advanced Materials Science			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Crystal systems and space groups, Close packing and various simple structure types like AB, AB<sub>2</sub>, AB<sub>3</sub> and complex structural types ABX<sub>3</sub>, AB<sub>2</sub>X<sub>4</sub>, etc. Factors affecting crystal structures, Common preparative methods; X-ray diffraction and Electron microscopy, Defect structures, colour centers, reciprocal lattices, Properties of solids – Band theory, metals, insulators, semiconductors, dielectric and ferroelectric properties, magnetic properties, optical properties, ionic conduction; structure-processing-property correlations.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-2-2511			
Course Title	Advanced Catalysis			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Homogeneous and heterogeneous catalysis, adsorption, diffusion, kinetics, equilibrium and rate expressions; Chiral catalysis, Surface Science in Catalysis, Catalytic Materials; Supports; Active Components, Classes of reactions and types of reactors; Catalyst preparation methods; Characterization of catalysts; Catalysis in super critical media; Brief introduction of organo and electro-catalysis; Structure-activity-property-stability of catalysts, Catalysts in chemical industry, Catalysis in petroleum refining and petrochemicals; Catalysis in the utilization of renewable feed stocks and concepts of sustainable chemistry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-2-2512			
Course Title	Advanced Surface Science			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction to Surface Science - Surface phenomena - Adsorption, Desorption, Adsorption Models, Special properties of surfaces and interfaces, Electronic structure of surfaces, Surface modification and its applications, Nanoscale catalysis and applications, Surface spectroscopy and microscopy tools for nanocatalysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-2-2513			
Course Title	Advanced Separation Science and Technology:			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Resins and membranes for separations, Classification of membranes; electromembrane Processes; Ion-exchange membranes and their applications, Electrodialysis and related processes. Polymer electrolyte membrane and their applications for fuel cells; Water electrolyzer for hydrogen production; Reverse electrodialysis for non-renewable energy from concentration gradient, reverse osmosis, nanofiltration, ultrafiltration, pervaporation and gas separation: Membrane fouling, concentration polarization and other limitations of Pressure-driven membrane technologies.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-2-2514			
Course Title	Advanced Materials Characterization Techniques:			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Optical Microscopy, Electron microscopy: TEM, HRTEM, SEM, STEM, EDX, FIB, e-beam lithography, Scanning probe microscopy: AFM, STM, MFM, confocal, etc, Raman spectroscopy/microscopy, Thermal analysis techniques, Magnetic measurements, Electrical measurements, Spectroscopic ellipsometry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-2-2515			
Course Title	Advances in Nanoscience and Nanotechnology			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Low-dimensional structures: Quantum wells, Quantum wires, and Quantum dots, Nano clusters & Nano crystals, fullerenes, carbon nano tubes and graphene, Nano Composites, synthesis and characterization techniques, Properties at Nano Scales and comparison with bulk materials, fabrication techniques, general applications, nanomaterials in biology.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-2-2516			
Course Title	Green chemistry			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Green chemistry concepts: Basic understanding, scope and interdisciplinary nature of green chemistry; Environmental factors; Carbon credit, Energy efficiency and atom economy, Catalysis and green chemistry, Alternate reaction media and reaction systems, ionic liquids, supercritical fluids, solventless chemistry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-2-2517			
Course Title	Natural products			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Carbohydrates and polysaccharides, Structure and functions of important derivatives of monosaccharides, Classification and nomenclature and synthesis of some simple Alkaloids; Terpenoids and Steroids such as pinene; Camphor and Cadenine;  $\alpha$ -vetinone; Hirsutene and Abietic acid (Terpenoids); Cholesterol; Testosterone and Andestrone (Steroids) etc. isolation and characterization, elucidation of structure-property relationships. Biosynthesis of steroids, terpenoids, fatty acids, alkaloids and polysaccharides, biosynthesis of natural products



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-2-2518			
Course Title	Ionic liquids			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Introduction to ionic liquids, ionic liquids vs. molecular solvents/ionic salts (solids), ionic liquids vs. eutectic mixtures, solvent polarities using different spectral techniques (parameters), physicochemical properties of ionic liquids, effect of functional groups on the properties of ionic liquids, surface active ionic liquids, aggregation behavior of ionic liquids, interaction of ionic liquids with different molecular solvents, interaction of ionic liquids with biopolymers, thermodynamics of the binary mixtures of ionic liquids, structure property relationship in ionic liquids.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-2-2519			
Course Title	Organic reaction mechanisms			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Basics, The concept of Aromaticity, How to write an organic reaction mechanism?, Popular name reactions, Reactive intermediates: Generation, stability, structures and reactivity of carbocation, carbaion, carbene, radicals, benzyne, nitrene, Types of mechanism: classification, limitations examples of aliphatic nucleophilic substitution - aliphatic electrophilic substitution - aromatic nucleophilic substitution - aromatic electrophilic Substitution - types of radical reactions - molecular rearrangements oxidation and reduction; Electrophilic reactions-Friedel crafts reaction, Riemeier Tiemann reaction, Beckmann rearrangements; nucleophilic reactions- aldol condensation, perkin reaction, benzoin condensation; free radical reaction-halogenation of alkane, addition of HBr on alkene in presence of peroxide; allylic halogenation - using N-Bromo Succinamide (NBS), thermal halogenation of alkene  $\text{CH}_3 - \text{CH} = \text{CH}_2$

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-3-2501			
Course Title	Molecular modeling and simulation			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Molecular Mechanics: Features of molecular mechanics - Force Fields: Bonds structure and bending angles, Electrostatic Vander Waals and non-bonded interactions, Hydrogen bonding - Derivatives of molecular mechanics energy function - Calculating thermodynamic properties - Force Field for inorganic systems - Energy minimization, Molecular Dynamics Simulation: Molecular Dynamics using simple models, Molecular Dynamics with continuous potentials, Solvent effects, Conformational changes, Thermostats, Barostas, Lincs and shake algorithms, Monte Carlo simulation Methods, sorption, Applications of Molecular Modeling

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-3-2502			
Course Title	Marine Natural products			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

name reactions, Reactive intermediates: Generation, stability, structures and reactivity of carbocation, carbanion, carbene, radicals, benzyne, nitrene, Types of mechanism: classification, limitations examples of aliphatic nucleophilic substitution - aliphatic electrophilic substitution - aromatic nucleophilic substitution - aromatic electrophilic Substitution - types of radical reactions - molecular rearrangements oxidation and reduction; Electrophilic reactions-Friedel crafts reaction, Riemer Tiemann reaction, Beckmann rearrangements; nucleophilic reactions- aldol condensation, perkin reaction, benzoin condensation; free radical reaction-halogenation of alkane, addition of HBr on alkene in presence of peroxide; allylic halogenation - using N-Bromo Succinamide (NBS), thermal halogenation of alkene  $\text{CH}_3 - \text{CH} = \text{CH}_2$

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-3-2503			
Course Title	Supramolecular chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Nature of supramolecular interactions, role of various non-covalent interactions, multiple hydrogen bonding motifs, Stability of H-bonds, Jorgensen model for H-bonding, supramolecular synthons , dimensions of supramolecular chemistry, Janus molecules. Photoresponsive molecules and self-assembly, Molecular recognition, classification of supramolecular host-guest complexes, supramolecular self-assembly, supramolecular polymers, molecular capsules, self- assembled dendrimers, self-assembled nanotubes, low molecular weight organogels. Characterization techniques of self-assemblies, supramolecular sensors.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-3-2504			
Course Title	Asymmetric Synthesis			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Strategies for the preparation of optically pure compounds; Stereoselective, Enantioselective and Diastereoselective reactions; Stoichiometric asymmetric synthesis-chiral auxiliaries; Importance of Asymmetric synthesis, Metal catalyzed asymmetric organic transformations, Metal free organocatalyst for asymmetric organic transformations for the designing of chiral drugs via asymmetric epoxidation of non-functionalized alkenes, hydrolytic kinetic resolution of racemic epoxides, aminolytic kinetic resolution of racemic terminal/aryloxy epoxides with amine and amine derivatives, asymmetric nitroaldol reaction of aldehydes, asymmetric hydrogenation reaction, asymmetric dihydroxylation, asymmetric isomerization reaction, asymmetric Michael addition reaction, asymmetric hydroformylation . 1) reaction, asymmetric cyanation of aldehydes and imines.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-3-2505			
Course Title	Salts from marine resources			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Physicochemical properties of NaCl crystals, Chemistry of salt manufacture, Influence of other dissolved salts in the salt purity, Survey of site for solar salt production, Scientific design and layout of solar salt works, Solar Salt manufacture, Mechanization of solar salt industries, Preparation of ultra pure salt through innovative methods, Fortification of salt with essential nutrients, Application of phase equilibrium for recovery of marine chemicals, Recovery of valuable marine chemicals from bittern, High purity magnesium chemicals from bittern

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-3-2506			
Course Title	Applications of ionic liquids			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Introduction to task specific ionic liquids, self-assembly of ionic liquids in aqueous/non aqueous media and synthesis of nanomaterials therein, ionic liquids in catalysis, extraction of metal ions, ionic liquids and biopolymers: dissolution, regeneration and ionic-gel formation, processing of lignocellulosic biomass using ionic liquids, clean separation of various fractions of biomass and recovery of valuable chemicals using ionic liquids, application of ionic liquids in electrochemistry, separation of azeotropic mixtures using ionic liquids, organic reactions in ionic liquids.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-3-2507			
Course Title	Homogeneous Catalysis			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Organometallic Catalysis, Applications in organic synthesis: Olefin Isomerization, C-C Coupling reactions: Heck, Suzuki, Stille and Sonogashira reactions, Alkene and Alkyne Metathesis, C-Heteroatom coupling: Hydroamination, Olefin Oxidation, C-H activation, Oxidation reactions, hydrogenation of Alkenes, Industrial Applications.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-3-2508			
Course Title	Catalysis for organic synthesis			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

A background on fine and specialty chemicals in chemical industry; Concept of atom economy; Homogeneous and heterogeneous catalytic reactions: hydrogenation, hydrogenolysis, dehydrogenation, selective oxidation, alkylation & acylation, isomerization and C-C bond forming reactions, Enzyme catalysis in organic synthesis; Reaction mechanisms

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-3-2509			
Course Title	Catalysis for biomass refining			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Classification of biomass; Catalytic processing of cellulosic and lignocellulosic materials for monomers or oligomers; Catalytic transformation biomass to fuels; Value addition of biomass/monomers to fine and specialty chemicals; Value addition of glycerol and their derivatives; Concept of bio-refinery – Role of catalysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-3-2510			
Course Title	Porous structures			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Definitions, Micro-Porous and Mesoporous Solids, Structural Chemistry of Zeolite Framework Types, MOFs, COFs, Synthesis, Structure Determination, Role of the Structure-directing Agents, The Chemistry of Microporous Framework Solids, Adsorption and Diffusion, Catalytic Applications, hydrogen storage, separation, CO<sub>2</sub> sequestration, sensors,

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-3-2511			
Course Title	Electrochemical power sources			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Energy scenario, emissions and global warming, fuel cells, thermodynamic potentials, electrochemical processes and electrode kinetics, Proton exchange membranes, proton conducting mechanisms, recent advances, Operating conditions, overview of characterization techniques, technical aspects, advantages, materials, significances and challenges, Materials for supercapacitor applications, recent advances in the system development, battery vs. supercapacitor, modern technologies, challenges and prospects.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-3-2512			
Course Title	Alternate energy materials			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Framework Types, MOFs, COFs, Synthesis, Structure Determination, Role of the Structure-directing Agents, The Chemistry of Microporous Framework Solids, Adsorption and Diffusion, Catalytic Applications, hydrogen storage, separation, CO<sub>2</sub> sequestration, sensors,

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-3-2513			
Course Title	Photoinduced electron and Energy transfer			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Thermodynamic aspects, Calculation of free energy change from redox potentials, Weller equation, Kinetic aspects, concept of reorganization energy, Marcus theory, Inverted region kinetics, Back electron transfer, circumventing back electron transfer, Applications of photoinduced electron and energy transfer, Reaction centre and photoinduced electron transfer processes in photosynthetic bacteria, Solar water splitting, Dye-sensitized solar cells, Organic photovoltaics, Few organic reactions initiated by PET, Photo-remediation of organic waste materials, Mechanisms and dynamics of fluorescence quenching, Fluorescence anisotropy, Energy transfer to single and multiple acceptors, Resonance energy transfer and its implication, Sensors based on photoinduced processes.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-3-2514			
Course Title	Thermochemical Conversion of Biomass			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Thermochemical conversion technologies for biomass pyrolysis, gasification, combustion, thermal and catalytic conversion of biomass; upgradation of pyrolysis products; bio-refining products and applications; biorefinery concept; Hybrid methods of conversion and effective utilization; Alternative and/or clean fuels, functional and bulk chemicals from biomass; life cycle analysis; carbon and water foot prints; Utilization of products and feasibility assessment; Science, technology and policy of biomass energy; Strategies for Enhancing role of renewable energy and Indian scenario.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-3-2515			
Course Title	CO2 sequestration and conversion			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

CO2 Sequestration; Capture techniques; overview of transportation and storage techniques, Basic properties of CO2, Reactivity of CO2, Utilization of CO2 as chemical feedstock, Utilization of CO2 as inert solvent for chemical synthesis, Coordination chemistry of CO2 and reactivity of coordinated CO2, Transition metal promoted reactions of CO2, The chemistry of N-CO2 bonds, Applications of CO2 for the synthesis of polymers, photochemical reduction of CO2, utilization of CO2 for the production of hydrocarbon fuels.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-3-2516			
Course Title	Block copolymers			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Chain and controlled block copolymerization, monomer reactivity ratios, Copolymer compositions, molecular architecture, blends, grafts, melts, self assembly and phase separation, phase diagram, range of applicability of copolymerization equation; types of copolymerization; Block copolymers with controlled molecular weight, Living Polymerization, block copolymer synthesis, characterization techniques, block copolymers for biomedical and industrial applications, Amphiphilic block copolymer micelles, Block copolymer thin films.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-3-2517			
Course Title	Polymers for membrane applications			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Polymers as membrane materials, functional polymers containing styrene and its derivatives; Functionalized poly(arylene ether)s, Nafion and other Poly(perfluorosulfonic acid) Membranes, Post functionalized polymeric membranes, random and block copolymers; functional poly(imide)s; functional polyphosphazene; functionalized bio- polymers, design of new functional polymers; Glassy and rubbery polymers, characterization of polymer membranes, transport phenomena, polymer nanocomposites for membranes in the separation of gases and liquids, membrane fouling.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-3-2518			
Course Title	Ion exchange polymers			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Adsorbents and ion exchange resins, Classification of ion exchange resins, Synthesis and characterization of ion-exchange resins and polymers, Water treatment and other applications, fouling, regeneration.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-3-2519			
Course Title	Conducting polymers			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Synthesis and characterization, electrical transport properties, theory of conductivity, doping, electrochromic properties, Classification and types of organic conductors, Structure and properties of conducting charge-transfer salts, Conducting polymers based on organometallic compounds, Applications of conducting polymers, EMI shielding, supercapacitors, sensors

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-3-2520			
Course Title	X-Ray Diffraction and Structure of Solids			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction to X-ray crystallography, Crystal growth, evaluation and mounting, Symmetry and space group determination, Background theory for data collection, Data collection using four-circle diffractometers, Area detectors, Crystal lattices, Structure factors, Crystal symmetry, Structure solutions, Structure refinement, An introduction to maximum entropy, Least squares fitting of parameters, Practical aspects of structure refinement, Crystallographic Database, Structure solution from Powder Diffraction Data

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-3-2521			
Course Title	NMR spectroscopy			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Quantum Mechanics of NMR, Multinuclear NMR spectroscopy, Periodic table of NMR, Heteronuclear double resonance experiments, Magnetization transfer and signal enhancement, NMR of diamagnetic and paramagnetic compounds, Multidimensional NMR: 2D NMR, <sup>1</sup>H-<sup>1</sup>H correlations, Heteronuclear Correlation Spectroscopy, 2D Exchange (EXSY), 2D NOESY, ROESY, DOSY Structure elucidation of small molecules, NMR of macromolecules, Multidimensional NMR Spectra, NMR Spectroscopy of Solids, 2D experiments in solids, semi rigid systems: HR MAS, Magnetic Resonance Imaging: In Vivo NMR, Imaging, MRI, functional MRI, NMR imaging of materials.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-4-2501			
Course Title	Project proposal writing & presentation			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Compulsory			

### Course Description:

Formulation of a project proposal by selecting topics of high relevance and novelty and will have state-of-the-art review, methodologies, recommendations etc. in specified format in a holistic manner preferably candidate's own research work suitable for submission to appropriate funding agencies.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-4-2502			
Course Title	Review Article			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Compulsory			

### Course Description:

Preparation of one review article on specific research area of the student.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-CSMCRI, Bhavnagar			
Course Nomenclature	CHE-CSMCRI-4-2503			
Course Title	CSIR-800 Societal Program			
Credit Distribution (L-T-P-C)	0	0	8	4
Core/Elective	Compulsory			

### Course Description:

The students have to undertake a project in rural areas for 6-8 weeks in the line with CSIR-800 programme which is primarily prepared at empowering 800 million Indians by way of S&T inventions. The theme for the project may be chosen from CSIR-800 documents and as per expertise available in the laboratory. Students will select the topics in consultation with Doctoral Advisory Committee (DAC).

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IHBT, Palampur			
Course Nomenclature	CHE-IHBT-1-2701			
Course Title	Research Methodology:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Philosophy and structure of scientific thoughts, Objective and Motivation of Research, Meaning of the Research, What constitutes a research topic? How to select a research topic?, Importance of literature review, Selection of appropriate methodology, Collection of data, Interpretation of data, Importance of documentation, Procedure for Hypothesis Testing, Criteria of Good Research, Asking the right questions: Originality, Depth, Precision can co-exist Formulating and refining the hypothesis: Those who do not learn from the past are condemned to repeat it, Statistical methods, Study design: Recognizing and minimizing bias Experiment design: Sometimes less is more and the importance of controls, Data interpretation; objectivity, quantification, double blind studies and necessity of Statistics, Paper presentation in scientific conference, (Communicating your data: presenting your findings), Good laboratory practices, Chemical, Radioactive and Biological safety: Possible hazards and precautionary measures; do and don'ts upon exposure, Radiation safety, Chemical and Biosafety Good lab practices: Record keeping, organizing data, organizing the lab space, Writing research paper (Communicating your data: writing up your research articles), Intellectual property rights, What is ethics, the different interpretations & historical instances of unethical science Case studies: Data fraud/plagiarism and Human Ethics violation, Literature review, searching the literature, Managing references, Presentation by students and review writing, Computer applications and tools

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IHBT, Palampur			
Course Nomenclature	CHE-IHBT-1-2702			
Course Title	Analytical Chromatographic Techniques			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Liquid chromatography: Theory and applications, types of adsorbents and their selection. Thin layer Chromatography: TLC, HPTLC, theory and applications, types of adsorbents, visualizing reagents and related techniques. High Performance Liquid Chromatography: Principles, instrumentation, choice of columns, detectors and applications, UPLC, analytical HPLC and prep-HPLC. Gas Chromatography: GC, principles, instrumentation, headspace, choice of column, detectors and applications.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IHBT, Palampur			
Course Nomenclature	CHE-IHBT-1-2703			
Course Title	Organic Spectroscopy Techniques			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

