BANASTHALI VIDYAPITH
DEPARTMENT OF CHEMISTRY

Summary of BOS Meeting

B. Sc.

S. No.	Program	Changes made by Board of Studies		Unit/ Section	Page / Ref	Recommendation
		In Scheme of Examination	In Courses & Curricula			
1.	B. Sc First Semester	**No Change**	1.1: Inorganic Chemistry	----	**----**	Approved by BOS
			1.2: Practical	----	**----**	Approved by BOS
	B. Sc Second Semester		2.1: Organic Chemistry	Unit-1 and Books suggested	**8**	Approved by BOS
			2.2: Practical	----	**----**	Approved by BOS
2.	B. Sc Third Semester		3.1: Physical Chemistry	----	**----**	Approved by BOS
			3.2: Practical	----	**----**	Approved by BOS
	B. Sc Fourth Semester		4.1: Inorganic Chemistry	----	**----**	Approved by BOS
			4.2: Practical	Practicals added	**8,9**	Approved by BOS
3.	B. Sc Fifth Semester		5.1: Organic Chemistry	Unit-2	**9**	Approved by BOS
			5.2: Practical	----	**----**	Approved by BOS
	B. Sc Sixth Semester		6.1: Physical Chemistry	----	**----**	Approved by BOS
			6.2: Practical	----	**----**	Approved by BOS

M. Sc. Chemistry

S. No.	Program	Changes made by Board of Studies		Unit/ Section	Page / Ref	Recommendation
		In Scheme of Examination	In Courses & Curricula			
4.	M. Sc. First Semester	**Paper-III: Physical Chemistry** has been written **Physical Chemistry-I.**	Paper-I: Inorganic Chemistry	**Change in section C.**	**9**	Approved by BOS
			Paper-II: Organic Chemistry	Changes in section A , B & C.	**10**	Approved by BOS
			Paper-III: Physical Chemistry	**Changes in Sec-A.**	**11**	Approved by BOS
			Paper-IV: Analytical Chemistry	No Change.	**-**	-
			Paper-V: Mathematics for Chemists	No Change.	**-**	-
			Paper-VI: Practical	**Changes in Organic & Physical Chemistry.**	**11,12**	Approved by BOS
	M. Sc. Second Semester	**Paper-III: Physical Chemistry** has been written as **Physical Chemistry-II.**	Paper-I: Spectral Techniques in Inorganic Chemistry	No Change.	**-**	-
			Paper-II: Organic Chemistry	No Changes.	**--**	-
			Paper-III: Physical Chemistry	**Changes in section B & C.**	**12,13**	Approved by BOS -
			Paper-IV: Spectroscopy	No Change.	**-**	-
			Paper-V: Computer Application in Chemistry	No Change.	**--**	-
			Paper-VI: Practical	**Changes in Inorganic & Organic Chemistry.**	**13,14**	Approved by BOS
5.	M. Sc. Third Semester	**Paper-V: Advanced Principles of Physical Chemistry** has been written as **Physical Chemistry**-III.	Paper-I: Bio-inorganic Chemistry	No Change.	**-**	-
			Paper-II: Group Theory & Photo-inorganic Chemistry	**Change in section A.**	**14**	Approved by BOS
			Paper-III: Bio-organic Chemistry	**Changes in section A& B.**	**14,15**	Approved by BOS -
			Paper-IV: Chemistry of Natural Products	No Change.	**--**	-
			Paper-V: Advanced Principles of Physical Chemistry	**Change in section A**	**16**	Approved by BOS
			Paper-VI: Practical	**Changes in Inorganic, Organic & Physical Chemistry.**	**16,17**	Approved by BOS
	M. Sc. Fourth Semester	**Paper V: Advanced Physical Chemistry** has been written as **Physical Chemistry-IV.**	Paper-I: Organotransition-metal Chemistry	No Change.	**--**	-
			Paper-II: Bio-inorganic and Supramolecular Chemistry	No Change.	**-**	-
			Paper-III: Photo-organic and Heterocyclic Chemistry	**Changes in section B & C.**	**19**	Approved by BOS
			Paper-IV: Organic Synthesis	No Change.	**-**	-
			Paper-V: **Advanced Physical Chemistry**	**Changes in section A & C**	**19,20**	Approved by BOS
			Paper-VI: Practical	**Changes in Inorganic & Physical Chemistry.**	**20,21**	Approved by BOS

MINUTES OF MEETING OF BOARD OF STUDIES IN CHEMISTRY HELD ON APRIL 25, 2016 AT 10:30 AM IN CONFERENCE ROOM, VIGYAN MANDIR, BANASTHALI VIDYAPITH