Infra Red Spectroscopy: Instrumentation and sample handling, Characteristic vibrational frequencies of common organic compounds. Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones. Applications of IR in organic chemistry. Mass Spectrometry: Introduction, ion production—EI, CI, FD and FAB, factors affecting fragmentation, ion analysis, and ion abundance. Mass spectral fragmentation of organic compounds, common functional groups, Molecular ion peaks, meta-stable peaks, McLafferty rearrangement. Nitrogen Rule. High-resolution mass spectrometry. Examples of mass spectral fragmentations of organic compounds with respect to their structure determination. Introduction to negative ion Mass spectrometry, TOF-MALDI. Ultra Violet and Visible Spectroscopy: Electronic transitions (185-800 nm), Beer-Lambert Law, effect of solvent on electronic transitions, ultra violet bands of carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes. Fieser-Woodward rules for conjugated dienes and carbonyl compounds, ultra-violet spectra of aromatic and heterocyclic compounds. Steric effect in biphenyls.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IHBT, Palampur			
Course Nomenclature	CHE-IHBT-2-2701			
Course Title	Advanced Organic Synthesis			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Balz-Schiemann reaction, Bamford-Stevens reaction, Baylis-Hillman reaction, Biginelli reaction, Bergman cyclization, Yamaguchi esterification, Wittig-Horner reaction, Woodward cis-hydroxylation, Vilsmeier reaction, Ugi reaction, Tsuji-Trost reaction, Staudinger reduction, Sharpless epoxidation, Seebach Umpolung, ring closing metathesis, Pinner reaction, Pauson-Khand reaction, Olefin Metathesis, Nozaki-Hiyama coupling, Mukaiyama Aldol addition, Hay coupling, Glaser coupling, Fukuyama coupling, Aldol condensation, Mannich, Michael, Claisen-Schmidt condensation, Suzuki-Miyaura, Heck, Stille, Sonogashira, Buchwal-Hartwig and heterocyclic reactions etc.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IHBT, Palampur			
Course Nomenclature	CHE-IHBT-2-2702			
Course Title	Advances in Oxidation and Reduction Reactions			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction, different oxidative processes, aromatization of six membered ring, dehydrogenation yielding C-C double bond, oxidation of alcohols, oxidation involving C-C double bond, oxidative cleavage of ketones, aldehydes and alcohols, double bonds and aromatic rings, ozonolysis, oxidative decarboxylation, bisdecarboxylation, oxidation of methylene to carbonyl, oxidation of olefines to aldehydes and ketones, reduction of carbonyl to methylene in aldehydes and ketones, reduction of nitro compounds and oximes, reductive coupling, bimolecular reduction of aldehydes or ketones to alkenes and metal hydride reduction.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IHBT, Palampur			
Course Nomenclature	CHE-IHBT-2-2703			
Course Title	Advances in Natural Products: Traditional methods and Terpenoids			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Medicinal and aromatic plants: primary and secondary metabolites; traditional systems of medicine: use of herbal remedies and potential of drug development from natural products and novel drug templates: paclitaxel, podophyllotoxin, artemisinin etc. Definition, nomenclature, classification of terpenoids, monoterpenoids, iridoids, sesquiterpenoids, diterpenes, triterpenoids, steroids. Isoprene rule, biosynthesis of terpenoids and steroids, mevalonate and non-mevalonate pathways. Essential oils, their production, uses and characterization, saponins, sapogenins, steroidal triterpenoid saponins. General methods of purification, detection and characterization of terpenoids and saponins. Case studies of essential oils, diterpenoids and triterpenoids.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IHBT, Palampur			
Course Nomenclature	CHE-IHBT-2-2704			
Course Title	Advances in Natural Products: Alkaloids and Polyphenols			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants. Structure stereochemistry and biosynthesis of the following: Ephedrine, (+)-Conine, Nicotine, Atropine, Quinine and Morphine. Occurrence, nomenclature, classification of polyphenols and general methods of structure determination, isolation and detection. Polyphenols will cover-lignans, coumarins, flavonoids, chalcones, anthocyanin, proanthocyanin and tannins etc. Biosynthetic pathways for the formation of polyphenols. Case studies of lignans, flavonoids, chalcones, anthocyanin etc

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IHBT, Palampur			
Course Nomenclature	CHE-IHBT-3-2701			
Course Title	Green Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Principles and importance of green chemistry, techniques, reagents, solvents and processes, water mediated reactions, ionic liquids, solid-supported/neat reaction conditions. Industrial applications of green chemistry and laboratory practical work.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IHBT, Palampur			
Course Nomenclature	CHE-IHBT-3-2702			
Course Title	Advances in Catalyst and Reagent Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Advantages, physico-chemical properties of nanoparticles, nanoparticles as heterogeneous catalysts, applications of nanoparticles in coupling, cross-coupling, oxidation and reduction reactions, coupling and cross-coupling reagents, asymmetric synthesis using chiral environments, modern reagents in oxidation and reduction reactions, homo/ heterogeneous catalysts, phase transfer reagents and role of ligands in organic synthesis, protection and deprotection reagents, recent reports in methodology development, scale up processes and mechanistic studies.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IHBT, Palampur			
Course Nomenclature	CHE-IHBT-3-2703			
Course Title	Advances in Natural Products: Extraction and Isolation Techniques			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Flash chromatography, micro wave –assisted and ultrasound extraction techniques, solid phase micro extraction (SPME), solid phase extraction (SPE), supercritical fluid extraction (SFE), single drop micro extraction (SDME): principles, instrumentation, types of solvents, adsorbents and applications, modern isolation techniques.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IHBT, Palampur			
Course Nomenclature	CHE-IHBT-3-2704			
Course Title	NMR Spectroscopy and its Applications in Organic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Concept and theory of NMR,  $^1\text{H}$ - and  $^{13}\text{C}$ -NMR, practical aspects of NMR, chemical shift, chemical equivalence and spin-spin coupling, magnetic equivalence, spin systems, Pople notation, spin-spin coupling in stereochemistry and structure determination, dynamic effects in NMR spectroscopy, nuclear overhauser effect (NOE), DEPT, two-dimensional (2-D) NMR (COSY, HMQC, HMBC, TOCSY, NOESY, ROESY), structure elucidation of natural products (flavonoids, alkaloids, terpenoids, steroids etc.)

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IHBT, Palampur			
Course Nomenclature	CHE-IHBT-4-2701			
Course Title	Project proposal writing & presentation			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Formulation of a project proposal by selecting topics of high relevance and novelty and will have state-of-the-art review, methodologies, recommendations etc. in specified format in a holistic manner preferably candidate's own research work suitable for submission to appropriate funding agencies.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IHBT, Palampur			
Course Nomenclature	CHE-IHBT-4-2702			
Course Title	Review Article			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Preparation of one review article on specific research area of the student.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IHBT, Palampur			
Course Nomenclature	CHE-IHBT-4-2703			
Course Title	CSIR-800 Societal Program			
Credit Distribution (L-T-P-C)	0	0	8	4
Core/Elective	Core			

### Course Description:

The students have to undertake a project in rural areas for 6-8 weeks in the line with CSIR-800 programme which is primarily prepared at empowering 800 million Indians by way of S&T inventions. The theme for the project may be chosen from CSIR-800 documents and as per expertise available in the laboratory. Students will select the topics in consultation with Doctoral Advisory Committee (DAC).



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-1-2901			
Course Title	Research Methodology (communication & writing skill)			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

NA

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-1-2902			
Course Title	Analytical Tools and Instrumentation			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Thermal methods (TG, DTG, DTA, TMA, DSC), X-ray methods (XRD, XRF, SAXS), NMR (<sup>1</sup>H, <sup>13</sup>C) and other Spectroscopic methods (EPR, IR, UV, Fluorescence), Chromatographic methods (TLC, GC, LC), Mass spectroscopy, Electron Microscopy (SEM, TEM), Electron Probe Micro Analysis (EDS, WDS), Quantitative Analysis (AAS, ICP, CHN)

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-1-2905			
Course Title	Introduction to Nanoscience and Nanotechnology			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

General considerations, Introduction, definitions, consequences of size reduction, Properties: structural, thermodynamic, optical, electrical and magnetic properties, Methods of synthesis, Surface modifications, factors governing the stability and assembly, Characterization of nanomaterials, Applications of Nanomaterials

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-2-2901			
Course Title	Advanced Physical Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Thermodynamics and chemical kinetics, Quantum Mechanics, Atomic structure and spectroscopy, Chemical bonding in diatomics, Chemical applications of group theory, Colloids and Surface science, surfactants, Interface and Interfacial properties, Electrochemistry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-2-2902			
Course Title	Advanced Organic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Stereochemistry, reaction mechanism, C-C and C-X bond formations, Retrosynthetic analysis, photochemistry, pericyclic reactions, reactive intermediates, Methods of asymmetric synthesis and their application in total synthesis, oxidation-reduction reactions, organocatalysis, metathesis reactions.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-2-2903			
Course Title	Advanced Analytical Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Analytical instrumentation, signal and noise, Overview of optical methods of analysis: Components of optical instruments, atomic and molecular spectrometry based on absorption, emission and scattering, Electroanalytical techniques (basic electrochemistry, voltammetry, potentiometry), Analytical separations and introduction to chromatographic methods, GC, LC, Mass spectrometry, electromigration techniques, hyphenated techniques, detectors, Analytical tools for petroleum refining.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-2-2904			
Course Title	Advanced Polymer Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Techniques of polymerization, polymer characterization techniques, Stereochemistry of Polymers, polymer nano-architectures, random and block copolymers, Liquid Crystalline Polymers, Conducting Polymers, Non-linear Polymers, Polymer Blends and Composites, polymer rheology, inorganic, bio and supramolecular polymers

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-2-2905			
Course Title	Advanced Catalysis			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Homogeneous and heterogeneous catalysis, adsorption, diffusion, kinetics, equilibrium and rate expressions; Chiral catalysis, Surface Science in Catalysis, Catalytic Materials; Supports; Active Components, Classes of reactions and types of reactors; Catalyst preparation methods; Characterization of catalysts; Catalysis in super critical media; Brief introduction of organo and electro-catalysis; Structure-activity-property-stability of catalysts, Catalysts in chemical industry, Catalysis in petroleum refining and petrochemicals; Catalysis in the utilization of renewable feed stocks and concepts of sustainable chemistry.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-2-2906			
Course Title	Advanced Separation Science and Technology:			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Resins and membranes for separations, Classification of membranes; electromembrane Processes; Ion-exchange membranes and their applications, Electrodialysis and related processes. Polymer electrolyte membrane and their applications for fuel cells; Water electrolyzer for hydrogen production; Reverse electrodialysis for non-renewable energy from concentration gradient, reverse osmosis, nanofiltration, ultrafiltration, pervaporation and gas separation: Membrane fouling, concentration polarization and other limitations of Pressure-driven membrane technologies.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-2-2907			
Course Title	Advances in Nanoscience and Nanotechnology			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Low-dimensional structures: Quantum wells, Quantum wires, and Quantum dots, Nano clusters & Nano crystals, fullerenes, carbon nano tubes and graphene, Nano Composites, synthesis and characterization techniques, Properties at Nano Scales and comparison with bulk materials, fabrication techniques, general applications, nanomaterials in biology.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-2-2908			
Course Title	Advances in soft matter chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Condensed Matter, Colloids, Characterization of colloids by light scattering and electric-field based techniques, Micelles, Self-assembled systems, Molecular gels, Lyotropic liquid crystalline phases, One-, Two- and Three-dimensionally ordered phases, Thermotropic Liquid crystals textures and their identification, characterization of mesophases, Description of order parameter, Phase transitions.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-2-2909			
Course Title	Green chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Green chemistry concepts: Basic understanding, scope and interdisciplinary nature of green chemistry; Environmental factors; Carbon credit, Energy efficiency and atom economy, Catalysis and green chemistry, Alternate reaction media and reaction systems, ionic liquids, supercritical fluids, solventless chemistry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-2-2910			
Course Title	Dyes and pigments			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Colour and constitution, chromogen and chromophore. Classification of dyes based on structure and mode of dyeing, Chemistry of some important dyes, NIR reflecting dyes, Dyes for solar cells

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-2-2911			
Course Title	Composite materials			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Concept of Composite materials, Various types of composites, Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites, Reinforcements/Fibers ,Types of fibres, Multiphase fibers, Whiskers and Flakes, Mechanical properties of fibres, Processing of Advanced composites, Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing; Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering; Carbon – Carbon composites: Knitting, Braiding, Weaving; Polymer matrix composites: Preparation of Moulding compounds and prepregs – hand lay up method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding, Processing and characteristics of nanocomposites, hybrid composites, functionally graded composites, smart and functional composites

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-2-2912			
Course Title	Advanced NMR Spectroscopic Method			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

2D NMR, <sup>1</sup>H-<sup>1</sup>H correlations, Heteronuclear Correlation Spectroscopy, 2D Exchange (EXSY), 2D NOESY, ROESY, DOSY Structure elucidation of small molecules, NMR of macromolecules, Multidimensional NMR Spectra, NMR Spectroscopy of Solids, 2D experiments in solids, semi rigid systems: HR MAS, Magnetic Resonance Imaging: In Vivo NMR, Imaging, MRI, functional MRI, NMR imaging of materials.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-3-2901			
Course Title	Supramolecular chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Nature of supramolecular interactions, role of various non-covalent interactions, multiple hydrogen bonding motifs, Stability of H-bonds, Jorgensen model for H-bonding, supramolecular synthons , dimensions of supramolecular chemistry, Janus molecules. Photoresponsive molecules and self-assembly, Molecular recognition, classification of supramolecular host-guest complexes, supramolecular self-assembly, supramolecular polymers, molecular capsules, self- assembled dendrimers, self-assembled nanotubes, low molecular weight organogels. Characterization techniques of self-assemblies, supramolecular sensors.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-3-2902			
Course Title	Total Synthesis			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Synthesis of complex organic molecules – planning and execution; Concepts of Retrosynthetic Analysis and Total synthesis of Natural products; Retrosynthesis; Disconnection; Synthons; Linear and Convergent Synthesis; Photochemistry in total synthesis; MCRs in total synthesis; Breakthrough synthesis – past and present.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-3-2903			
Course Title	Asymmetric Synthesis			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Strategies for the preparation of optically pure compounds; Stereoselective, Enantioselective and Diastereoselective reactions; Stoichiometric asymmetric synthesis-chiral auxiliaries, Evans Alsdol and modified versions; Catalytic asymmetric synthesis; Asymmetric Dihydroxylation; Asymmetric Aminohydroxylation; Asymmetric Hydrogenation; Asymmetric allylation, propargylation, and alkylation; Chiral Organocatalysis; Cascade reactions by organocatalysis; Transition Metal based catalysis; Asymmetric amplification and autocatalysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-3-2904			
Course Title	Agrochemicals			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Biochemistry in agriculture, Carbohydrates, Proteins, Lipids, Vitamins and Minerals and Enzymes, Soil science, guidelines on agricultural crops micronutrients and fertilizers, Chemistry of pesticides, synthesis, formulations, mode of action, toxicology, resistance and residual analysis, Methodologies for the synthesis of agrochemicals and other relevant organic molecules, chemistry in Integrated Pest Management, Semiochemicals, insect growth regulators, botanical pesticides and other biotechnological approaches, Analysis of agrochemicals and residues - Botanical pesticides, hormones, pheromone, kairomones and plant volatiles

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-3-2905			
Course Title	Fluoro organic chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Importance of fluorine in organic compounds, Strategies to introduce fluorine/ trifluoromethyl group into organic molecules, Preparation of fluorinated reagents, Preparation of fluorinated carbon materials and their uses, Known fluorinated drugs and their mode of action, Overview on CFCs, HCFCs, HFCs, their preparation and applications, Halon substitutes, Harmful effects of fluorine and inorganic fluorides

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-3-2906			
Course Title	Corrosion science			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Basic aspects, Forms of corrosion, Atmospheric corrosion and protective coatings, Immersion corrosion and electrochemical protection, Corrosion monitoring, impedance spectroscopy, harmonics and NDT techniques.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-3-2907			
Course Title	Catalysis for biomass refining			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Classification of biomass; Catalytic processing of cellulosic and lignocellulosic materials for monomers or oligomers; Catalytic transformation biomass to fuels; Value addition of biomass/monomers to fine and specialty chemicals; Value addition of glycerol and their derivatives; Concept of bio-refinery – Role of catalysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-3-2908			
Course Title	Materials and devices for energy conversion			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Design of organic and Inorganic semiconductors, Approaches to process organic semiconductors by covalent and non covalent modifications , band edges and band gaps, Modulation of charge transport properties, kinetics of electron transfer, Design of small molecule dyes for DSSC, Electron transfer at interfaces, Transistors and solar cells, Fabrication of Devices, Device characterisation using dark current, IV curves under illumination, IPCE, Calculation of Voc, Jsc, Vpp, Ipp, FF and Pmax. hybrid solar cells

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-3-2909			
Course Title	Electrochemical power sources			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Energy scenario, emissions and global warming, fuel cells, Thermodynamic potentials, electrochemical processes and electrode kinetics, Proton exchange membranes, proton conducting mechanisms, recent advances, Operating conditions, overview of characterization techniques, technical aspects, advantages, materials, significances and challenges, Materials for supercapacitor applications, recent advances in the system development, battery vs. supercapacitor, modern technologies, challenges and prospects.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-3-2910			
Course Title	Hydrogen generation and storage			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Fabrication of Devices, Device characterisation using dark current, IV curves under illumination, IPCE, Calculation of Voc, Jsc, Vpp, Ipp, FF and Pmax. hybrid solar cells

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-3-2911			
Course Title	CO2 sequestration and conversion			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

CO2 Sequestration; Capture techniques; overview of transportation and storage techniques, Basic properties of CO2, Reactivity of CO2, Utilization of CO2 as chemical feedstock, Utilization of CO2 as inert solvent for chemical synthesis, Coordination chemistry of CO2 and reactivity of coordinated CO2, Transition metal promoted reactions of CO2, The chemistry of N-CO2 bonds, Applications of CO2 for the synthesis of polymers, photochemical reduction of CO2, utilization of CO2 for the production of hydrocarbon fuels.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-3-2912			
Course Title	Block copolymers			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Chain and controlled block copolymerization, monomer reactivity ratios, Copolymer compositions, molecular architecture, blends, grafts, melts, self assembly and phase separation, phase diagram, range of applicability of copolymerization equation; types of copolymerization; Block copolymers with controlled molecular weight, Living Polymerization, block copolymer synthesis, characterization techniques, block copolymers for biomedical and industrial applications, Amphiphilic block copolymer micelles, Block copolymer thin films.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-3-2913			
Course Title	Conducting polymers			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Synthesis and characterization, electrical transport properties, theory of conductivity, doping, electrochromic properties, Classification and types of organic conductors, Structure and properties of conducting charge-transfer salts, Conducting polymers based on organometallic compounds, Applications of conducting polymers, EMI shielding, supercapacitors, sensors

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-3-2914			
Course Title	Polymers and Colloidal Solutions			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Intermolecular forces and potentials, Overview of Statistical physics, DLVO theory, charged colloids, Poisson Boltzmann theory, Debye radius, Bjerrum length, electrophoresis, zeta potential, diffusion, Hydrodynamic interactions. Brief overview of Phase transitions in hard sphere colloids, Random walk, self avoiding random walk, flexible polymers, persistence length, Excluded volume interactions, Polymer solutions in the dilute limit/semi-dilute limit, Entropy of mixing, theta temperature, rubber elasticity, Polyelectrolytes, polymer at surfaces: Brushes, polymer dynamics.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-3-2915			
Course Title	Controlled Radical/Living Polymerizations and Macromolecular Architectures			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Controlled or Living Radical Polymerization, TEMPO-mediated polymerization and atom Transfer radical Polymerization (ATRP), Kinetics of ATRP, Reversible Addition Chain Fragmentation Transfer (RAFT), Nitroxide mediated polymerization (NMP), Ring opening Metathesis polymerization (ROMP), living ROP, Macromolecular architectures using controlled living polymerizations

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-3-2916			
Course Title	Pi-conjugated polymers			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Synthesis and characterization, electronic and optical properties, energy band structure, Display Materials: Organic Light Emitting Diodes, Organic thin film transistors, device preparation, working principle, advantages, drawbacks; Organic photovoltaics, OFETs, device preparation and characterization, factors influencing efficiency, stability.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-3-2917			
Course Title	Liquid Crystals			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Liquid crystal phases, classification, Chiral liquid crystalline phases, Ferroelectric liquid crystalline phases, discotic liquid crystalline phases, Characterization techniques, Surface Alignment of Liquid Crystals, Dichroic LCs, Polycatenar mesogenes, Display and photovoltaic applications.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-3-2918			
Course Title	X-Ray Diffraction and Structure of Solids			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction to X-ray crystallography, Crystal growth, evaluation and mounting, Symmetry and space group determination, Background theory for data collection, Data collection using four-circle diffractometers, Area detectors, Crystal lattices, Structure factors, Crystal symmetry, Structure solutions, Structure refinement, An introduction to maximum entropy, Least squares fitting of parameters, Practical aspects of structure refinement, Crystallographic Database, Structure solution from Powder Diffraction Data

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-3-2919			
Course Title	NMR spectroscopy			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Quantum Mechanics of NMR, Multinuclear NMR spectroscopy, Periodic table of NMR, Heteronuclear double resonance experiments, Magnetization transfer and signal enhancement, NMR of diamagnetic and paramagnetic compounds, Multidimensional NMR: 2D NMR, <sup>1</sup>H-<sup>1</sup>H correlations, Heteronuclear Correlation Spectroscopy, 2D Exchange (EXSY), 2D NOESY, ROESY, DOSY Structure elucidation of small molecules, NMR of macromolecules, Multidimensional NMR Spectra, NMR Spectroscopy of Solids, 2D experiments in solids, semi rigid systems: HR MAS, Magnetic Resonance Imaging: In Vivo NMR, Imaging, MRI, functional MRI, NMR imaging of materials.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-3-2920			
Course Title	Mass spectrometry applications			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Applications to analyze molecular, macromolecular and biological samples, Sample Preparation Protocols, Drug Metabolism and Pharmacokinetics (DMPK), Development of Quantitative analytical methods using mass spectrometry, Application to some model drugs, Metabolomics , Proteomics, GC-MS, LC-MS, MALDI-TOF, GC-TOF, TOF/TOF MS, LC-ESI-MS, Protein Database search (MASCOT), Clinical Mass Spectrometry,

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-4-2901			
Course Title	Project proposal writing & presentation			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Compulsory			

### Course Description:

Formulation of a project proposal by selecting topics of high relevance and novelty and will have state-of-the-art review, methodologies, recommendations etc. in specified format in a holistic manner preferably candidate's own research work suitable for submission to appropriate funding agencies.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-4-2902			
Course Title	Review Article			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Compulsory			

### Course Description:

Preparation of one review article on specific research area of the student.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IICT, Hyderabad			
Course Nomenclature	CHE-IICT-4-2903			
Course Title	CSIR-800 Societal Program			
Credit Distribution (L-T-P-C)	0	0	8	4
Core/Elective	Compulsory			

### Course Description:

The students have to undertake a project in rural areas for 6-8 weeks in the line with CSIR-800 programme which is primarily prepared at empowering 800 million Indians by way of S&T inventions. The theme for the project may be chosen from CSIR-800 documents and as per expertise available in the laboratory. Students will select the topics in consultation with Doctoral Advisory Committee (DAC).

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIIM, Jammu			
Course Nomenclature	CHE-IIIM-1-3001			
Course Title	Research Methodology:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Good laboratory practices, Safety in the laboratory, First aid in the laboratory, Maintenance of laboratory records, Scientific literature management, Communication skills (scientific writing and presentation), Intellectual property management & planning, Ethics in science, Computer applications and tools, Statistical methods & data analysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIIM, Jammu			
Course Nomenclature	CHE-IIIM-1-3002			
Course Title	Analytical Tools and Instrumentation			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Thermal methods (TG, DTG, DTA, TMA, DSC), X-ray methods (XRD, XRF, SAXS), NMR (<sup>1</sup>H, <sup>13</sup>C) and other Spectroscopic methods (EPR, IR, UV, Fluorescence), Chromatographic methods (TLC, GC, LC), Mass spectroscopy, Electron Microscopy (SEM, TEM), Electron Probe Micro Analysis (EDS, WDS), Quantitative Analysis (AAS, ICP, CHN)



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIIM, Jammu			
Course Nomenclature	CHE-IIIM-1-3004			
Course Title	Basic Chemistry for Interdisciplinary sciences:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

Basics of spectroscopy and other analytical techniques (NMR, Mass, UV and IR spectroscopy and Separation techniques etc), Basics of chemistry and biochemistry, Nomenclature (IUPAC), Thermodynamic, Types of bonding, Ionic, Covalent and non-bonding interactions, Acids and bases, Atomic structure, Periodic table and periodic properties, Chemical reactions and kinetics, Solvent effects, Functional groups in organic compounds, General named reactions and reaction mechanisms, Carbohydrates, Lipids, Proteins, Nucleotides, Enzymes, General medicinal chemistry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIIM, Jammu			
Course Nomenclature	CHE-IIIM-1-3006			
Course Title	Basic Biology for interdisciplinary sciences			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

An introduction to biological macromolecules including Proteins, Nucleic acids and Carbohydrates. Structure and function of biological macromolecules. Basic Molecular Biology Techniques: Isolation of RNA and DNA PCR and RT-PCR Gene cloning Cloning vectors and host organisms used for genetic engineering. Gene transfer techniques, chemical transformation, electroporation Gel electrophoresis Applications of gene cloning Cell Culture basics (Plant, microbial and mammalian cell culture): Introduction to Cell Culture Various Types of cell cultures Morphology of Cells in Culture Determination of cell counts and viability Maintenance of aseptic conditions and safety considerations Preservation and storage Application of Cell Culture

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIIM, Jammu			
Course Nomenclature	CHE-IIIM-2-3001			
Course Title	Advanced Organic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Core			

### Course Description:

Name reaction and reaction mechanism, Methods of asymmetric synthesis and their applications in total synthesis, Retrosynthetic analysis, catalysis, stereochemistry, Green and sustainable chemistry, tool of green chemistry, concept of atom economy.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIIM, Jammu			
Course Nomenclature	CHE-IIIM-2-3002			
Course Title	Natural Product			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Traditional system of Indian medicine, Isolation of bioactive metabolite from Natural resources, Advanced separation technique and its application, Dereliction of Natural product using hyphenated techniques, Advanced spectroscopy techniques for identification of complex natural product, Peptides, carbohydrates and polysaccharides, Biosynthesis of natural products, Chemical ecology.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIIM, Jammu			
Course Nomenclature	CHE-IIIM-2-3003			
Course Title	Drug Discovery			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Medicinal chemistry, Natural products and its importance in drug discovery, SAR studies, pharmacokinetics and metabolism, drug targets, target validation, pharmacological screening, hit and lead identification, animal models, Drug delivery and pharmaceutical formulations, process chemistry, toxicology, regulatory and clinical trials.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIIM, Jammu			
Course Nomenclature	CHE-IIIM-2-3004			
Course Title	Molecular Modelling and Simulation			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Chem-informatics and its application; General features of molecular mechanics force fields; Energy minimization: derivative & non-derivative methods; Protein flexibility and molecular dynamics; Protein folds and fold based classification of proteins; Strategies for ligand based drug design; Strategies for structure based drug design; Lead optimization strategies; fragment based drug design.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIIM, Jammu			
Course Nomenclature	CHE-IIIM-3-3001			
Course Title	Medicinal Chemistry (Oncology/Infection), Isolations and Synthesis			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Medicinal chemistry; Design and Synthesis of NCEs for therapeutic areas (Oncology/Infection/Inflammation); Hit, Lead identification and Lead optimization; Case studies, Isolation, synthesis and characterization of naturally occurring bio-active molecules from plants, microbes and marines; Structure guided drug design.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIIM, Jammu			
Course Nomenclature	CHE-IIIM-3-3002			
Course Title	Seminar for individual			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Student has to prepare a lecture related to given topic by the seminar committee



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIIM, Jammu			
Course Nomenclature	CHE-IIIM-4-3001			
Course Title	Project proposal writing & presentation			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Formulation of a project proposal by selecting topics of high relevance and novelty and will have state-of-the-art review, methodologies, recommendations etc. in specified format in a holistic manner preferably candidate's own research work suitable for submission to appropriate funding agencies.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIIM, Jammu			
Course Nomenclature	CHE-IIIM-4-3002			
Course Title	Review Article			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Preparation of one review article on specific research area of the student.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIIM, Jammu			
Course Nomenclature	CHE-IIIM-4-3003			
Course Title	CSIR-800 Societal Program			
Credit Distribution (L-T-P-C)	0	0	8	4
Core/Elective	Core			

### Course Description:

The students have to undertake a project in rural areas for 6-8 weeks in the line with CSIR-800 programme which is primarily prepared at empowering 800 million Indians by way of S&T inventions. The theme for the project may be chosen from CSIR-800 documents and as per expertise available in the laboratory. Students will select the topics in consultation with Doctoral Advisory Committee (DAC).

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIP, Dehradun			
Course Nomenclature	CHE-IIP-1-3101			
Course Title	Research Methodology			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Good laboratory practices, Safety in the laboratory, First Aid in the laboratory, Maintenance of laboratory records, Scientific literature management, Communication skills (scientific writing and presentation), Intellectual property management & planning, Ethics in Science, Computer applications and tools, Statistical methods & Data analysis.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIP, Dehradun			
Course Nomenclature	CHE-IIP-1-3102			
Course Title	Analytical Tools and Instrumentation			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Thermal methods (TG, DTG, DTA, TMA, DSC), X-ray methods (XRD, XRF, SAXS), NMR (<sup>1</sup>H, <sup>13</sup>C) and other Spectroscopic methods (EPR, IR, UV, Fluorescence), Chromatographic methods (TLC, GC, LC), Mass spectroscopy, Electron Microscopy (SEM, TEM), Electron Probe Micro Analysis (EDS, WDS), Quantitative Analysis (AAS, ICP, CHN)

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIP, Dehradun			
Course Nomenclature	CHE-IIP-2-3101			
Course Title	Advanced Organic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Core			

### Course Description:

Stereochemistry, reaction mechanism, C-C and C-X bond formations, Retrosynthetic analysis, photochemistry, pericyclic reactions, reactive intermediates, Methods of asymmetric synthesis and their application in total synthesis, oxidation-reduction reactions, organocatalysis, metathesis reactions.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIP, Dehradun			
Course Nomenclature	CHE-IIP-2-3102			
Course Title	Advanced Analytical Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Analytical instrumentation, signal and noise, Overview of optical methods of analysis: Components of optical instruments, atomic and molecular spectrometry based on absorption, emission and scattering, Electroanalytical techniques (basic electrochemistry, voltammetry, potentiometry), Analytical separations and introduction to chromatographic methods, GC, LC, Mass spectrometry, electromigration techniques, hyphenated techniques, detectors, Analytical tools for petroleum refining.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIP, Dehradun			
Course Nomenclature	CHE-IIP-2-3103			
Course Title	Advances in hydrocarbon chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Chemistry of crude oil, thermal cracking, visbreaking and coking processes, catalytic cracking, hydro cracking and hydrogen production processes, catalytic reforming process, Chemistry and industrial processes for alkylates, isomerisation processes, Petrochemicals, Basic Building blocks; C1-Chemistry; Petrochemicals from n-paraffins; Petrochemicals from olefins and aromatics; Refinery-Petrochemical Integration, Future Prospects



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIP, Dehradun			
Course Nomenclature	CHE-IIP-2-3104			
Course Title	Advanced Catalysis			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Homogeneous and heterogeneous catalysis, adsorption, diffusion, kinetics, equilibrium and rate expressions; Chiral catalysis, Surface Science in Catalysis, Catalytic Materials; Supports; Active Components, Classes of reactions and types of reactors; Catalyst preparation methods; Characterization of catalysts; Catalysis in super critical media; Brief introduction of organo and electro-catalysis; Structure-activity-property-stability of catalysts, Catalysts in chemical industry, Catalysis in petroleum refining and petrochemicals; Catalysis in the utilization of renewable feed stocks and concepts of sustainable chemistry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIP, Dehradun			
Course Nomenclature	CHE-IIP-2-3105			
Course Title	Alternative feedstock options for petrochemicals			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Global scenario of Petrochemicals, Renewable resources; categorization of resources; chemicals from edible renewable resource; Chemicals from non-edible renewable resources; Catalytic reactions (mineral acid, bases; enzymes, homogeneous and heterogeneous catalysts); alternate fuels; fuels derived from renewable resources; biodiesel, bioethanol, biobutanol; Hydrogen generation from renewable feed stocks, Conversion of glycerol; Naphtha as a conventional source, Need for sustainability in production of Petrochemicals, Alternate Options; from Refineries sources, Natural Gas/Methane as an Option and other Non Refinery Sources, CO<sub>2</sub> utilization, Identification and Recommendations based on techno-economic analysis for India.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIP, Dehradun			
Course Nomenclature	CHE-IIP-3-3101			
Course Title	Multiphase reaction kinetics			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Mass transfer theories, Multi phase reactors, Multi phase reactors selection criteria; Mass transfer coupled with chemical reaction; measurement of gas-liquid parameters, Reaction in porous catalysts; effective diffusivity and structure of porous catalysts, Important design parameters for gas-liquid and solid reactors, Reactor modeling in petroleum refining industry, Modeling of catalytic sweetening, isomerisation, hydro treating, and FT synthesis.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIP, Dehradun			
Course Nomenclature	CHE-IIP-3-3102			
Course Title	Ionic liquids for lubricants			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Lubrication by Ionic liquids and its structural correlation, Ionic liquids interaction with surfaces, synthetic oil lubricants, synthesis of lubricating ionic liquids, effect of alkyl chain length and anions, IL lubrication oils at variable temperatures, thin films, heat capacity and thermal properties, viscosity and wetting properties, ionic liquids as additives for lubricants, comparison with conventional hydrocarbon oils, Case studies.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIP, Dehradun			
Course Nomenclature	CHE-IIP-3-3103			
Course Title	Catalysis in petroleum refining			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Deactivation in Catalysts and its Consequences, Regeneration and Rejuvenation in Catalysis, Industrial Catalytic Processes; Hydro cracking; Hydro treating; Reforming; Isomerization and Alkylation; Fluid Catalytic Cracking and Deep Catalytic Cracking, Catalysis for Clean Fuels; Gas to Liquid Technology; Catalysis for Hydrogen Production, Catalysis beyond Petroleum; Electro catalysis; Photo catalysis, Laboratory Training in Catalysis.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIP, Dehradun			
Course Nomenclature	CHE-IIP-3-3104			
Course Title	Biocatalysis in petroleum refining			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Scope of Biocatalysis in Petroleum Refining, Thermophilic microorganisms and the thermozymes, Structure and function of proteins, Non-aqueous Biocatalysis, Protein Engineering and rate improvement, Enzyme kinetics and models, Challenges and opportunities on Bioprocess development on: Bio-desulphurization of crude oil and petroleum fractions; Bio-cracking and Bio-vis breaking; Bio-desulphurization of waste gases; Biocatalysts for renewable hydrocarbons and petrochemicals.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIP, Dehradun			
Course Nomenclature	CHE-IIP-3-3105			
Course Title	Thermochemical Conversion of Biomass			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Thermochemical conversion technologies for biomass pyrolysis, gasification, combustion, thermal and catalytic conversion of biomass; upgradation of pyrolysis products; bio-refining products and applications; biorefinery concept; Hybrid methods of conversion and effective utilization; Alternative and/or clean fuels, functional and bulk chemicals from biomass; life cycle analysis; carbon and water foot prints; Utilization of products and feasibility assessment; Science, technology and policy of biomass energy; Strategies for Enhancing role of renewable energy and Indian scenario.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIP, Dehradun			
Course Nomenclature	CHE-IIP-3-3106			
Course Title	CO2 sequestration and conversion			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

CO2 Sequestration; Capture techniques; overview of transportation and storage techniques, Basic properties of CO2, Reactivity of CO2, Utilization of CO2 as chemical feedstock, Utilization of CO2 as inert solvent for chemical synthesis, Coordination chemistry of CO2 and reactivity of coordinated CO2, Transition metal promoted reactions of CO2, The chemistry of N-CO2 bonds, Applications of CO2 for the synthesis of polymers, photochemical reduction of CO2, utilization of CO2 for the production of hydrocarbon fuels.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIP, Dehradun			
Course Nomenclature	CHE-IIP-3-3107			
Course Title	Natural gas to liquid fuels			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

generation processes; SMR; POx; ATR; DMR and Tri reforming, Syngas conversion processes; FT Synthesis, LTFT, HTFT, Low Pressure versus high pressure FT, Syn-crude up gradation by hydrocracking, methanol synthesis, chemistry of the processes; catalysts, development in reactors; tubular; multitubular; fixed bed; fluidized bed; FFB; CFB, SBCR, variables affecting SCBR, Commercial Processes; MTO; UOP/Hydro MTO; Exxon Mobil MTO; Lurgi MTP, DME Synthesis, status and prospects of DME production; Challenges for DME commercialization, commercialization activities of GTL plants, SSPD, SMDS, AGC- 21 and Gasel Processes.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIP, Dehradun			
Course Nomenclature	CHE-IIP-3-3108			
Course Title	Gasoline reformulation techniques			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Environmental regulations on Fuel quality, Gasoline specifications and concept of reformulated gasoline, Gasoline production routes; Gasoline from Crude oil; General Properties of gasoline; Gasoline quality improvement drivers ; Chronological development in gasoline composition; Gasoline additives, Gasoline blending unit in a refinery; Dealing with aromatics, olefins and sulfur concentrations; Integration techniques to obtain reformulated gasoline, Refining processes; Reforming; Isomerisation, FCC Gasoline, Alkylation, Technologies for Alkylation.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIP, Dehradun			
Course Nomenclature	CHE-IIP-4-3101			
Course Title	Project proposal writing & presentation			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Compulsory			

### Course Description:

Formulation of a project proposal by selecting topics of high relevance and novelty and will have state-of-the-art review, methodologies, recommendations etc. in specified format in a holistic manner preferably candidate's own research work suitable for submission to appropriate funding agencies.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIP, Dehradun			
Course Nomenclature	CHE-IIP-4-3102			
Course Title	Review Article			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Compulsory			

### Course Description:

Preparation of one review article on specific research area of the student.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IIP, Dehradun			
Course Nomenclature	CHE-IIP-4-3103			
Course Title	CSIR-800 Societal Program			
Credit Distribution (L-T-P-C)	0	0	8	4
Core/Elective	Compulsory			

### Course Description:

The students have to undertake a project in rural areas for 6-8 weeks in the line with CSIR-800 programme which is primarily prepared at empowering 800 million Indians by way of S&T inventions. The theme for the project may be chosen from CSIR-800 documents and as per expertise available in the laboratory. Students will select the topics in consultation with Doctoral Advisory Committee (DAC).

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IITR, Lucknow			
Course Nomenclature	CHE-IITR-1-3201			
Course Title	Research Methodology:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Good laboratory practices, Safety in the laboratory, First Aid in the laboratory, Maintenance of laboratory records, Scientific literature management, Communication skills (scientific writing and presentation), Intellectual property management & planning, Ethics in Science, Computer applications and tools, Statistical methods & Data analysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IITR, Lucknow			
Course Nomenclature	CHE-IITR-1-3202			
Course Title	Analytical Tools and Instrumentation			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Core			

### Course Description:

Thermal methods (TG, DTG, DTA, TMA, DSC), X-ray methods (XRD, XRF, SAXS), NMR (<sup>1</sup>H, <sup>13</sup>C) and other Spectroscopic methods (EPR, IR, UV, Fluorescence), Chromatographic methods (TLC, GC, LC), Mass spectroscopy, Electron Microscopy (SEM, TEM), Electron Probe Micro Analysis (EDS, WDS), Quantitative Analysis (AAS, ICP, CHN)

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IITR, Lucknow			
Course Nomenclature	CHE-IITR-2-3201			
Course Title	Advanced Organic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Stereochemistry, reaction mechanism, C-C and C-X bond formations, Retrosynthetic analysis, photochemistry, pericyclic reactions, reactive intermediates, Methods of asymmetric synthesis and their application in total synthesis, oxidation-reduction reactions, organocatalysis, metathesis reactions.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IITR, Lucknow			
Course Nomenclature	CHE-IITR-2-3202			
Course Title	Advanced Analytical Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Analytical instrumentation, signal and noise, Overview of optical methods of analysis: Components of optical instruments, atomic and molecular spectrometry based on absorption, emission and scattering, Electroanalytical techniques (basic electrochemistry, voltammetry, potentiometry), Analytical separations and introduction to chromatographic methods, GC, LC, Mass spectrometry, electromigration techniques, hyphenated techniques, detectors, Analytical tools for petroleum refining.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IITR, Lucknow			
Course Nomenclature	CHE-IITR-2-3203			
Course Title	Advanced Photochemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction to photochemistry, excited state processes, fluorescence and phosphorescence, quantum yields, charge-transfer spectra, solvatochromism, photochromism, transient absorption techniques, Luminescence emission lifetimes, two- and multiphoton processes, photoinduced energy and electron transfer, FRET, fluorescence polarization, excimers, exciplexes, delayed fluorescence, Photochemistry of Organic chromophores. Photochemistry in organized and confined media.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IITR, Lucknow			
Course Nomenclature	CHE-IITR-2-3204			
Course Title	Green chemistry			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Green chemistry concepts: Basic understanding, scope and interdisciplinary nature of green chemistry; Environmental factors; Carbon credit, Energy efficiency and atom economy, Catalysis and green chemistry, Alternate reaction media and reaction systems, ionic liquids, supercritical fluids, solventless chemistry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IITR, Lucknow			
Course Nomenclature	CHE-IITR-2-3205			
Course Title	Ionic liquids			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Introduction to ionic liquids, ionic liquids vs. molecular solvents/ionic salts (solids), ionic liquids vs. eutectic mixtures, solvent polarities using different spectral techniques (parameters), physicochemical properties of ionic liquids, effect of functional groups on the properties of ionic liquids, surface active ionic liquids, aggregation behavior of ionic liquids, interaction of ionic liquids with different molecular solvents, interaction of ionic liquids with biopolymers, thermodynamics of the binary mixtures of ionic liquids, structure property relationship in ionic liquids.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IITR, Lucknow			
Course Nomenclature	CHE-IITR-2-3206			
Course Title	Synthetic methods for organic chemists			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Formation of carbon-carbon bond employing various kinds of organometallic reagents, C-C double bonds through different reactions, oxidation, reduction through various kinds of reagents, functional group interconversion, by substitution including protection and deprotection, alkylation of enolates, and other carbon nucleophiles, reaction of carbon nucleophiles with carbonyl compounds, electrophilic addition to C-C multiple bonds, reactions of C-C multiple bonds, Retrosynthesis, disconnection, synthons, linear and convergent synthesis, umpolung of reactivity and protecting groups.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IITR, Lucknow			
Course Nomenclature	CHE-IITR-2-3207			
Course Title	Dyes and pigments			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Colour and constitution, chromogen and chromophore. Classification of dyes based on structure and mode of dyeing, Chemistry of some important dyes, NIR reflecting dyes, Dyes for solar cells

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IITR, Lucknow			
Course Nomenclature	CHE-IITR-2-3208			
Course Title	Thermodynamics and Statistical Mechanics			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction: Thermodynamics – A Macroscopic Theory of Matter; Laws of Thermodynamics, Ideal Gas Laws, Specific Heat Capacities; Concept of Free Energy, Hamiltonian Mechanics, Equilibrium Distributions and Ergodic Hypothesis, Ensembles, Thermodynamic Functions and the Distribution Function,  $g(r)$ , Imperfect Gases, Kinetic Theory of Gases, Time Dependent Processes, Phase Transitions

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IITR, Lucknow			
Course Nomenclature	CHE-IITR-2-3209			
Course Title	Organic Spectroscopy Applications			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Mass spectroscopy, IR spectroscopy, Proton magnetic resonance spectroscopy, Structural assignment by employing NMR techniques, Carbon-13 NMR spectroscopy, Introduction COSY, HSQC, HMBC, NOESY, ROESY, Structural elucidation using 2D-NMR methods



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IITR, Lucknow			
Course Nomenclature	CHE-IITR-3-3201			
Course Title	Applications of ionic liquids			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Introduction to task specific ionic liquids, self-assembly of ionic liquids in aqueous/non aqueous media and synthesis of nanomaterials therein, ionic liquids in catalysis, extraction of metal ions, ionic liquids and biopolymers: dissolution, regeneration and ionic-gel formation, processing of lignocellulosic biomass using ionic liquids, clean separation of various fractions of biomass and recovery of valuable chemicals using ionic liquids, application of ionic liquids in electrochemistry, separation of azeotropic mixtures using ionic liquids, organic reactions in ionic liquids.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IITR, Lucknow			
Course Nomenclature	CHE-IITR-3-3202			
Course Title	Biodegradable polymers			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Polymers from biomass, microbial production, synthetic polymers, structure and properties, Biodegradation mechanism, measurement techniques, processing techniques, sterilization and storage, global standards, market potential, applications.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IITR, Lucknow			
Course Nomenclature	CHE-IITR-3-3203			
Course Title	NMR spectroscopy			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Quantum Mechanics of NMR, Multinuclear NMR spectroscopy, Periodic table of NMR, Heteronuclear double resonance experiments, Magnetization transfer and signal enhancement, NMR of diamagnetic and paramagnetic compounds, Multidimensional NMR: 2D NMR, <sup>1</sup>H-<sup>1</sup>H correlations, Heteronuclear Correlation Spectroscopy, 2D Exchange (EXSY), 2D NOESY, ROESY, DOSY Structure elucidation of small molecules, NMR of macromolecules, Multidimensional NMR Spectra, NMR Spectroscopy of Solids, 2D experiments in solids, semi rigid systems: HR MAS, Magnetic Resonance Imaging: In Vivo NMR, Imaging, MRI, functional MRI, NMR imaging of materials.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IITR, Lucknow			
Course Nomenclature	CHE-IITR-3-3204			
Course Title	Mass spectrometry applications			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Applications to analyze molecular, macromolecular and biological samples, Sample Preparation Protocols, Drug Metabolism and Pharmacokinetics (DMPK), Development of Quantitative analytical methods using mass spectrometry, Application to some model drugs, Metabolomics , Proteomics, GC-MS, LC-MS, MALDI-TOF, GC-TOF, TOF/TOF MS, LC-ESI-MS, Protein Database search (MASCOT), Clinical Mass Spectrometry,

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IITR, Lucknow			
Course Nomenclature	CHE-IITR-3-3205			
Course Title	Natural products and drug discovery			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Natural products: Importance, lead, clinical trials in drug discovery research, Case studies of marketed natural product drugs, Synthetic Biology and Genetic engineering in the production of natural product, A brief overview of drug discovery approach, Cause of diseases, Target identification, Target validation, Modeling, Synthesis and SAR, Drug Delivery, Clinical Trials, Etiology, pathogenesis, prevention, drug targets and chemotherapy, drug resistance and remedies of tropical infectious diseases, Etiology and remedies of diseases developed through metabolic disorders.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IITR, Lucknow			
Course Nomenclature	CHE-IITR-3-3206			
Course Title	Photobiology			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Primary processes in photosynthesis, antenna effect, reaction center, primary processes in vision, bio and chemiluminescence and environmental photobiology and UV effects, Phototherapy and photodynamic therapy, sensitizers, structures of porphyrinic and non-porphyrinic sensitizers, type I and type II mechanisms, advantages and disadvantages of light in medicine.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IITR, Lucknow			
Course Nomenclature	CHE-IITR-4-3201			
Course Title	Project proposal writing & presentation			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Formulation of a project proposal by selecting topics of high relevance and novelty and will have state-of-the-art review, methodologies, recommendations etc. in specified format in a holistic manner preferably candidate's own research work suitable for submission to appropriate funding agencies.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IITR, Lucknow			
Course Nomenclature	CHE-IITR-4-3202			
Course Title	Review Article			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Preparation of one review article on specific research area of the student.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IITR, Lucknow			
Course Nomenclature	CHE-IITR-4-3203			
Course Title	CSIR-800 Societal Program			
Credit Distribution (L-T-P-C)	0	0	8	4
Core/Elective	Core			

### Course Description:

The students have to undertake a project in rural areas for 6-8 weeks in the line with CSIR-800 programme which is primarily prepared at empowering 800 million Indians by way of S&T inventions. The theme for the project may be chosen from CSIR-800 documents and as per expertise available in the laboratory. Students will select the topics in consultation with Doctoral Advisory Committee (DAC).

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IMMT, Bhubaneswar			
Course Nomenclature	CHE-IMMT-1-3301			
Course Title	Research Methodology			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective				

### Course Description:

Good laboratory practices, Safety in the laboratory, First Aid in the laboratory, Maintenance of laboratory records, Scientific literature management, Communication skills (scientific writing and presentation), Intellectual property management & planning, Ethics in Science, Computer applications and tools, Statistical methods & Data analysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IMMT, Bhubaneswar			
Course Nomenclature	CHE-IMMT-1-3302			
Course Title	Materials Characterization Techniques			
Credit Distribution (L-T-P-C)	3	0	2	4
Core/Elective				

### Course Description:

Size and surface area analysis; Interaction of X-rays with matter, diffraction techniques and applications; Optical principles of microscopy; electron diffraction, imaging (various contrasts), determination of crystal structure, burgers vector, electron beam-specimen interactions and other applications of Transmission Electron Microscopy; Applications of Scanning Electron Microscopy and, Electron Probe Micro-Analyser; Principles of Quantitative Microscopy: Overview of other characterization techniques such as Auger electron spectroscopy, Scanning Tunneling Microscopy, Atomic Force Microscopy.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IMMT, Bhubaneswar			
Course Nomenclature	CHE-IMMT-2-3301			
Course Title	Advanced Materials Chemistry			
Credit Distribution (L-T-P-C)	3	0	2	4
Core/Elective				

### Course Description:

Course available in AcSIR Course Booklet

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IMMT, Bhubaneswar			
Course Nomenclature	CHE-IMMT-2-3302			
Course Title	Environmental Science			
Credit Distribution (L-T-P-C)	3	0	2	4
Core/Elective				

### Course Description:

Introduction to industrial wastes, their definition, classification, sources and characteristics. hazardous wastes, their classification and characteristics. treatment and disposal of industrial wastes, physico-chemical processes, solidification & stabilisation. air pollutants, their sources and types, global warming, green house gases and their capture, air quality monitoring, air pollution control devices. environmental analysis & parameters - air, noise, water, and soil pollution. environmental impact & risk assessment, ambient air quality monitoring & modelling, industrial disaster modelling, its regulations and framework

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IMMT, Bhubaneswar			
Course Nomenclature	CHE-IMMT-3-3301			
Course Title	Advanced Chemistry for Hydro & Electrometallurgy			
Credit Distribution (L-T-P-C)	3	0	2	4
Core/Elective				

### Course Description:

Leaching: Atmospheric leaching, Pressure leaching, Bio leaching, Optimisation of process parameters, Solid liquid separation: Concepts of solid liquid separation, Thickening and thickener design, Counter-current decantation, Flocculation, Filtration and centrifugation, Solvent Extraction: Basic principle of solvent extraction, Partition coefficient and distribution ratio, Separation coefficient, Types of extractants and extraction mechanism of metals, Membrane Separation Technique: Salient features of membrane separation, Different types of membrane separation, Supported liquid membrane, Extraction mechanism of liquid membrane, hollow fiber membrane, Reverse osmosis, Nano-filtration, Ultra-filtration, Transport equations. Electro Chemistry: Principles of Electrowinning, Effect of impurities on electrowinning, electrorefining, Preparation of energy materials, electro organic Chemicals, Electro-inorganic Chemicals, Fused salt electrolysis.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IMMT, Bhubaneswar			
Course Nomenclature	CHE-IMMT-3-3302			
Course Title	Advanced Self Study on Special topic 4C			
Credit Distribution (L-T-P-C)	3	0	2	4
Core/Elective				

Course Description:

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IMMT, Bhubaneswar			
Course Nomenclature	CHE-IMMT-4-3301			
Course Title	Project Proposal writing & presentation			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective				

### Course Description:

Formulation of a project proposal by selecting topics of high relevance and novelty and will have state-of-the-art review, methodologies, recommendations etc. in specified format in a holistic manner preferably candidate's own research work suitable for submission to appropriate funding agencies.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IMMT, Bhubaneswar			
Course Nomenclature	CHE-IMMT-4-3302			
Course Title	Review Article			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective				

### Course Description:

Preparation of one review article on specific research area of the student.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-IMMT, Bhubaneswar			
Course Nomenclature	CHE-IMMT-4-3303			
Course Title	CSIR-800 Societal Program			
Credit Distribution (L-T-P-C)	0	0	8	4
Core/Elective				

### Course Description:

The students have to undertake a project in rural areas for 6-8 weeks in the line with CSIR-800 programme which is primarily prepared at empowering 800 million Indians by way of S&T inventions. The theme for the project may be chosen from CSIR-800 documents and as per expertise available in the laboratory. Students will select the topics in consultation with Doctoral Advisory Committee (DAC).

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-1-3701			
Course Title	Research Methodology:			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Compulsory			

### Course Description:

Good laboratory practices, Safety in the laboratory, First Aid in the laboratory, Maintenance of laboratory records, Scientific literature management, Communication skills (scientific writing and presentation), Intellectual property management & planning, Ethics in Science, Computer applications and tools, Statistical methods & Data analysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-1-3702			
Course Title	Analytical Tools and Instrumentation			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Compulsory			

### Course Description:

Thermal methods (TG, DTG, DTA, TMA, DSC), X-ray methods (XRD, XRF, SAXS), NMR (<sup>1</sup>H, <sup>13</sup>C) and other Spectroscopic methods (EPR, IR, UV, Fluorescence), Chromatographic methods (TLC, GC, LC), Mass spectroscopy, Electron Microscopy (SEM, TEM), Electron Probe Micro Analysis (EDS, WDS), Quantitative Analysis (AAS, ICP, CHN)

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-1-3703			
Course Title	Basic mathematics and numerical methods			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Compulsory			

### Course Description:

Determinants and Matrices, Complex Variables, Vector analysis, Infinite Series, Special Functions, Differential Equations, Interpolation and Approximation, Numerical differentiation and Integration, Basic Linux, Introduction to Algorithms, basic programming, Shell and Shell Scripting, Network Computing and Parallel Computing, Matlab/Scilab/Octave/Gnuplot Algorithms, basic programming, Shell and Shell Scripting, Network Computing and Parallel Computing, Matlab/Scilab/Octave/Gnuplot

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-1-3704			
Course Title	Basic Chemistry for Interdisciplinary sciences:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

Basics of inorganic, organic, physical and biochemistry, Nomenclature (IUPAC), molarity, molality and normality, types of bonding, Ionic, covalent and non-bonding interactions, Acids and bases, Atomic structure, periodic table and periodic properties, stoichiometry, chemical reactions and kinetics, solvent effects, functional groups in organic compounds, general named reactions and reaction mechanisms, carbohydrates, lipids, proteins, nucleotides, enzymes, photosynthesis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-1-3705			
Course Title	Introduction to Nanoscience and Nanotechnology			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

General considerations, Introduction, definitions, consequences of size reduction, Properties: structural, thermodynamic, optical, electrical and magnetic properties, Methods of synthesis, Surface modifications, factors governing the stability and assembly, Characterization of nanomaterials, Applications of Nanomaterials

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-1-3706			
Course Title	Introduction to Chemical Biology			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

chemical biology/synthetic biology, Structure, function and chemistry of biological macromolecules including amino acids, proteins, nucleic acids and carbohydrates, Chemical kinetics and thermodynamics in biology, Chemical reactions and chemical diversity in Biology The Chemistry of Enzymes, Lipids, Fats & Steroids, Drug discovery, Drugs from Nature, Drug interaction



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3701			
Course Title	Advanced Physical Chemistry			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Thermodynamics and chemical kinetics, Quantum Mechanics, Atomic structure and spectroscopy, Chemical bonding in diatomics, Chemical applications of group theory, Colloids and Surface science, surfactants, Interface and Interfacial properties, Electrochemistry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3702			
Course Title	Advanced Inorganic Chemistry			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Structure & Bonding in Inorganic Compounds, Chemistry of Coordination Compounds, Symmetry in Chemistry & Group Theory, Main group chemistry, Organometallic chemistry, Electronic Spectra of Transition Metal Compounds, Magneto Chemistry, Metal Cluster Compounds, Inorganic Reaction Mechanism, Electron Transfer Reactions in Metal Complexes, Bioinorganic Chemistry (Metalloenzymes, Metal complexes as oxygen carriers, Photosynthesis), Metal Complexes in Medicinal Chemistry, Catalysis by Inorganic Complexes.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3703			
Course Title	Advanced Organic Chemistry			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Stereochemistry, reaction mechanism, C-C and C-X bond formations, Retrosynthetic analysis, photochemistry, pericyclic reactions, reactive intermediates, Methods of asymmetric synthesis and their application in total synthesis, oxidation-reduction reactions, organocatalysis, metathesis reactions.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3704			
Course Title	Advanced Analytical Chemistry			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Analytical instrumentation, signal and noise, Overview of optical methods of analysis: Components of optical instruments, atomic and molecular spectrometry based on absorption, emission and scattering, Electroanalytical techniques (basic electrochemistry, voltammetry, potentiometry), Analytical separations and introduction to chromatographic methods, GC, LC, Mass spectrometry, electromigration techniques, hyphenated techniques, detectors, Analytical tools for petroleum refining.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3705			
Course Title	Advanced Quantum Mechanics			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Revision of Hydrogen atom and particle in box (1D and 3D), Approximate methods in quantum mechanics; Non degenerate perturbation; Perturbation treatment of the Helium atom ground state and first excited state; Variation method for Helium atom ground state; Comparison of perturbation and variation method, Structure of many electron wave function, Antisymmetry, Valence bond theory for homo and hetero nuclear diatomic molecules; Molecular orbital theory Comparison of MO and VB theory; Introduction to density functional theory; Hartree Fock theory, Overview of methods beyond Hartree Fock theory; Configuration Interaction; Many body perturbation; Coupled cluster

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3706			
Course Title	Advanced Organometallic Chemistry			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Fundamentals, The 18 Valence Electron Rule; Structure and bonding of organometallic complexes using molecular orbital theory.  $\sigma$ -Donor Ligands: Transition-Metal-Alkyl and -Aryl compounds;  $\sigma$ -Donor/ $\pi$  – Acceptor Ligands: Transition-Metal-Alkenyl, -Aryl and –Alkynyl Complexes, Transition-Metal-Carbenes (Fischer and Schrock Carbenes); Metal Carbonyl; Structure, properties and principal reaction types of the above complexes;  $\sigma$ ,  $\pi$  -Donor/ $\pi$  –Acceptor Ligands: Olefin Complexes; Alkyne, Allyl and Enyl Complexes, Complexes of the cyclic  $C_nH_n$ , Fundamental Mechanism of Organometallic Transformations: Oxidative addition, Migratory Insertion,  $\beta$ -hydride elimination and reductive elimination; Interaction of C-C and C-H  $\sigma$ -bonds with Transition Metals

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3707			
Course Title	Advanced Photochemistry			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Introduction to photochemistry, excited state processes, fluorescence and phosphorescence, quantum yields, charge-transfer spectra, solvatochromism, photochromism, transient absorption techniques, Luminescence emission lifetimes, two- and multiphoton processes, photoinduced energy and electron transfer, FRET, fluorescence polarization, excimers, exciplexes, delayed fluorescence, Photochemistry of Organic chromophores. Photochemistry in organized and confined media.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3708			
Course Title	Advanced Polymer Chemistry			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Techniques of polymerization, polymer characterization techniques, Stereochemistry of Polymers, polymer nano-architectures, random and block copolymers, Liquid Crystalline Polymers, Conducting Polymers, Non-linear Polymers, Polymer Blends and Composites, polymer rheology, inorganic, bio and supramolecular polymers



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3709			
Course Title	Advanced Electrochemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Basic electrochemistry concepts, Reference electrodes, Electrochemical Thermodynamics, Kinetics of electron transfer, the Taft equation, Diffusion, Double Layers, electrode Kinetics, the Gibbs adsorption isotherm, the Lippmann equation, infinitely dilute solutions and thermal balance, Electro capillary phenomena, Faradaic vs. capacitive currents, transport properties, potential theory, Electrochemical Techniques, Voltammetry, Reversible and irreversible reactions, Mass transport by convection, rotating electrodes, Equivalent circuits, A.C. voltammetry, Electrolysis methods, Adsorption, Thin layer cells, Electrochemistry of polymers and inorganic solids, Spectroelectrochemistry, Applications.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3710			
Course Title	Advanced Materials Science			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Crystal systems and space groups, Close packing and various simple structure types like AB, AB<sub>2</sub>, AB<sub>3</sub> and complex structural types ABX<sub>3</sub>, AB<sub>2</sub>X<sub>4</sub>, etc. Factors affecting crystal structures, Common preparative methods; X-ray diffraction and Electron microscopy, Defect structures, colour centers, reciprocal lattices, Properties of solids – Band theory, metals, insulators, semiconductors, dielectric and ferroelectric properties, magnetic properties, optical properties, ionic conduction; structure-processing-property correlations.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3711			
Course Title	Advanced Catalysis			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Homogeneous and heterogeneous catalysis, adsorption, diffusion, kinetics, equilibrium and rate expressions; Chiral catalysis, Surface Science in Catalysis, Catalytic Materials; Supports; Active Components, Classes of reactions and types of reactors; Catalyst preparation methods; Characterization of catalysts; Catalysis in super critical media; Brief introduction of organo and electro-catalysis; Structure-activity-property-stability of catalysts, Catalysts in chemical industry, Catalysis in petroleum refining and petrochemicals; Catalysis in the utilization of renewable feed stocks and concepts of sustainable chemistry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3712			
Course Title	Advanced Surface Science			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction to Surface Science - Surface phenomena - Adsorption, Desorption, Adsorption Models, Special properties of surfaces and interfaces, Electronic structure of surfaces, Surface modification and its applications, Nanoscale catalysis and applications, Surface spectroscopy and microscopy tools for nanocatalysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3713			
Course Title	Advanced Separation Science and Technology:			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Resins and membranes for separations, Classification of membranes; electromembrane Processes; Ion-exchange membranes and their applications, Electrodialysis and related processes. Polymer electrolyte membrane and their applications for fuel cells; Water electrolyzer for hydrogen production; Reverse electrodialysis for non-renewable energy from concentration gradient, reverse osmosis, nanofiltration, ultrafiltration, pervaporation and gas separation: Membrane fouling, concentration polarization and other limitations of Pressure-driven membrane technologies.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3714			
Course Title	Advanced Materials Characterization Techniques:			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Optical Microscopy, Electron microscopy: TEM, HRTEM, SEM, STEM, EDX, FIB, e-beam lithography, Scanning probe microscopy: AFM, STM, MFM, confocal, etc, Raman spectroscopy/microscopy, Thermal analysis techniques, Magnetic measurements, Electrical measurements, Spectroscopic ellipsometry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3715			
Course Title	Advances in Nanoscience and Nanotechnology			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Low-dimensional structures: Quantum wells, Quantum wires, and Quantum dots, Nano clusters & Nano crystals, fullerenes, carbon nano tubes and graphene, Nano Composites, synthesis and characterization techniques, Properties at Nano Scales and comparison with bulk materials, fabrication techniques, general applications, nanomaterials in biology.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3716			
Course Title	Advances in Chemical Biology			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Amino Acids, Peptides & Proteins, Design of poly peptides, Peptide hormones and their pharmaceutical significance, Peptide mimetics as therapeutics, Chemistry of Carbohydrates, Nucleic acids, Structure & function of DNA and RNA, Nucleic acid mimetics & their therapeutic applications, Chemistry of Enzymes, Lipids, Fats & Steroids, Drug discovery, Basic principles of medicinal chemistry, Drugs from Nature, Natural products based drug discovery, Kinetics and thermodynamics of biological process, Enzyme Catalysis, consecutive, parallel and competitive reactions in biological systems, Thermodynamics, allosteric effect in biology, types of bonds, hydration and their specific contribution towards specific thermodynamic parameters, enthalpy or entropy, Scatchard analysis, hill plot analysis.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3717			
Course Title	Advanced Biomaterials			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Definition of biomaterials, Surface property requirements of biomaterials, Types of materials used in medicine, Synthesis and surface characterization, Biology of wound healing, foreign body response and tissue remodeling, Molecular and cellular interactions of materials with biological environment, Degradation and long term fate of materials used in medicine, Requirements of biomaterials for biomedical implants, surface coatings, wound dressings, sutures, cardiovascular devices, ophthalmology, dentistry, orthopedics and cosmetic surgeries, Applications in drug delivery and tissue engineering, Standard protocols for testing the efficacy and efficiency of biomaterials, The regulatory environment for biomaterials, Some concepts for design development of common biomaterials.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3718			
Course Title	Green chemistry			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Green chemistry concepts: Basic understanding, scope and interdisciplinary nature of green chemistry; Environmental factors; Carbon credit, Energy efficiency and atom economy, Catalysis and green chemistry, Alternate reaction media and reaction systems, ionic liquids, supercritical fluids, solventless chemistry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3719			
Course Title	Organic reaction mechanisms			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Basics, The concept of Aromaticity, How to write an organic reaction mechanism?, Popular name reactions, Reactive intermediates: Generation, stability, structures and reactivity of carbocation, carbaion, carbene, radicals, benzyne, nitrene, Types of mechanism: classification, limitations examples of aliphatic nucleophilic substitution - aliphatic electrophilic substitution - aromatic nucleophilic substitution - aromatic electrophilic Substitution - types of radical reactions - molecular rearrangements oxidation and reduction; Electrophilic reactions-Friedel crafts reaction, Rieme r Tiemenn reaction, Beckmann rearrangements; nucleophilic reactions- aldol condensation, perkin reaction, benzoin condensation;free radical reaction-halogenation of alkane, addition of HBr on alkene in presence of peroxide;allylic halogenation - using N-Bromo Succinamide (NBS), thermal halogenation of alkene  $\text{CH}_3 - \text{CH} = \text{CH}_2$

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3720			
Course Title	Thermodynamics and Statistical Mechanics			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Introduction: Thermodynamics – A Macroscopic Theory of Matter; Laws of Thermodynamics, Ideal Gas Laws, Specific Heat Capacities; Concept of Free Energy, Hamiltonian Mechanics, Equilibrium Distributions and Ergodic Hypothesis, Ensembles, Thermodynamic Functions and the Distribution Function,  $g(r)$ , Imperfect Gases, Kinetic Theory of Gases, Time Dependent Processes, Phase Transitions

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3721			
Course Title	Composite materials			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Concept of Composite materials, Various types of composites, Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites, Reinforcements/Fibers ,Types of fibres, Multiphase fibers, Whiskers and Flakes, Mechanical properties of fibres, Processing of Advanced composites, Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing; Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering; Carbon – Carbon composites: Knitting, Braiding, Weaving; Polymer matrix composites: Preparation of Moulding compounds and prepregs – hand lay up method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding, Processing and characteristics of nanocomposites, hybrid composites, functionally graded composites, smart and functional composites.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3722			
Course Title	Carbon allotropes			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Ensembles, Thermodynamic Functions and the Distribution Function,  $g(r)$ , Imperfect Gases, Kinetic Theory of Gases, Time Dependent Processes, Phase Transitions

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3723			
Course Title	Organic spectroscopy applications			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Mass spectroscopy, IR spectroscopy, Proton magnetic resonance spectroscopy, Structural assignment by employing NMR techniques, Carbon-13 NMR spectroscopy, Introduction COSY, HSQC, HMBC, NOESY, ROESY, Structural elucidation using 2D-NMR methods

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3724			
Course Title	Surface characterization techniques			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

XPS, LEED, XAS, SEM, AFM, TEM, NSOM, SPR, SERS, static and dynamic contact angle measurements, Ellipsometry.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-2-3725			
Course Title	Organic Biomolecular Chemistry			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Peptidomimetics, Molecular Recognition & Self-assembly, The Bio-organic Chemistry of Carbohydrates, Nucleic acids, chemistry of lipids, Organic Medicinal Chemistry and Drug Discovery

## Chemical Sciences Coursework PhD

Faculty	CHE			
Lab Name	NCL			
Course Nomenclature	CHE-NCL-2-3726			
Course Title	Physical Organic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Hammett concepts-Quantitative structure activity relationships, linear free energy relationships, Molecular mechanics, Semi-empirical and ab initio molecular theory, Pericyclic Reactions; Substituent Effects; Frontier Molecular Orbitals, HOMO-LUMO Interactions, Aromaticity, Odd and Even Alternant Hydrocarbons, Pericyclic Reactions The Woodward-Hoffman Rules.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3701			
Course Title	Mathematical Methods			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Structural assignment by employing NMR techniques, Carbon-13 NMR spectroscopy, Introduction COSY, HSQC, HMBC, NOESY, ROESY, Structural elucidation using 2D-NMR methods

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3702			
Course Title	Numerical Methods			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Fortran and Linux basics, Solution to the linear algebraic equations, Eigen Values problems, Interpolation and extrapolation, Random number and sorting, Minimization and maximization of functions, Modeling of data

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3703			
Course Title	Electronic structure theory			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Post-Hartree-Fock methods: Moller-Plesset perturbation theory (MP2, MP3, and MP4), Configuration Interaction (CI), Coupled-Cluster single double (triple) (CCSD(T))– performance of various methods for the prediction of van der Waal and hydrogen bonding interactions, spectral properties. Density functional theory based methods: Hybrid and Minnesota functional – Application of DFT methods (excitation energy calculations). Density functional methods with Dispersion correction (Grimme's approaches). Car-Parrinello Molecular Dynamics (CPMD) and Born-Oppenheimer Molecular Dynamics (BOMD).

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3704			
Course Title	Molecular modeling and simulation			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Molecular Mechanics: Features of molecular mechanics - Force Fields: Bonds structure and bending angles, Electrostatic Vander Waals and non-bonded interactions, Hydrogen bonding - Derivatives of molecular mechanics energy function - Calculating thermodynamic properties - Force Field for inorganic systems - Energy minimization, Molecular Dynamics Simulation: Molecular Dynamics using simple models, Molecular Dynamics with continuous potentials, Solvent effects, Conformational changes, Thermostats, Barostas, Lincs and shake algorithms, Monte Carlo simulation Methods, sorption, Applications of Molecular Modeling

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3705			
Course Title	Computational materials design			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Solids, Drude and Sommerfield theories of metals, Kronig-Penning model, Tight-Binding approximation, band structure, density of states, prediction of electrical and magnetic properties, Prediction of properties of organic molecules and polymers, Introduction to Multiscale Modeling and Simulations and applications. Monte Carlo simulation in various ensembles, Gas sensing properties of various porous materials using grand canonical Monte Carlo method, Dissipative particle dynamics, Mesoscale dynamics and applications.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3706			
Course Title	Carbohydrate chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Mono and disaccharides, polysaccharides, Bacterial polysaccharides, starch and cellulose, derivatives of cellulose, Protecting groups, Glycosylation reactions, Dynamics and interactions, carboxy methyl cellulose and gun cotton, structure, Conformational analyses, glycoconjugates, Immunology of carbohydrates.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3707			
Course Title	Chemistry and biology of Heterocycles			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Privileged heterocycles, Electronic properties, reactivity (electrophilicity and nucleophilicity), Synthetic methodologies, Biological properties of Natural products and drug candidates, Biosynthesis, Dimeric compounds and related stereochemistry

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3708			
Course Title	Homogeneous Catalysis			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Organometallic Catalysis, Applications in organic synthesis: Olefin Isomerization, C-C Coupling reactions: Heck, Suzuki, Stille and Sonogashira reactions, Alkene and Alkyne Metathesis, C-Heteroatom coupling: Hydroamination, Olefin Oxidation, C-H activation, Oxidation reactions, hydrogenation of Alkenes, Industrial Applications.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3709			
Course Title	Materials and devices for energy conversion			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Design of organic and Inorganic semiconductors, Approaches to process organic semiconductors by covalent and non covalent modifications , band edges and band gaps, Modulation of charge transport properties, kinetics of electron transfer, Design of small molecule dyes for DSSC, Electron transfer at interfaces, Transistors and solar cells, Fabrication of Devices, Device characterisation using dark current, IV curves under illumination, IPCE, Calculation of Voc, Jsc, Vpp, Ipp, FF and Pmax. hybrid solar cells

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3710			
Course Title	Functional Ceramics			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Advanced Electronic Ceramics, high temperature ceramic super conductors, Dielectric ceramics, microwave ceramics, low k materials, SOFC materials, solid-ionic conductors, phosphor materials, Impedance analysis, varistors, sensors, ceramic magnets, thermal shock resistance and super plastic ceramics.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3711			
Course Title	Modern Magnetic Materials			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Types of magnetism, molecular field theory, measurement techniques, magnetoresistance (AMR, GMR, CMR, TMR), hard and soft magnets, New magnetic materials, applications.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3712			
Course Title	Porous structures			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Definitions, Micro-Porous and Mesoporous Solids, Structural Chemistry of Zeolite Framework Types, MOFs, COFs, Synthesis, Structure Determination, Role of the Structure-directing Agents, The Chemistry of Microporous Framework Solids, Adsorption and Diffusion, Catalytic Applications, hydrogen storage, separation, CO<sub>2</sub> sequestration, sensors,

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3713			
Course Title	Electrochemical power sources			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Energy scenario, emissions and global warming, fuel cells, Thermodynamic potentials, electrochemical processes and electrode kinetics, Proton exchange membranes, proton conducting mechanisms, recent advances, Operating conditions, overview of characterization techniques, technical aspects, advantages, materials, significances and challenges, Materials for supercapacitor applications, recent advances in the system development, battery vs. supercapacitor, modern technologies, challenges and prospects.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3714			
Course Title	Alternate energy materials			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Energy scenario, Non-renewable and renewable energy sources; description of renewable sources and their importance. Technologies for biomass energy conversion, Solar energy, Wind Turbines, Geothermal Technologies; Applications; Sustainable sources of hydrogen; Fuel cell technologies; Hydrogen storage and distribution; Applications and feasibility assessment; Science, technology and policy of energy conservation; Strategies for enhancing role of renewable energy.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3715			
Course Title	Hydrogen generation and storage			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Sustainable sources of hydrogen; Fuel cell technologies; Hydrogen storage and distribution; Applications and feasibility assessment; Science, technology and policy of energy conservation; Strategies for enhancing role of renewable energy.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3716			
Course Title	Polymers and Colloidal Solutions			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Intermolecular forces and potentials, Overview of Statistical physics, DLVO theory, charged colloids, Poisson Boltzmann theory, Debye radius, Bjerrum length, electrophoresis, zeta potential, diffusion, Hydrodynamic interactions. Brief overview of Phase transitions in hard sphere colloids, Random walk, self avoiding random walk, flexible polymers, persistence length, Excluded volume interactions, Polymer solutions in the dilute limit/semi-dilute limit, Entropy of mixing, theta temperature, rubber elasticity, Polyelectrolytes, polymer at surfaces: Brushes, polymer dynamics.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3717			
Course Title	Controlled Radical/Living Polymerizations and Macromolecular Architectures			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Controlled or Living Radical Polymerization, TEMPO-mediated polymerization and atom Transfer radical Polymerization (ATRP), Kinetics of ATRP, Reversible Addition Chain Fragmentation Transfer (RAFT), Nitroxide mediated polymerization (NMP), Ring opening Metathesis polymerization (ROMP), living ROP, Macromolecular architectures using controlled living polymerizations

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3718			
Course Title	X-Ray Diffraction and Structure of Solids			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Introduction to X-ray crystallography, Crystal growth, evaluation and mounting, Symmetry and space group determination, Background theory for data collection, Data collection using four-circle diffractometers, Area detectors, Crystal lattices, Structure factors, Crystal symmetry, Structure solutions, Structure refinement, An introduction to maximum entropy, Least squares fitting of parameters, Practical aspects of structure refinement, Crystallographic Database, Structure solution from Powder Diffraction Data

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3719			
Course Title	NMR spectroscopy			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Quantum Mechanics of NMR, Multinuclear NMR spectroscopy, Periodic table of NMR, Heteronuclear double resonance experiments, Magnetization transfer and signal enhancement, NMR of diamagnetic and paramagnetic compounds, Multidimensional NMR: 2D NMR, <sup>1</sup>H-<sup>1</sup>H correlations, Heteronuclear Correlation Spectroscopy, 2D Exchange (EXSY), 2D NOESY, ROESY, DOSY Structure elucidation of small molecules, NMR of macromolecules, Multidimensional NMR Spectra, NMR Spectroscopy of Solids, 2D experiments in solids, semi rigid systems: HR MAS, Magnetic Resonance Imaging: In Vivo NMR, Imaging, MRI, functional MRI, NMR imaging of materials.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3720			
Course Title	Mass spectrometry applications			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Applications to analyze molecular, macromolecular and biological samples, Sample Preparation Protocols, Drug Metabolism and Pharmacokinetics (DMPK), Development of Quantitative analytical methods using mass spectrometry, Application to some model drugs, Metabolomics , Proteomics, GC-MS, LC-MS, MALDI-TOF, GC-TOF, TOF/TOF MS, LC-ESI-MS, Protein Database search (MASCOT), Clinical Mass Spectrometry,

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3721			
Course Title	Small Angle Scattering Techniques			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

SAXS and Fourier Transforms, General Theorems in Small Angle Scattering: Particulate systems: Porod and Guinier regimes, Pair density distribution functions, Single particle form factor for spheres, rods and plates, polydispersity, Structure factors for equilibrium concentrated particulate systems, measured structure factors for systems exhibiting polydispersity, Two phase systems: General Theorems, Detailed analysis of scattering from lamellar systems, relevance to semicrystalline polymers.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3722			
Course Title	Operando Surface Techniques			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Basic aspects of XPS, EELS, XAS, Surface spectroscopy and microscopy tools for catalysis- applications of XPS, XAS, FT-IR, STM etc in exploring catalysis at nanoscale, Surface science techniques at operando conditions –bridging the pressure gap, Electronic structure of surfaces – techniques for probing electronic structure with examples



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3723			
Course Title	Chromatographic Techniques			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

High Performance Liquid Chromatography: Principles and methods in Natural Products; Modern Thin-Layer Chromatography: Practical Aspects and applications; Measuring Diffusion with PFG's; Enantioselective GC in flavor and fragrance Analysis: Strategies for Identification of Plant Volatiles; GC-MS: Applications in Plant Volatile Identification; Analysis of Natural Products by LC-MS; Analysis of Natural Products by LC-MS/MS; Centrifugal Accelerated Radial TLC (Cromotron): Principles and its Applications in Natural Product Separation.; Vacuum Liquid Chromatography: Principles and its Applications in Natural Product Separation.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3724			
Course Title	Equilibrium and non-equilibrium statistical mechanics for soft matter			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Imperfect Gases: The Virial equations Coefficients, Relationship of Thermodynamic Functions to Probability Distribution Functions, Onsagers regression hypothesis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3725			
Course Title	Modern Polymerization Methods for Functional Macromolecules			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Combination of mechanistically distinct polymerization techniques, Incorporation of functionalities into polymers using Click Chemistry, Use of click reactions in combination with above polymerization techniques

## Chemical Sciences Coursework PhD

Faculty	CHE			
Lab Name	NCL			
Course Nomenclature	CHE-NCL-3726			
Course Title	Molecular Self assembly			
Credit Distribution (L-T-P-C)	3	0	0	3
Core/Elective	Elective			

### Course Description:

Basic physical chemistry of self-assembly, Thermodynamics and kinetic factors affecting self-assembly, Self-assembly of small molecules, Non-covalent interactions, Supramolecular chemistry, Crystal engineering, Metal-mediated self-assembly

## Chemical Sciences Coursework PhD

Faculty	CHE			
Lab Name	NCL			
Course Nomenclature	CHE-NCL-3727			
Course Title	Total Synthesis			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Synthesis of complex organic molecules – planning and execution; Concepts of Retrosynthetic Analysis and Total synthesis of Natural products; Retrosynthesis; Disconnection; Synthons; Linear and Convergent Synthesis; Photochemistry in total synthesis; MCRs in total synthesis; Breakthrough synthesis – past and present

## Chemical Sciences Coursework PhD

Faculty	CHE			
Lab Name	NCL			
Course Nomenclature	CHE-NCL-3728			
Course Title	Catalysis in Petroleum Refining			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Deactivation in Catalysts and its Consequences, Regeneration and Rejuvenation in Catalysis, Industrial Catalytic Processes; Hydro cracking; Hydro treating; Reforming; Isomerization and Alkylation; Fluid Catalytic Cracking and Deep Catalytic Cracking, Catalysis for Clean Fuels; Gas to Liquid Technology; Catalysis for Hydrogen Production, Catalysis beyond Petroleum; Electro catalysis; Photo catalysis, Laboratory Training in Catalysis

## Chemical Sciences Coursework PhD

Faculty	CHE			
Lab Name	NCL			
Course Nomenclature	CHE-NCL-3729			
Course Title	Thermochemical Conversion of Biomass			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Thermochemical conversion technologies for biomass pyrolysis, gasification, combustion, thermal and catalytic conversion of biomass; upgradation of pyrolysis products; bio-refining products and applications

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3701			
Course Title	Project proposal writing & presentation			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Compulsory			

### Course Description:

Formulation of a project proposal by selecting topics of high relevance and novelty and will have state-of-the-art review, methodologies, recommendations etc. in specified format in a holistic manner preferably candidate's own research work suitable for submission to appropriate funding agencies.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3702			
Course Title	Review Article			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Compulsory			

### Course Description:

Preparation of one review article on specific research area of the student.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NCL, Pune			
Course Nomenclature	CHE-NCL-3-3703			
Course Title	CSIR-800 Societal Program			
Credit Distribution (L-T-P-C)	0	0	8	4
Core/Elective	Compulsory			

### Course Description:

The students have to undertake a project in rural areas for 6-8 weeks in the line with CSIR-800 programme which is primarily prepared at empowering 800 million Indians by way of S&T inventions. The theme for the project may be chosen from CSIR-800 documents and as per expertise available in the laboratory. Students will select the topics in consultation with Doctoral Advisory Committee (DAC).

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-1-3901			
Course Title	Research Methodology:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	core			

### Course Description:

Good laboratory practices, Safety in the laboratory, First Aid in the laboratory, Maintenance of laboratory records, Scientific literature management, Communication skills (scientific writing and presentation), Intellectual property management & planning, Ethics in Science, Computer applications and tools, Statistical methods & Data analysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-1-3902			
Course Title	Analytical Tools and Instrumentation			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	core			

### Course Description:

Thermal methods (TG, DTG, DTA, TMA, DSC), X-ray methods (XRD, XRF, SAXS), NMR (<sup>1</sup>H, <sup>13</sup>C) and other Spectroscopic methods (EPR, IR, UV, Fluorescence), Chromatographic methods (TLC, GC, LC), Mass spectroscopy, Electron Microscopy (SEM, TEM), Electron Probe Micro Analysis (EDS, WDS), Quantitative Analysis (AAS, ICP, CHN)

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-1-3903			
Course Title	Basic mathematics and numerical methods			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	core			

### Course Description:

Determinants and Matrices, Complex Variables, Vector analysis, Infinite Series, Special Functions, Differential Equations, Interpolation and Approximation, Numerical differentiation and Integration, Basic Linux, Introduction to Algorithms, basic programming, Shell and Shell Scripting, Network Computing and Parallel Computing, Matlab/Scilab/Octave/Gnuplot Algorithms, basic programming, Shell and Shell Scripting, Network Computing and Parallel Computing, Matlab/Scilab/Octave/Gnuplot

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-1-3904			
Course Title	Basic Chemistry for Interdisciplinary sciences:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

Basics of inorganic, organic, physical and biochemistry, Nomenclature (IUPAC), molarity, molality and normality, types of bonding, Ionic, covalent and non-bonding interactions, Acids and bases, Atomic structure, periodic table and periodic properties, stoichiometry, chemical reactions and kinetics, solvent effects, functional groups in organic compounds, general named reactions and reaction mechanisms, carbohydrates, lipids, proteins, nucleotides, enzymes, photosynthesis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-1-3905			
Course Title	Introduction to Nanoscience and Nanotechnology			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

General considerations, Introduction, definitions, consequences of size reduction, Properties: structural, thermodynamic, optical, electrical and magnetic properties, Methods of synthesis, Surface modifications, factors governing the stability and assembly, Characterization of nanomaterials, Applications of Nanomaterials

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-1-3906			
Course Title	Introduction to Chemical Biology			
Credit Distribution (L-T-P-C)				
Core/Elective	Optional			

### Course Description:

chemical biology/synthetic biology, Structure, function and chemistry of biological macromolecules including amino acids, proteins, nucleic acids and carbohydrates, Chemical kinetics and thermodynamics in biology, Chemical reactions and chemical diversity in Biology The Chemistry of Enzymes, Lipids, Fats & Steroids, Drug discovery, Drugs from Nature, Drug interaction



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3901			
Course Title	Advanced Physical Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Thermodynamics and chemical kinetics, Quantum Mechanics, Atomic structure and spectroscopy, Chemical bonding in diatomics, Chemical applications of group theory, Colloids and Surface science, surfactants, Interface and Interfacial properties, Electrochemistry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3902			
Course Title	Advanced Inorganic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Structure & Bonding in Inorganic Compounds, Chemistry of Coordination Compounds, Symmetry in Chemistry & Group Theory, Main group chemistry, Organometallic chemistry, Electronic Spectra of Transition Metal Compounds, Magneto Chemistry, Metal Cluster Compounds, Inorganic Reaction Mechanism, Electron Transfer Reactions in Metal Complexes, Bioinorganic Chemistry (Metalloenzymes, Metal complexes as oxygen carriers, Photosynthesis), Metal Complexes in Medicinal Chemistry, Catalysis by Inorganic Complexes.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3903			
Course Title	Advanced Organic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Stereochemistry, reaction mechanism, C-C and C-X bond formations, Retrosynthetic analysis, photochemistry, pericyclic reactions, reactive intermediates, Methods of asymmetric synthesis and their application in total synthesis, oxidation-reduction reactions, organocatalysis, metathesis reactions.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3904			
Course Title	Advanced Analytical Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Analytical instrumentation, signal and noise, Overview of optical methods of analysis: Components of optical instruments, atomic and molecular spectrometry based on absorption, emission and scattering, Electroanalytical techniques (basic electrochemistry, voltammetry, potentiometry), Analytical separations and introduction to chromatographic methods, GC, LC, Mass spectrometry, electromigration techniques, hyphenated techniques, detectors, Analytical tools for petroleum refining.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3905			
Course Title	Advanced Organometallic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Fundamentals, The 18 Valence Electron Rule; Structure and bonding of organometallic complexes using molecular orbital theory.  $\sigma$ -Donor Ligands: Transition-Metal-Alkyl and -Aryl compounds;  $\sigma$ -Donor/ $\pi$  – Acceptor Ligands: Transition-Metal-Alkenyl, -Aryl and –Alkynyl Complexes, Transition-Metal-Carbenes (Fischer and Schrock Carbenes); Metal Carbonyl; Structure, properties and principal reaction types of the above complexes;  $\sigma$ ,  $\pi$  -Donor/ $\pi$  –Acceptor Ligands: Olefin Complexes; Alkyne, Allyl and Enyl Complexes, Complexes of the cyclic  $C_nH_n$ , Fundamental Mechanism of Organometallic Transformations: Oxidative addition, Migratory Insertion,  $\beta$ -hydride elimination and reductive elimination; Interaction of C-C and C-H  $\sigma$ -bonds with Transition Metals

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3906			
Course Title	Advanced Coordination Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Naming of coordination compounds, classification of ligands, chelate and macrocyclic effect, Theories dealing with the formation of Coordination Compounds, Spectrochemical Series; Splitting of d-orbitals, Jahn–Teller Effect; Stability constants of Transition metal complexes and their determination by Job's Method. Spin–Orbit Coupling, Electronic states and term symbols, Selection rules (Laporte and spin selection rule), Interpretation of electronic spectra of Transition metal complexes, Orgel and Tanabe Sugano diagrams. Charge Transfer spectra, Magnetic Properties of Transition elements, Chemistry of Inner Transition Elements.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3907			
Course Title	Advanced Polymer Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Techniques of polymerization, polymer characterization techniques, Stereochemistry of Polymers, polymer nano-architectures, random and block copolymers, Liquid Crystalline Polymers, Conducting Polymers, Non-linear Polymers, Polymer Blends and Composites, polymer rheology, inorganic, bio and supramolecular polymers

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3908			
Course Title	Advanced Electrochemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Basic electrochemistry concepts, Reference electrodes, Electrochemical Thermodynamics, Kinetics of electron transfer, the Taft equation, Diffusion, Double Layers, electrode Kinetics, the Gibbs adsorption isotherm, the Lippmann equation, infinitely dilute solutions and thermal balance, Electro capillary phenomena, Faradaic vs. capacitive currents, transport properties, potential theory, Electrochemical Techniques, Voltammetry, Reversible and irreversible reactions, Mass transport by convection, rotating electrodes, Equivalent circuits, A.C. voltammetry, Electrolysis methods, Adsorption, Thin layer cells, Electrochemistry of polymers and inorganic solids, Spectroelectrochemistry, Applications.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3909			
Course Title	Advances in Bioinorganic chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Metal ions in biology, structure and function of metallo-proteins and enzymes, Communication role for metals in biology. Heme and non-heme systems with one-, two- or multi-metal, photosynthesis and photosystem II; O<sub>2</sub>-binding, reduction to O<sub>2</sub><sup>-</sup>, O<sub>2</sub><sup>2-</sup>, and O<sub>2</sub>-species their utilization in hydroxylation and epoxidation; nitrogen fixation, water-oxidation reactions. Synthetic models, Correlation with structure and function of the natural enzymes, design and synthesis, mechanisms. Metal based drugs, Porphyrins, Corrins, hydroporphyrins.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3910			
Course Title	Advances in hydrocarbon chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Chemistry of crude oil, thermal cracking, visbreaking and coking processes, catalytic cracking, hydro cracking and hydrogen production processes, catalytic reforming process, Chemistry and industrial processes for alkylates, isomerisation processes, Petrochemicals, Basic Building blocks; C1-Chemistry; Petrochemicals from n-paraffins; Petrochemicals from olefins and aromatics; Refinery-Petrochemical Integration, Future Prospects

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3911			
Course Title	Advanced Catalysis			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Homogeneous and heterogeneous catalysis, adsorption, diffusion, kinetics, equilibrium and rate expressions; Chiral catalysis, Surface Science in Catalysis, Catalytic Materials; Supports; Active Components, Classes of reactions and types of reactors; Catalyst preparation methods; Characterization of catalysts; Catalysis in super critical media; Brief introduction of organo and electro-catalysis; Structure-activity-property-stability of catalysts, Catalysts in chemical industry, Catalysis in petroleum refining and petrochemicals; Catalysis in the utilization of renewable feed stocks and concepts of sustainable chemistry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3912			
Course Title	Advanced Surface Science			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction to Surface Science - Surface phenomena - Adsorption, Desorption, Adsorption Models, Special properties of surfaces and interfaces, Electronic structure of surfaces, Surface modification and its applications, Nanoscale catalysis and applications, Surface spectroscopy and microscopy tools for nanocatalysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3913			
Course Title	Advanced Materials Characterization Techniques:			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Optical Microscopy, Electron microscopy: TEM, HRTEM, SEM, STEM, EDX, FIB, e-beam lithography, Scanning probe microscopy: AFM, STM, MFM, confocal, etc, Raman spectroscopy/microscopy, Thermal analysis techniques, Magnetic measurements, Electrical measurements, Spectroscopic ellipsometry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3914			
Course Title	Advances in Nanoscience and Nanotechnology			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Low-dimensional structures: Quantum wells, Quantum wires, and Quantum dots, Nano clusters & Nano crystals, fullerenes, carbon nano tubes and graphene, Nano Composites, synthesis and characterization techniques, Properties at Nano Scales and comparison with bulk materials, fabrication techniques, general applications, nanomaterials in biology.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3915			
Course Title	Advances in Chemical Biology			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Amino Acids, Peptides & Proteins, Design of poly peptides, Peptide hormones and their pharmaceutical significance, Peptide mimetics as therapeutics, Chemistry of Carbohydrates, Nucleic acids, Structure & function of DNA and RNA, Nucleic acid mimetics & their therapeutic applications, Chemistry of Enzymes, Lipids, Fats & Steroids, Drug discovery, Basic principles of medicinal chemistry, Drugs from Nature, Natural products based drug discovery, Kinetics and thermodynamics of biological process, Enzyme Catalysis, consecutive, parallel and competitive reactions in biological systems, Thermodynamics, allosteric effect in biology, types of bonds, hydration and their specific contribution towards specific thermodynamic parameters, enthalpy or entropy, Scatchard analysis, hill plot analysis.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3916			
Course Title	Sol-gel chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction, Hydrolysis and condensation reactions, Solution chemistry and physics of intermediates, Role of the anion on the hydrolysis and condensation reactions, Kinetics of Hydrolysis and Condensation, Non-Hydrolytic Sol-Gel Processing, Gelation, Ageing, Drying, Densification, Characterization, Chemistry of Sol-Gel Silicates, Solution chemistry of transition metal alkoxide precursors, Sol-gel synthesis and characterization of important materials, structure-property relationships



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3917			
Course Title	Green chemistry			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Green chemistry concepts: Basic understanding, scope and interdisciplinary nature of green chemistry; Environmental factors; Carbon credit, Energy efficiency and atom economy, Catalysis and green chemistry, Alternate reaction media and reaction systems, ionic liquids, supercritical fluids, solventless chemistry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3918			
Course Title	Coal chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Mining processes, mine safety, Sampling methods of coal and its importance, Coal classification systems, Physical characterization, proximate analysis, Ultimate analysis, Sulphur analysis, Ash fusion temperature, Low temperature Carbonization, Swell Index, Cracking Index , Thermogravimetric analysis etc, Size Reduction and Size Classification of Coal, Structure of coal, Organic functionality of coal, aromatic Index, Mineral matter content, Mineralogy of coal, Geological origin of coal, petrographic analysis, geochemical processes during mining of coals, Coal Utilization, Coal Conversion processes, Other useful products from coal, Environmental Issues, CO<sub>2</sub> sequestration.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3919			
Course Title	Alternative feedstock options for petrochemicals			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Global scenario of Petrochemicals, Renewable resources; categorization of resources; chemicals from edible renewable resource; Chemicals from non-edible renewable resources; Catalytic reactions (mineral acid, bases; enzymes, homogeneous and heterogeneous catalysts); alternate fuels; fuels derived from renewable resources; biodiesel, bioethanol, biobutanol; Hydrogen generation from renewable feed stocks, Conversion of glycerol; Naphtha as a conventional source, Need for sustainability in production of Petrochemicals, Alternate Options; from Refineries sources, Natural Gas/Methane as an Option and other Non Refinery Sources, CO<sub>2</sub> utilization, Identification and Recommendations based on techno-economic analysis for India.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3920			
Course Title	Natural products			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Carbohydrates and polysaccharides, Structure and functions of important derivatives of monosaccharides, Classification and nomenclature and synthesis of some simple Alkaloids; Terpenoids and Steroids such as pinene; Camphor and Cadenine;  $\alpha$ -vetinone; Hirsutene and Abietic acid (Terpenoids); Cholesterol; Testosterone and Andestrone (Steroids) etc. isolation and characterization, elucidation of structure-property relationships. Biosynthesis of steroids, terpenoids, fatty acids, alkaloids and polysaccharides, biosynthesis of natural products

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3921			
Course Title	Ionic liquids			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Introduction to ionic liquids, ionic liquids vs. molecular solvents/ionic salts (solids), ionic liquids vs. eutectic mixtures, solvent polarities using different spectral techniques (parameters), physicochemical properties of ionic liquids, effect of functional groups on the properties of ionic liquids, surface active ionic liquids, aggregation behavior of ionic liquids, interaction of ionic liquids with different molecular solvents, interaction of ionic liquids with biopolymers, thermodynamics of the binary mixtures of ionic liquids, structure property relationship in ionic liquids.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3922			
Course Title	Synthetic methods for organic chemists			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Formation of carbon-carbon bond employing various kinds of organometallic reagents, C-C double bonds through different reactions, oxidation, reduction through various kinds of reagents, functional group interconversion, by substitution including protection and deprotection, alkylation of enolates, and other carbon nucleophiles, reaction of carbon nucleophiles with carbonyl compounds, electrophilic addition to C-C multiple bonds, reactions of C-C multiple bonds, Retrosynthesis, disconnection, synthons, linear and convergent synthesis, umpolung of reactivity and protecting groups.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3923			
Course Title	Organic reaction mechanisms			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Basics, The concept of Aromaticity, How to write an organic reaction mechanism?, Popular name reactions, Reactive intermediates: Generation, stability, structures and reactivity of carbocation, carbaion, carbene, radicals, benzyne, nitrene, Types of mechanism: classification, limitations examples of aliphatic nucleophilic substitution - aliphatic electrophilic substitution - aromatic nucleophilic substitution - aromatic electrophilic Substitution - types of radical reactions - molecular rearrangements oxidation and reduction; Electrophilic reactions-Friedel crafts reaction, Rieme r Tiemenn reaction, Beckmann rearrangements; nucleophilic reactions- aldol condensation, perkin reaction, benzoin condensation;free radical reaction-halogenation of alkane, addition of HBr on alkene in presence of peroxide;allylic halogenation - using N-Bromo Succinamide (NBS), thermal halogenation of alkene  $\text{CH}_3 - \text{CH} = \text{CH}_2$

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3924			
Course Title	Physical organic chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Hammett concepts-Quantitative structure activity relationships, linear free energy relationships, Molecular mechanics, Semi-empirical and ab initio molecular theory, Pericyclic Reactions; Substituent Effects; Frontier Molecular Orbitals, HOMO-LUMO Interactions, Aromaticity, Odd and Even Alternant Hydrocarbons, Pericyclic Reactions The Woodward-Hoffman Rules. Free Energy Changes, Transition State Theory, The Eyring Equation, The Mechanistic Significance of Kinetic versus Thermodynamic Control of Organic Reactions, The Hammond Postulate, The Curtin-Hammett Principle; Kinetic Isotope Effects, The Reactivity-Selectivity Principle, Substituent Effects, Absorption of Light by Organic Molecules, Jablonsky Diagrams, Morse Potential Energy Curves, Common Photochemical Reactions, Photocycloadditions.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3925			
Course Title	Composite materials			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Concept of Composite materials, Various types of composites, Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites, Reinforcements/Fibers ,Types of fibres, Multiphase fibers, Whiskers and Flakes, Mechanical properties of fibres, Processing of Advanced composites, Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing; Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering; Carbon – Carbon composites: Knitting, Braiding, Weaving; Polymer matrix composites: Preparation of Moulding compounds and prepregs – hand lay up method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding, Processing and characteristics of nanocomposites, hybrid composites, functionally graded composites, smart and functional composites

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3926			
Course Title	Carbon allotropes			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Synthesis, characterization, structure, properties and applications of: Diamond, Graphite, Amorphous carbon, Charcoals, Fullerene and related compounds, Carbon nanotubes, Graphene.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3927			
Course Title	Organic spectroscopy applications			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Mass spectroscopy, IR spectroscopy, Proton magnetic resonance spectroscopy, Structural assignment by employing NMR techniques, Carbon-13 NMR spectroscopy, Introduction COSY, HSQC, HMBC, NOESY, ROESY, Structural elucidation using 2D-NMR methods

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3928			
Course Title	Surface characterization techniques			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

XPS, LEED, XAS, SEM, AFM, TEM, NSOM, SPR, SERS, static and dynamic contact angle measurements, Ellipsometry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-2-3929			
Course Title	Oil Field Materials and Operations			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Oil well drilling, Clay based and oil based drilling fluids, clay structure and chemistry, Drilling Chemicals, Oil well cementing, formation of damage, Oil well simulation, Water injection, polymer flooding, Water shut off, EOR Chemicals, Fracturing Chemicals and Materials, Environmental aspects related to oil filed.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-3-3901			
Course Title	Computer aided drug design			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Definition of a drug molecule and factor affecting their biological activity, definition of chemotherapeutic index, therapeutic index, design of a drug molecule and relationship of functional groups, discovery of new drugs: drug discovery without a lead, lead discovery, random screen, non-random screen, concept of absorption, distribution, metabolism, and excretion (ADME), drug receptors, physicochemical properties, mechanism of a drug action, stereochemistry and drug action, synthetic and natural drugs and their modifications to increase oral bioavailability, chirality and drug action, bioisosterism, drug receptor-interactions, topographical and stereo-chemical considerations, concept of drug resistance, drug synergism, enzyme inhibition and activation, molecular modeling and insilico drug design, concept of structure-activity relationship(SAR) and quantitative structure-activity relationship (QSAR), Lipinski rule of five, mechanism of action of some important drug molecules.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-3-3902			
Course Title	Carbohydrate chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Mono and disaccharides, polysaccharides, Bacterial polysaccharides, starch and cellulose, derivatives of cellulose, Protecting groups, Glycosylation reactions, Dynamics and interactions, carboxy methyl cellulose and gun cotton, structure, Conformational analyses, glycoconjugates, Immunology of carbohydrates.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-3-3903			
Course Title	Total Synthesis			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Synthesis of complex organic molecules – planning and execution; Concepts of Retrosynthetic Analysis and Total synthesis of Natural products; Retrosynthesis; Disconnection; Synthons; Linear and Convergent Synthesis; Photochemistry in total synthesis; MCRs in total synthesis; Breakthrough synthesis – past and present.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-3-3904			
Course Title	Asymmetric Synthesis			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Strategies for the preparation of optically pure compounds; Stereoselective, Enantioselective and Diastereoselective reactions; Stoichiometric asymmetric synthesis-chiral auxiliaries, Evans Alsdol and modified versions; Catalytic asymmetric synthesis; Asymmetric Dihydroxylation; Asymmetric Aminohydroxylation; Asymmetric Hydrogenation; Asymmetric allylation, propargylation, and alkylation; Chiral Organocatalysis; Cascade reactions by organocatalysis; Transition Metal based catalysis; Asymmetric amplification and autocatalysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-3-3905			
Course Title	Chemistry and biology of Heterocycles			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Privileged heterocycles, Electronic properties, reactivity (electrophilicity and nucleophilicity), Synthetic methodologies, Biological properties of Natural products and drug candidates, Biosynthesis, Dimeric compounds and related stereochemistry

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-3-3906			
Course Title	Fluoro organic chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Importance of fluorine in organic compounds, Strategies to introduce fluorine/ trifluoromethyl group into organic molecules, Preparation of fluorinated reagents, Preparation of fluorinated carbon materials and their uses, Known fluorinated drugs and their mode of action, Overview on CFCs, HCFCs, HFCs, their preparation and applications, Halon susbsitutes, Harmful effects of fluorine and inorganic fluorides

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-3-3907			
Course Title	Nutraceuticals			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Raw material preparation, and characterization, extraction of valuable biomolecules, characterization of these molecules with stability study, preparation and formulations for functional foods. Characterization and stability study of nutraceuticals, properties and stability packaging of nutraceuticals.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-3-3908			
Course Title	Homogeneous Catalysis			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Organometallic Catalysis, Applications in organic synthesis: Olefin Isomerization, C-C Coupling reactions: Heck, Suzuki, Stille and Sonogashira reactions, Alkene and Alkyne Metathesis, C-Heteroatom coupling: Hydroamination, Olefin Oxidation, C-H activation, Oxidation reactions, hydrogenation of Alkenes, Industrial Applications.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-3-3909			
Course Title	Catalysis for organic synthesis			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

A background on fine and specialty chemicals in chemical industry; Concept of atom economy; Homogeneous and heterogeneous catalytic reactions: hydrogenation, hydrogenolysis, dehydrogenation, selective oxidation, alkylation & acylation, isomerization and C-C bond forming reactions, Enzyme catalysis in organic synthesis; Reaction mechanisms

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-3-3910			
Course Title	Functional Ceramics			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Advanced Electronic Ceramics, high temperature ceramic super conductors, Dielectric ceramics, microwave ceramics, low k materials, SOFC materials, solid-ionic conductors, phosphor materials, Impedance analysis, varistors, sensors, ceramic magnets, thermal shock resistance and super plastic ceramics.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-3-3911			
Course Title	Porous structures			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Definitions, Micro-Porous and Mesoporous Solids, Structural Chemistry of Zeolite Framework Types, MOFs, COFs, Synthesis, Structure Determination, Role of the Structure-directing Agents, The Chemistry of Microporous Framework Solids, Adsorption and Diffusion, Catalytic Applications, hydrogen storage, separation, CO<sub>2</sub> sequestration, sensors,



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-3-3912			
Course Title	Alternate energy materials			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Energy scenario, Non-renewable and renewable energy sources; description of renewable sources and their importance. Technologies for biomass energy conversion, Solar energy, Wind Turbines, Geothermal Technologies; Applications; Sustainable sources of hydrogen; Fuel cell technologies; Hydrogen storage and distribution; Applications and feasibility assessment; Science, technology and policy of energy conservation; Strategies for enhancing role of renewable energy.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-3-3913			
Course Title	Natural gas to liquid fuels			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

generation processes; SMR; POx; ATR; DMR and Tri reforming, Syngas conversion processes; FT Synthesis, LTFT, HTFT, Low Pressure versus high pressure FT, Syn-crude up gradation by hydrocracking, methanol synthesis, chemistry of the processes; catalysts, development in reactors; tubular; multitubular; fixed bed; fluidized bed; FFB; CFB, SBCR, variables affecting SCBR, Commercial Processes; MTO; UOP/Hydro MTO; Exxon Mobil MTO; Lurgi MTP, DME Synthesis, status and prospects of DME production; Challenges for DME commercialization, commercialization activities of GTL plants, SSPD, SMDS, AGC- 21 and Gasel Processes

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-3-3914			
Course Title	Block copolymers			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Chain and controlled block copolymerization, monomer reactivity ratios, Copolymer compositions, molecular architecture, blends, grafts, melts, self assembly and phase separation, phase diagram, range of applicability of copolymerization equation; types of copolymerization; Block copolymers with controlled molecular weight, Living Polymerization, block copolymer synthesis, characterization techniques, block copolymers for biomedical and industrial applications, Amphiphilic block copolymer micelles, Block copolymer thin films.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-3-3915			
Course Title	Conducting polymers			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Synthesis and characterization, electrical transport properties, theory of conductivity, doping, electrochromic properties, Classification and types of organic conductors, Structure and properties of conducting charge-transfer salts, Conducting polymers based on organometallic compounds, Applications of conducting polymers, EMI shielding, supercapacitors, sensors

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-3-3916			
Course Title	Polymers and Colloidal Solutions			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Intermolecular forces and potentials, Overview of Statistical physics, DLVO theory, charged colloids, Poisson Boltzmann theory, Debye radius, Bjerrum length, electrophoresis, zeta potential, diffusion, Hydrodynamic interactions. Brief overview of Phase transitions in hard sphere colloids, Random walk, self avoiding random walk, flexible polymers, persistence length, Excluded volume interactions, Polymer solutions in the dilute limit/semi-dilute limit, Entropy of mixing, theta temperature, rubber elasticity, Polyelectrolytes, polymer at surfaces: Brushes, polymer dynamics.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-3-3917			
Course Title	Biodegradable polymers			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Polymers from biomass, microbial production, synthetic polymers, structure and properties, Biodegradation mechanism, measurement techniques, processing techniques, sterilization and storage, global standards, market potential, applications.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-3-3918			
Course Title	Controlled Radical/Living Polymerizations and Macromolecular Architectures			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Controlled or Living Radical Polymerization, TEMPO-mediated polymerization and atom Transfer radical Polymerization (ATRP), Kinetics of ATRP, Reversible Addition Chain Fragmentation Transfer (RAFT), Nitroxide mediated polymerization (NMP), Ring opening Metathesis polymerization (ROMP), living ROP, Macromolecular architectures using controlled living polymerizations

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-3-3919			
Course Title	X-Ray Diffraction and Structure of Solids			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction to X-ray crystallography, Crystal growth, evaluation and mounting, Symmetry and space group determination, Background theory for data collection, Data collection using four-circle diffractometers, Area detectors, Crystal lattices, Structure factors, Crystal symmetry, Structure solutions, Structure refinement, An introduction to maximum entropy, Least squares fitting of parameters, Practical aspects of structure refinement, Crystallographic Database, Structure solution from Powder Diffraction Data



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-3-3920			
Course Title	NMR spectroscopy			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Quantum Mechanics of NMR, Multinuclear NMR spectroscopy, Periodic table of NMR, Heteronuclear double resonance experiments, Magnetization transfer and signal enhancement, NMR of diamagnetic and paramagnetic compounds, Multidimensional NMR: 2D NMR, <sup>1</sup>H-<sup>1</sup>H correlations, Heteronuclear Correlation Spectroscopy, 2D Exchange (EXSY), 2D NOESY, ROESY, DOSY Structure elucidation of small molecules, NMR of macromolecules, Multidimensional NMR Spectra, NMR Spectroscopy of Solids, 2D experiments in solids, semi rigid systems: HR MAS, Magnetic Resonance Imaging: In Vivo NMR, Imaging, MRI, functional MRI, NMR imaging of materials.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-3-3921			
Course Title	Natural products and drug discovery			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Natural products: Importance, lead, clinical trials in drug discovery research, Case studies of marketed natural product drugs, Synthetic Biology and Genetic engineering in the production of natural product, A brief overview of drug discovery approach, Cause of diseases, Target identification, Target validation, Modeling, Synthesis and SAR, Drug Delivery, Clinical Trials, Etiology, pathogenesis, prevention, drug targets and chemotherapy, drug resistance and remedies of tropical infectious diseases, Etiology and remedies of diseases developed through metabolic disorders.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-4-3901			
Course Title	Project proposal writing & presentation			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Formulation of a project proposal by selecting topics of high relevance and novelty and will have state-of-the-art review, methodologies, recommendations etc. in specified format in a holistic manner preferably candidate's own research work suitable for submission to appropriate funding agencies.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-4-3902			
Course Title	Review Article			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Preparation of one review article on specific research area of the student.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NEIST, Jorhat			
Course Nomenclature	CHE-NEIST-4-3903			
Course Title	CSIR-800 Societal Program			
Credit Distribution (L-T-P-C)	0	0	8	4
Core/Elective	Core			

### Course Description:

The students have to undertake a project in rural areas for 6-8 weeks in the line with CSIR-800 programme which is primarily prepared at empowering 800 million Indians by way of S&T inventions. The theme for the project may be chosen from CSIR-800 documents and as per expertise available in the laboratory. Students will select the topics in consultation with Doctoral Advisory Committee (DAC).

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-1-4101			
Course Title	Research Methodology:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	core			

### Course Description:

Good laboratory practices, Safety in the laboratory, First Aid in the laboratory, Maintenance of laboratory records, Scientific literature management, Communication skills (scientific writing and presentation), Intellectual property management & planning, Ethics in Science, Computer applications and tools, Statistical methods & Data analysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-1-4102			
Course Title	Analytical Tools and Instrumentation			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	core			

### Course Description:

Thermal methods (TG, DTG, DTA, TMA, DSC), X-ray methods (XRD, XRF, SAXS), NMR (<sup>1</sup>H, <sup>13</sup>C) and other Spectroscopic methods (EPR, IR, UV, Fluorescence), Chromatographic methods (TLC, GC, LC), Mass spectroscopy, Electron Microscopy (SEM, TEM), Electron Probe Micro Analysis (EDS, WDS), Quantitative Analysis (AAS, ICP, CHN)

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-1-4103			
Course Title	Basic mathematics and numerical methods			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	core			

### Course Description:

Determinants and Matrices, Complex Variables, Vector analysis, Infinite Series, Special Functions, Differential Equations, Interpolation and Approximation, Numerical differentiation and Integration, Basic Linux, Introduction to Algorithms, basic programming, Shell and Shell Scripting, Network Computing and Parallel Computing, Matlab/Scilab/Octave/Gnuplot Algorithms, basic programming, Shell and Shell Scripting, Network Computing and Parallel Computing, Matlab/Scilab/Octave/Gnuplot



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-1-4104			
Course Title	Basic Chemistry for Interdisciplinary sciences:			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

Basics of inorganic, organic, physical and biochemistry, Nomenclature (IUPAC), molarity, molality and normality, types of bonding, Ionic, covalent and non-bonding interactions, Acids and bases, Atomic structure, periodic table and periodic properties, stoichiometry, chemical reactions and kinetics, solvent effects, functional groups in organic compounds, general named reactions and reaction mechanisms, carbohydrates, lipids, proteins, nucleotides, enzymes, photosynthesis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-1-4105			
Course Title	Introduction to Nanoscience and Nanotechnology			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Optional			

### Course Description:

General considerations, Introduction, definitions, consequences of size reduction, Properties: structural, thermodynamic, optical, electrical and magnetic properties, Methods of synthesis, Surface modifications, factors governing the stability and assembly, Characterization of nanomaterials, Applications of Nanomaterials

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-1-4106			
Course Title	Introduction to Chemical Biology			
Credit Distribution (L-T-P-C)				
Core/Elective	Optional			

### Course Description:

chemical biology/synthetic biology, Structure, function and chemistry of biological macromolecules including amino acids, proteins, nucleic acids and carbohydrates, Chemical kinetics and thermodynamics in biology, Chemical reactions and chemical diversity in Biology The Chemistry of Enzymes, Lipids, Fats & Steroids, Drug discovery, Drugs from Nature, Drug interaction

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-2-4101			
Course Title	Advanced Inorganic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Structure & Bonding in Inorganic Compounds, Chemistry of Coordination Compounds, Symmetry in Chemistry & Group Theory, Main group chemistry, Organometallic chemistry, Electronic Spectra of Transition Metal Compounds, Magneto Chemistry, Metal Cluster Compounds, Inorganic Reaction Mechanism, Electron Transfer Reactions in Metal Complexes, Bioinorganic Chemistry (Metalloenzymes, Metal complexes as oxygen carriers, Photosynthesis), Metal Complexes in Medicinal Chemistry, Catalysis by Inorganic Complexes.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-2-4102			
Course Title	Advanced Organic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Stereochemistry, reaction mechanism, C-C and C-X bond formations, Retrosynthetic analysis, photochemistry, pericyclic reactions, reactive intermediates, Methods of asymmetric synthesis and their application in total synthesis, oxidation-reduction reactions, organocatalysis, metathesis reactions.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-2-4103			
Course Title	Advanced Quantum Mechanics			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Revision of Hydrogen atom and particle in box (1D and 3D), Approximate methods in quantum mechanics; Non degenerate perturbation; Perturbation treatment of the Helium atom ground state and first excited state; Variation method for Helium atom ground state; Comparison of perturbation and variation method, Structure of many electron wave function, Antisymmetry, Valence bond theory for homo and hetero nuclear diatomic molecules; Molecular orbital theory Comparison of MO and VB theory; Introduction to density functional theory; Hartree Fock theory, Overview of methods beyond Hartree Fock theory; Configuration Interaction; Many body perturbation; Coupled cluster

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-2-4104			
Course Title	Advanced Organometallic Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Fundamentals, The 18 Valence Electron Rule; Structure and bonding of organometallic complexes using molecular orbital theory.  $\sigma$ -Donor Ligands: Transition-Metal-Alkyl and -Aryl compounds;  $\sigma$ -Donor/ $\pi$  – Acceptor Ligands: Transition-Metal-Alkenyl, -Aryl and –Alkynyl Complexes, Transition-Metal-Carbenes (Fischer and Schrock Carbenes); Metal Carbonyl; Structure, properties and principal reaction types of the above complexes;  $\sigma$ ,  $\pi$  -Donor/ $\pi$  –Acceptor Ligands: Olefin Complexes; Alkyne, Allyl and Enyl Complexes, Complexes of the cyclic  $C_nH_n$ , Fundamental Mechanism of Organometallic Transformations: Oxidative addition, Migratory Insertion,  $\beta$ -hydride elimination and reductive elimination; Interaction of C-C and C-H  $\sigma$ -bonds with Transition Metals

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-2-4105			
Course Title	Advanced Coordination Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Naming of coordination compounds, classification of ligands, chelate and macrocyclic effect, Theories dealing with the formation of Coordination Compounds, Spectrochemical Series; Splitting of d-orbitals, Jahn–Teller Effect; Stability constants of Transition metal complexes and their determination by Job's Method. Spin–Orbit Coupling, Electronic states and term symbols, Selection rules (Laporte and spin selection rule), Interpretation of electronic spectra of Transition metal complexes, Orgel and Tanabe Sugano diagrams. Charge Transfer spectra, Magnetic Properties of Transition elements, Chemistry of Inner Transition Elements.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-2-4106			
Course Title	Advanced Photochemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction to photochemistry, excited state processes, fluorescence and phosphorescence, quantum yields, charge-transfer spectra, solvatochromism, photochromism, transient absorption techniques, Luminescence emission lifetimes, two- and multiphoton processes, photoinduced energy and electron transfer, FRET, fluorescence polarization, excimers, exciplexes, delayed fluorescence, Photochemistry of Organic chromophores. Photochemistry in organized and confined media.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-2-4107			
Course Title	Advanced Polymer Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Techniques of polymerization, polymer characterization techniques, Stereochemistry of Polymers, polymer nano-architectures, random and block copolymers, Liquid Crystalline Polymers, Conducting Polymers, Non-linear Polymers, Polymer Blends and Composites, polymer rheology, inorganic, bio and supramolecular polymers

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-2-4108			
Course Title	Advanced Materials Science			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Crystal systems and space groups, Close packing and various simple structure types like AB, AB<sub>2</sub>, AB<sub>3</sub> and complex structural types ABX<sub>3</sub>, AB<sub>2</sub>X<sub>4</sub>, etc. Factors affecting crystal structures, Common preparative methods; X-ray diffraction and Electron microscopy, Defect structures, colour centers, reciprocal lattices, Properties of solids – Band theory, metals, insulators, semiconductors, dielectric and ferroelectric properties, magnetic properties, optical properties, ionic conduction; structure-processing-property correlations.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-2-4109			
Course Title	Advanced Materials Characterization Techniques:			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Optical Microscopy, Electron microscopy: TEM, HRTEM, SEM, STEM, EDX, FIB, e-beam lithography, Scanning probe microscopy: AFM, STM, MFM, confocal, etc, Raman spectroscopy/microscopy, Thermal analysis techniques, Magnetic measurements, Electrical measurements, Spectroscopic ellipsometry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-2-4110			
Course Title	Advances in Nanoscience and Nanotechnology			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Low-dimensional structures: Quantum wells, Quantum wires, and Quantum dots, Nano clusters & Nano crystals, fullerenes, carbon nano tubes and graphene, Nano Composites, synthesis and characterization techniques, Properties at Nano Scales and comparison with bulk materials, fabrication techniques, general applications, nanomaterials in biology.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-2-4111			
Course Title	Rare Earth Chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Lanthanides and actinides, Electronic structure, periodic properties, extraction, separation, solution chemistry, coordination compounds, spectroscopy, luminescence, magnetism, dyes and pigments, trans-uranium elements, nuclear technology, displays and energy related applications.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-2-4112			
Course Title	Sol-gel chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Introduction, Hydrolysis and condensation reactions, Solution chemistry and physics of intermediates, Role of the anion on the hydrolysis and condensation reactions, Kinetics of Hydrolysis and Condensation, Non-Hydrolytic Sol-Gel Processing, Gelation, Ageing, Drying, Densification, Characterization, Chemistry of Sol-Gel Silicates, Solution chemistry of transition metal alkoxide precursors, Sol-gel synthesis and characterization of important materials, structure-property relationships

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-2-4113			
Course Title	Green chemistry concpets			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Green chemistry concepts: Basic understanding, scope and interdisciplinary nature of green chemistry; Environmental factors; Carbon credit, Energy efficiency and atom economy, Catalysis and green chemistry, Alternate reaction media and reaction systems, ionic liquids, supercritical fluids, solventless chemistry.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-2-4114			
Course Title	Natural products			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Carbohydrates and polysaccharides, Structure and functions of important derivatives of monosaccharides, Classification and nomenclature and synthesis of some simple Alkaloids; Terpenoids and Steroids such as pinene; Camphor and Cadenine;  $\alpha$ -vetinone; Hirsutene and Abietic acid (Terpenoids); Cholesterol; Testosterone and Andestrone (Steroids) etc. isolation and characterization, elucidation of structure-property relationships. Biosynthesis of steroids, terpenoids, fatty acids, alkaloids and polysaccharides, biosynthesis of natural products

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-2-4115			
Course Title	Synthetic methods for organic chemists			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Formation of carbon-carbon bond employing various kinds of organometallic reagents, C-C double bonds through different reactions, oxidation, reduction through various kinds of reagents, functional group interconversion, by substitution including protection and deprotection, alkylation of enolates, and other carbon nucleophiles, reaction of carbon nucleophiles with carbonyl compounds, electrophilic addition to C-C multiple bonds, reactions of C-C multiple bonds, Retrosynthesis, disconnection, synthons, linear and convergent synthesis, umpolung of reactivity and protecting groups.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-2-4116			
Course Title	Organic reaction mechanisms			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Basics, The concept of Aromaticity, How to write an organic reaction mechanism?, Popular name reactions, Reactive intermediates: Generation, stability, structures and reactivity of carbocation, carbaion, carbene, radicals, benzyne, nitrene, Types of mechanism: classification, limitations examples of aliphatic nucleophilic substitution - aliphatic electrophilic substitution - aromatic nucleophilic substitution - aromatic electrophilic Substitution - types of radical reactions - molecular rearrangements oxidation and reduction; Electrophilic reactions-Friedel crafts reaction, Riemer Tiemann reaction, Beckmann rearrangements; nucleophilic reactions- aldol condensation, perkin reaction, benzoin condensation; free radical reaction-halogenation of alkane, addition of HBr on alkene in presence of peroxide; allylic halogenation - using N-Bromo Succinamide (NBS), thermal halogenation of alkene  $\text{CH}_3 - \text{CH} = \text{CH}_2$

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-2-4117			
Course Title	Composite materials			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Concept of Composite materials, Various types of composites, Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites, Reinforcements/Fibers ,Types of fibres, Multiphase fibers, Whiskers and Flakes, Mechanical properties of fibres, Processing of Advanced composites, Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing; Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering; Carbon – Carbon composites: Knitting, Braiding, Weaving; Polymer matrix composites: Preparation of Moulding compounds and prepregs – hand lay up method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding, Processing and characteristics of nanocomposites, hybrid composites, functionally graded composites, smart and functional composites

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-2-4118			
Course Title	Organic spectroscopy applications			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Mass spectroscopy, IR spectroscopy, Proton magnetic resonance spectroscopy, Structural assignment by employing NMR techniques, Carbon-13 NMR spectroscopy, Introduction COSY, HSQC, HMBC, NOESY, ROESY, Structural elucidation using 2D-NMR methods

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-2-4119			
Course Title	Surface characterization techniques			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

XPS, LEED, XAS, SEM, AFM, TEM, NSOM, SPR, SERS, static and dynamic contact angle measurements, Ellipsometry.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4101			
Course Title	Electronic structure theory			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Post-Hartree-Fock methods: Moller-Plesset perturbation theory (MP2, MP3, and MP4), Configuration Interaction (CI), Coupled-Cluster single double (triple) (CCSD(T))– performance of various methods for the prediction of van der Waal and hydrogen bonding interactions, spectral properties. Density functional theory based methods: Hybrid and Minnesota functional – Application of DFT methods (excitation energy calculations). Density functional methods with Dispersion correction (Grimme's approaches). Car-Parrinello Molecular Dynamics (CPMD) and Born-Oppenheimer Molecular Dynamics (BOMD).

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4102			
Course Title	Molecular modeling and simulation			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Molecular Mechanics: Features of molecular mechanics - Force Fields: Bonds structure and bending angles, Electrostatic Vander Waals and non-bonded interactions, Hydrogen bonding - Derivatives of molecular mechanics energy function - Calculating thermodynamic properties - Force Field for inorganic systems - Energy minimization, Molecular Dynamics Simulation: Molecular Dynamics using simple models, Molecular Dynamics with continuous potentials, Solvent effects, Conformational changes, Thermostats, Barostats, Lincs and shake algorithms, Monte Carlo simulation Methods, sorption, Applications of Molecular Modeling



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4103			
Course Title	Carbohydrate chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Mono and disaccharides, polysaccharides, Bacterial polysaccharides, starch and cellulose, derivatives of cellulose, Protecting groups, Glycosylation reactions, Dynamics and interactions, carboxy methyl cellulose and gun cotton, structure, Conformational analyses, glycoconjugates, Immunology of carbohydrates.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4104			
Course Title	Supramolecular chemistry			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Nature of supramolecular interactions, role of various non-covalent interactions, multiple hydrogen bonding motifs, Stability of H-bonds, Jorgensen model for H-bonding, supramolecular synthons , dimensions of supramolecular chemistry, Janus molecules. Photoresponsive molecules and self-assembly, Molecular recognition, classification of supramolecular host-guest complexes, supramolecular self-assembly, supramolecular polymers, molecular capsules, self- assembled dendrimers, self-assembled nanotubes, low molecular weight organogels. Characterization techniques of self-assemblies, supramolecular sensors.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4105			
Course Title	Total Synthesis			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Synthesis of complex organic molecules – planning and execution; Concepts of Retrosynthetic Analysis and Total synthesis of Natural products; Retrosynthesis; Disconnection; Synthons; Linear and Convergent Synthesis; Photochemistry in total synthesis; MCRs in total synthesis; Breakthrough synthesis – past and present.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4106			
Course Title	Asymmetric Synthesis			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Strategies for the preparation of optically pure compounds; Stereoselective, Enantioselective and Diastereoselective reactions; Stoichiometric asymmetric synthesis-chiral auxiliaries, Evans Alsdol and modified versions; Catalytic asymmetric synthesis; Asymmetric Dihydroxylation; Asymmetric Aminohydroxylation; Asymmetric Hydrogenation; Asymmetric allylation, propargylation, and alkylation; Chiral Organocatalysis; Cascade reactions by organocatalysis; Transition Metal based catalysis; Asymmetric amplification and autocatalysis

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4107			
Course Title	Chemistry and biology of Heterocycles			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Privileged heterocycles, Electronic properties, reactivity (electrophilicity and nucleophilicity), Synthetic methodologies, Biological properties of Natural products and drug candidates, Biosynthesis, Dimeric compounds and related stereochemistry

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4108			
Course Title	Homogeneous Catalysis			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Organometallic Catalysis, Applications in organic synthesis: Olefin Isomerization, C-C Coupling reactions: Heck, Suzuki, Stille and Sonogashira reactions, Alkene and Alkyne Metathesis, C-Heteroatom coupling: Hydroamination, Olefin Oxidation, C-H activation, Oxidation reactions, hydrogenation of Alkenes, Industrial Applications.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4109			
Course Title	Catalysis for organic synthesis			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

A background on fine and specialty chemicals in chemical industry; Concept of atom economy; Homogeneous and heterogeneous catalytic reactions: hydrogenation, hydrogenolysis, dehydrogenation, selective oxidation, alkylation & acylation, isomerization and C-C bond forming reactions, Enzyme catalysis in organic synthesis; Reaction mechanisms

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4110			
Course Title	Materials and devices for energy conversion			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Design of organic and Inorganic semiconductors, Approaches to process organic semiconductors by covalent and non covalent modifications , band edges and band gaps, Modulation of charge transport properties, kinetics of electron transfer, Design of small molecule dyes for DSSC, Electron transfer at interfaces, Transistors and solar cells, Fabrication of Devices, Device characterisation using dark current, IV curves under illumination, IPCE, Calculation of Voc, Jsc, Vpp, Ipp, FF and Pmax. hybrid solar cells



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4111			
Course Title	Functional Ceramics			
Credit Distribution (L-T-P-C)	1	0	0	1
Core/Elective	Elective			

### Course Description:

Advanced Electronic Ceramics, high temperature ceramic super conductors, Dielectric ceramics, microwave ceramics, low k materials, SOFC materials, solid-ionic conductors, phosphor materials, Impedance analysis, varistors, sensors, ceramic magnets, thermal shock resistance and super plastic ceramics.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4112			
Course Title	Photoinduced electron and Energy transfer			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Thermodynamic aspects, Calculation of free energy change from redox potentials, Weller equation, Kinetic aspects, concept of reorganization energy, Marcus theory, Inverted region kinetics, Back electron transfer, circumventing back electron transfer, Applications of photoinduced electron and energy transfer, Reaction centre and photoinduced electron transfer processes in photosynthetic bacteria, Solar water splitting, Dye-sensitized solar cells, Organic photovoltaics, Few organic reactions initiated by PET, Photo-remediation of organic waste materials, Mechanisms and dynamics of fluorescence quenching, Fluorescence anisotropy, Energy transfer to single and multiple acceptors, Resonance energy transfer and its implication, Sensors based on photoinduced processes.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4113			
Course Title	Block copolymers			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Chain and controlled block copolymerization, monomer reactivity ratios, Copolymer compositions, molecular architecture, blends, grafts, melts, self assembly and phase separation, phase diagram, range of applicability of copolymerization equation; types of copolymerization; Block copolymers with controlled molecular weight, Living Polymerization, block copolymer synthesis, characterization techniques, block copolymers for biomedical and industrial applications, Amphiphilic block copolymer micelles, Block copolymer thin films.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4114			
Course Title	Pi-conjugated polymers			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Synthesis and characterization, electronic and optical properties, energy band structure, Display Materials: Organic Light Emitting Diodes, Organic thin film transistors, device preparation, working principle, advantages, drawbacks; Organic photovoltaics, OFETs, device preparation and characterization, factors influencing efficiency, stability.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4115			
Course Title	Liquid Crystals			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Liquid crystal phases, classification, Chiral liquid crystalline phases, Ferroelectric liquid crystalline phases, discotic liquid crystalline phases, Characterization techniques, Surface Alignment of Liquid Crystals, Dichroic LCs, Polycatenar mesogenes, Display and photovoltaic applications.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4116			
Course Title	Ultrafast processes and spectroscopy			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Different types of lasers, components and building of lasers and generation of ultrafast lasers. Principles, instrumentation and applications of different types of ultrafast spectroscopy, Conventional and laser flash Photolysis, and Pump-Probe spectroscopy, Steady state and time resolved Raman spectroscopy, Coherent anti-Stokes resonance Raman Spectroscopy, Femtosecond stimulated Raman Spectroscopy Femtosecond vibrational coherence spectroscopy, Transient grating Spectroscopy, Fluorescence up-conversion, Time correlated single photon counting, ultrafast physical, chemical and biological systems.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4117			
Course Title	Natural products and drug discovery			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Natural products: Importance, lead, clinical trials in drug discovery research, Case studies of marketed natural product drugs, Synthetic Biology and Genetic engineering in the production of natural product, A brief overview of drug discovery approach, Cause of diseases, Target identification, Target validation, Modeling, Synthesis and SAR, Drug Delivery, Clinical Trials, Etiology, pathogenesis, prevention, drug targets and chemotherapy, drug resistance and remedies of tropical infectious diseases, Etiology and remedies of diseases developed through metabolic disorders.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4118			
Course Title	Photobiology			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Primary processes in photosynthesis, antenna effect, reaction center, primary processes in vision, bio and chemiluminescence and environmental photobiology and UV effects, Phototherapy and photodynamic therapy, sensitizers, structures of porphyrinic and non-porphyrinic sensitizers, type I and type II mechanisms, advantages and disadvantages of light in medicine.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4119			
Course Title	Nanobiotechnology			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Concept of hybrid systems, signaling and signaling responses; biological systems as transducers, Biology at the nano-interface, fluorescent nanoparticles for life sciences, applications, DNA based particles used as building blocks, micelles, Nucleic Acid, Engineering using DNA as Nano materials, Cells & Microfabricated Devices, Nanomaterials for drug delivery, imaging, diagnostics, therapy, separation, Biosensors

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4120			
Course Title	Rare Earth Molecular Materials			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Chemistry of Rare Earth elements: Electronic configuration of lanthanide atoms in ground state, lanthanide contraction, specificity of the photophysical properties of rare earth compounds, spectral terms, selection rules for atomic spectra. Coordination Chemistry of Rare Earths: Bonding in rare earth complexes, coordination number and structure, stability and factors affecting stability. Magnetism of Rare Earths: Magnetic Coupling in lanthanide containing molecular materials, magnetic relaxation in lanthanide containing complexes. Photophysics of Rare Earths: Sensitization of lanthanide luminescence-the antenna effect, design of efficient lanthanide luminescent probes, luminescence quenching, radiative and non-radiative lifetimes, energy transfer pathways-singlet and triplet pathways, Latva's and Reinhoudt's empirical rules, measurement of quantum yields.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4121			
Course Title	Transition Metal Catalysed organic synthesis & Application in total synthesis of natural products, heterocycles and pharmaceutical intermediates			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Palladium complexes in organic synthesis: Versatility of palladium, industrial application, application in total synthesis of biologically active molecules and supramolecular chemistry. Pd catalyzed organic reactions : Heck coupling, Stille coupling, Suzuki coupling (Suzuki-Miyaura reaction), Negishi coupling, Sonogashira coupling, Tsuji-Trost reaction, Hiyama coupling, Buchwald-Hartwig reaction. Application of palladium catalyzed cross couplings in the synthesis of taxol, steroids, angucycloninone antibiotics, rapamycin, 2-epi-jatrphone synthesis, dynamycin, dragmacidin, phomactin, Yuehchukene, application to the synthesis of pharmaceutical intermediates such as losartan, valsartan and agrochemicals, and polymers Ruthenium catalysis: Properties and applications of Ruthenium in organic synthesis- oxidation reductive amination, TPAP, Ruthenacyclopentane, Aromatic C-H bond activation, reduction, coupling reactions, C-H bond activation. Metathesis: Types of carbenes for metathesis (Fischer carbene, Schrock carbene), Grubb's first, second and third generation catalysts in metathesis. Mechanism of metathesis, Ring Closing Metathesis (RCM), Cross Metathesis (CM), Ring Opening Metathesis (ROM), Ring Opening Metathesis Polymerization (ROMP), Enyne Metathesis, Acyclic Diene Metathesis Polymerization (ADMET). Application of RCM in the synthesis of epothilone, dactylol, jamin ketolactone, herbarumin, catenanes and molecular necklaces. Rh, Ir, Zr, and Ti metals in organic synthesis: Rhodium catalyzed organic transformations, CH activation. Ir, Ti and Zr in organic synthesis.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4122			
Course Title	EMI Shielding Materials			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Conducting Polymers and EMI Shielding : Characteristics of Conducting Polymers, Electrochemistry of electronically conducting polymers, source of electronic conduction in polymers – Solitons , Polarons and Bipolarons, Semiconductors and conducting polymers Composites in Microelectronics: Fabrication of Microelectronic devices: Crystal growth and wafer preparation, Film Deposition oxidation, Lithography, bonding and packaging, Reliability and yield, Printed Circuit boards, Computer aided design in Micro electronics, Surface mount technology, Integrated circuit economics.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4123			
Course Title	Advanced Materials Processing			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Ceramic processing – Consolidation of ceramic powders, mechanical compaction, powder packing, uniaxial pressing, isostatic pressing, hot pressing, hot isostatic pressing, Slurry processing, slip casting, tape casting, pressure casting, gel casting, plastic forming, extrusion, injection moulding. Rapid prototyping, electrophoretic casting, electro-spinning. Green strength, drying, binder burnout, green machining, sintering. Sol-gel processing, Thermal and plasma spraying, Thick and thin film coatings – PVD and CVD techniques. Vapor infiltration techniques. Metals processing: Metal Casting – sand, permanent, pressure, centrifugal and investment processes. Deformation processing - stress during various metal working operations, friction and its role in bulk metal forming operations, microstructural evolution during deformation processing, superplastic forming; Sheet metal forming, enhancement of sheet metal formability; Fundamentals of powder processing of metals, solid and liquid state sintering, driving force and mechanism of sintering Polymer Processing: Compounding of plastics and rubbers, fabricating processes like compression, transfer, injection and blow moulding, extrusion, calendaring, thermoforming, roto molding, casting, sintering and compaction, dip coating, RTM, RIM, RRIM, post forming and finishing operations. Composite Processing - Hand lay-up, Filament Winding, Pultrusion, Resin Transfer Molding, Processing Science of Reactive Polymer composites - Process steps for production, Selection of processing conditions Toolings, and equipments, Carbon- Carbon Composites –Processing, thermal and mechanical properties, Quality control

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4124			
Course Title	Advanced Functional Materials			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Advanced Functional Ceramic Coatings and Thin Films-Co-precipitation, Solgel processing, coating techniques, rheology of coating precursors, functional coatings, wetting and non wetting surfaces, coating characterizations, multilayered coatings, nanocomposites, porous ceramics ceramic membranes, organic-inorganic nano hybrids Advanced Electronic Ceramics and Applied Superconductors-Dielectric ceramics, microwave ceramics, low k materials, SOFC materials, solid-ionic conductors, phosphor materials, Impedance analysis, varistors, sensors, superconductivity and high temperature ceramic super conductors. Advanced High Temperature Ceramics-Engineering Ceramics – Properties and applications of Al<sub>2</sub>O<sub>3</sub>, SiC, Si<sub>3</sub>N<sub>4</sub>, zirconia, mullite, Al<sub>2</sub>TiO<sub>5</sub>, rare earth phosphates, B<sub>4</sub>C, Cubic Born nitride, thermal shock resistance and super plastic ceramics Functionally Graded Materials, Shape Memory Alloys, Piezoelectric materials, biomimetic functional materials.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4125			
Course Title	Surface Science and Technology			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Importance of Surface Science and Technology- Atomic and electronic structure of surfaces - surface degradation of metals, ceramics and polymers and their control measures. Surface and Coating Technologies-Selection of Coating and Surface Technologies, Surface Coating processes: Electroless deposition- Electro deposition - Chemical vapour deposition - Physical vapour deposition - Thermal spraying - Flame Spraying -Plasma spraying -surface heat treatments and hardening – Carburising – Nitriding - Anodising - Laser surfacing – Sputtering - Ion Plating -Sol-gel Coating - Hot-dip Coating - surface alloying - self-cleaning surfaces - surface functionalization - self assembly - Brazed and welded coating methods - Thin film technologies - Other advanced surface techniques - Testing methods and assessment of coatings - Coatings for Aerospace structures and components. Surface Coating Materials: Metallic, ceramic, polymer and composite coatings, nanomaterial coatings, superhard and functional and functionally graded coatings. Corrosion and its control - Corrosion processes, Corrosion problems in the aerospace industry, General corrosion, pitting corrosion, crevice corrosion, stress corrosion cracking, influence of deposits and anaerobic conditions, Exfoliation, corrosion. Corrosion control. High temperature oxidation and hot corrosion, Corrosion / mechanical property interactions. Paint and paint systems. Tribology-Friction, Lubrication and wear of surfaces, coefficient of friction, Types of wear- Abrasive, erosive and sliding wear, interactions between machine parts and environments, failure mechanisms of wear, Interaction between wear and corrosion, Testing methods and control measures of wear.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4126			
Course Title	ADVANCED DYE-REMOVAL TECHNOLOGIES			
Credit Distribution (L-T-P-C)	1	0	2	2
Core/Elective	Elective			

### Course Description:

Introduction, different types of organic synthetic-dyes, their physical and chemical properties, applications, significance of dye-removal technology. Different methods of dye-removal from aqueous solutions and industry waste-water: Physical methods, membrane filtration, nano-filtration, reverse osmosis, electrcatalysis, adsorption, different types of adsorbents, adsorption kinetics models, adsorption isotherm models, adsorption capacity, advantages and limitations Chemicals methods, coagulation, flocculation, flotation, precipitation and filtration, electrofloatation, electrokinetic coagulation, conventional oxidation, oxidizing agents, ozone,hydroxyl radicals, advanced oxidation process, Fenton-reaction, irradiation, photocatalysis, advantages and limitations Biological methods, fungal decoloration, microbial degradation, adsorption by microbial biomass, bioremediation systems, advantages and limitations New emerging dye-removal technologies and other recent developments Experimentation with the selected dye-removal technologies



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4127			
Course Title	Nanomaterials Science and Technology			
Credit Distribution (L-T-P-C)				
Core/Elective	Elective			

### Course Description:

Introduction: Importance of materials at Nano Size, Properties at Nano Scales, Advantages and Disadvantages, Application in comparison with bulk materials (Nano structure, nano wires, tubes, nano composites), Low-dimensional structures: Quantum wells, Quantum wires, and Quantum dots, Nano clusters & Nano crystals, Processing of Nanomaterials: Fabrication techniques, Top down vs. bottom up techniques, nucleation theory, surface energy, and stabilization; Chemical Processing Methods, Physical processing methods (lithography, thin film deposition and doping) MEMS fabrication techniques-Nano fabrication techniques (E-Beam nano-imprint fabrication, Epitaxy and strain engineering. Scanned probe techniques), Mechanical Processing techniques - Mechanical alloying/milling, mechanochemical synthesis, Bulk nanostructured material Processes. Properties of Nanomaterials: Size and Properties relationship, Physical, Chemical, Magnetic, mechanical and tribological properties of nanomaterials, Properties of nano particles and Bulk nanomaterials. Nano Particles: Synthetic Methods– wet chemical approach & physical vapour synthesis approach etc – size effect & shape change and their properties – examples of systems involved – characterization techniques – properties & their applications Nano tubes/Nanowires: Different systems involved in nano tubes – single walled, multiwalled, Carbon based, metal incorporated tubes. Synthesis procedures (Solid & gaseous carbon source based production techniques etc.) Growth mechanism of carbon nano tubes – properties of carbon nano tubes – characterization – applications. Nano Composites: Introduction-Synthesis Methods-various systems (metal, ceramics and polymer based nanocomposites). Characteristics– Applications. Applications of Nanomaterials: Catalysis, Electronic, Aerospace, Automotive, Surface coatings, Magnetic, Optical, Medicine etc.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4128			
Course Title	Ionic Conductors			
Credit Distribution (L-T-P-C)	2	0	2	2
Core/Elective	Elective			

### Course Description:

Ionic conductors and electronic conductors: Characteristics of ionic and electronic conductors, conductivity behavior and mechanism of conduction, electronic conductivity in oxides, Correlation effects: tracer diffusion and ionic conduction Types of ionic conductors: Solid electrolytes, fast ionic conductors, super ionic conductors, anionic conductors: oxide ion conductors, classification of oxide ion conductors, fluoride ion conductors, cationic conductors: proton conductors. Material characteristics enabling oxide ion conductivity: Non-stoichiometry, crystal defects, free volume, ionic radii mismatch and elastic strain, effect of concentration of ion vacancy, effect of crystallographic index. Crystal defects: Their origin and classifications: Point defects: notation for description of point defects and charged defects, electroneutrality, Vacancies: Schottky defects, Frenkel defects, color centers, interstitial impurity, substitutional impurity, extended defects, shear structures, Line defects: Dislocations: edge dislocations, screw dislocations, Burgers vector  $b$ , Planar defects: Grain boundaries, polycrystals, Defects in plastic deformation and fracture. Applications of ionic conductors: Solid oxide fuel cells, oxygen sensors, exhaust catalyst in catalytic converters, dense ceramic membrane.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4129			
Course Title	Polymeric Hierarchical Structure and Properties			
Credit Distribution (L-T-P-C)	2	0	2	2
Core/Elective	Elective			

### Course Description:

Solid-state chemistry and physics of various polymeric materials ranging from crystalline polymers to liquid crystalline polymers, colloids, gels and block copolymers. hierarchical assembly, materials self-assembly, molecular vs. material self-assembly, Classification of polymers in the structure point of view; hierarchical structure in semicrystalline polymers, synthesis of liquid crystalline (LC) polymers; thermotropic and lyotropic LC behavior, phase structure and transitions in LC polymers. Thermodynamics of phase separation in Block copolymers, Block copolymer phase diagram, Block copolymer thin films: morphology and thermodynamics on surface, Characterization techniques to assess polymer behavior in thin films and interphases, supramolecular chemistry using block copolymers, structural hierarchy in block copolymer Supramolecules. Bioinspired structure formation of polymers, bottom-up synthesis of materials and nanopatterning, polymer based colloidal self-assembly, intermolecular forces and potentials, charged colloids, DLVO theory for colloidal stability, colloidal surface modifications, surface wetting, design and synthesis of hierarchical polymer structures, advanced applications

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4130			
Course Title	Advanced sol gel processing			
Credit Distribution (L-T-P-C)	2	0	2	2
Core/Elective	Elective			

### Course Description:

Hydrolysis and condensation reactions, Gelation, Aging, Drying, Densification, Particulate sols, Zeta Potential, Surface chemistry and chemical stability of sols, DLVO theory, Mono-dispersed particles from solution, Sol-gel synthesis and characterization of important materials, Solution chemistry of transition metal Alkoxide precursors, Comparison of gel derived and conventional ceramics, Applications: Thin films and coatings, Composites, Porous gels and Membranes, Monoliths, Fibers.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4131			
Course Title	Soft nanomaterials & Functional Polymers			
Credit Distribution (L-T-P-C)	2	0	2	2
Core/Elective	Elective			

### Course Description:

Hierarchical assembly, materials self-assembly, molecular vs. material self-assembly bottom-up, polymer based colloidal self-assembly, intermolecular forces and potentials, charged colloids, DLVO theory for colloidal stability, colloidal surface modifications, surface wetting, design and synthesis of hierarchical polymer structures, synthesis of materials and nanopatterning, synthesis of nanoparticles using novel approaches, microwave, ultrasound and plasma-assisted synthesis, polymer-inorganic hybrids, advanced biomaterials, bio-inspired structure formation, advances in biopolymers and its applications, cellulose and their derivatives- general structures and main industrial applications; general methods for extraction of nanocellulose- bottom-up and top-down approaches; MFC, NFC, MCC, NCC- general structures properties and applications; current trends in nanocellulose research in composites, bio-medical field, smart materials etc. References: Nanochemistry: A Chemical Approach to Nanomaterials, Geoffrey Ozin, Andre Arsenault and Ludovico Cademartiri, RSC Publication, 2009 Principles and Applications of Emulsion Polymerization, Chong-Shyan Chern, Wiley, 2008 • Mesocrystals and Nonclassical Crystallization, Helmut Cölfen, Markus Antonietti, Wiley, 2008 • Chemistry and Applications of Nanocrystalline Cellulose and its Derivatives: a Nanotechnology Perspective, B. L. Peng, N. Dhar, H. L. Liu and K. C. Tam, THE CANADIAN JOURNAL OF CHEMICAL ENGINEERING, VOLUME 9999, 2011

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-3-4132			
Course Title	Porous structures			
Credit Distribution (L-T-P-C)	2	0	0	2
Core/Elective	Elective			

### Course Description:

Definitions- micro porous and meso porous solids, zeolitic structures,, Frame work types- MOFs, COFs; High surface area nano porous materials; nano clays; Synthesis of gels; gelation; gel rheology; aerogels, hybrid aerogels, composite aerogels; double layered hydroxides; role of structure directing agents, chemistry of micro porous frame works solids, membranes; pore size analysis; Isotherms; adsorption; catalytic applications, hydrogen storage, separation, CO<sub>2</sub> sequestration; hazardous pollutant remediation. References 1. Functional Hybrid materials, Wiley Publishers Edited by Pedro Gmez et al (2006) 2. Porous materials: processing and applications, Elsevier Publications; Edited by Pei Sheng Liu (2014) 3. Sol gel Science: Physics and Chemsirty of Sol gel processing. Academic press Inc, C. Jeffrey Brinker (1990)

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-4-4101			
Course Title	Project proposal writing & presentation			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Formulation of a project proposal by selecting topics of high relevance and novelty and will have state-of-the-art review, methodologies, recommendations etc. in specified format in a holistic manner preferably candidate's own research work suitable for submission to appropriate funding agencies.

## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-4-4102			
Course Title	Review Article			
Credit Distribution (L-T-P-C)	0	0	4	2
Core/Elective	Core			

### Course Description:

Preparation of one review article on specific research area of the student.



## Chemical Sciences Coursework PhD

Faculty	Chemical Sciences			
Lab Name	CSIR-NIIST, Thiruvananthapuram			
Course Nomenclature	CHE-NIIST-4-4103			
Course Title	CSIR-800 Societal Program			
Credit Distribution (L-T-P-C)	0	0	8	4
Core/Elective	Core			

### Course Description:

The students have to undertake a project in rural areas for 6-8 weeks in the line with CSIR-800 programme which is primarily prepared at empowering 800 million Indians by way of S&T inventions. The theme for the project may be chosen from CSIR-800 documents and as per expertise available in the laboratory. Students will select the topics in consultation with Doctoral Advisory Committee (DAC).