PRESENT

1.	Prof. M. S. Singh	**External Member**
2.	Prof. D. Kishore	Internal Member
3.	Dr. Dinesh Kumar	Internal Member
4.	Dr. Kavita Poonia	Internal Member
5.	Dr. Manish Srivastava	Internal Member
6.	Dr. Navjit Kaur	Internal Member
7.	Dr. Rajendra	Internal Member
8.	Dr. Shurti	Internal Member
9.	Dr. Sonika Jain	Internal Member
10.	Dr. Sudhansu Sharma	Internal Member
11.	Dr. Sudesh Kumar	Internal Member
12.	Dr. Ved Prakash Verma	Internal Member
13.	Ms. Aarti Singh	Special Invitee
14.	Ms. Anamika Srivastva	Special Invitee
15.	Dr. Jaya Dwivedi	**Convenor**

Note: Prof. R.C. Maurya the external member and Ms. Ankita Dhillon the special invitee could not attend the meeting.

Before proceeding to discuss the Agenda of the meeting, the Convenor on behalf of the Department of Chemistry, Banasthali University accorded a cordial welcome to all the external and internal members of the BOS.

1. BOS took up the confirmation of the minutes of its last meeting held on March 14, 2012 and as no comments were received from the members, the Board resolved that the minutes of its last meeting be confirmed.

2. BOS updated the existing panel of examiners in each paper of Undergraduate and Postgraduate examinations of Chemistry in accordance to the Byelaws 15.03.2002 of the Vidyapith.
   Panel of examiners has been updated in the provided format keeping in view that all the examiners are fulfill the criteria for appointment as an examiner.
   The updated list of examiners has been handed over to the examination (secrecy) section.

3. The Board reviewed the Courses of Study, Curricula and Scheme of Examinations of the following undergraduate and postgraduate examinations of Chemistry:

(I) Bachelor of Science (B. Sc.) Examination:

(i) First Semester Examination, December 2016
(ii) Second Semester Examination, April/May 2017
(iii) Third Semester Examination, December 2017
(iv) Fourth Semester Examination, April/May 2018
(v) Fifth Semester Examination, December 2018
(vi) Sixth Semester Examination, April/May 2019

(II) Master of Science (M. Sc.) Chemistry Examination:

(i) First Semester Examination, December 2016
(ii) Second Semester Examination, April/May 2017
(iii) Third Semester Examination, December 2017
(iv) Fourth Semester Examination, April/May 2018

Details of the Scheme of Examinations and the syllabi of different courses are given as below:

(I) Bachelor of Science (B. Sc.) Examinations:

No change has been made in scheme of examination and only a minor change has been made in the syllabus of Inorganic and Organic Chemistry.

(II) Master of Science (M. Sc.) Chemistry Examination:

Scheme of Examinations (Existing and Modified Schemes of Sem. Exam)

Annexure-1(Page No. 5 to 6)

Syllabi (Existing and Modified Syllabi of Semester Examinations)

Annexure-2 (Page No. 7 to 21)

4. BOS considered the reports of the examiners of various examinations of 2014-2015 and observed that in all the cases examiners were satisfied with the performance of the students.

5. BOS has thoroughly analyzed the quality of question papers of the year 2014-2015 keeping the following points in mind:
   (i) Percentage of analytical based questions.
   (ii) Percentage of descriptive questions
   (iii) Percentage of application based questions.
   (iv) Percentage of information based questions.
   (v) Time allotted to the question papers was appropriate or not.

   In most of the papers, it has been found that there has been a judicious balance of all these components in the papers. The outcome of the analysis of the papers of year 2014-2015 is shown in the **Annexure-3 (Page No. 22)**.

6. Under bye-law 9-2-03 to co-opt external members of BOS for a fresh term of three years commencing from 1st January, 2017.

(a) Following shall be the co-opted external members of the BOS in a subject of chemistry for a fresh term of three years:

(i) Prof. M. S. Singh
Department of Chemistry
Faculty of Science, Banaras Hindu University
Varanasi (Utter Pradesh)-221 005
Telephone No.: 0542-6702502; 2307320, 0542-2369983 (Res.)
Mobile No.: 09415372614
E-mail: mssinghbhu@yahoo.co.in

(ii) Prof. Rajeev Gupta
Department of Chemistry, University of Delhi
Mobile: 91-981 000 1819
E-Mail: rgupta@chemistry.du.ac.in
E-Mail: rgupta.chemistry@gmail.com

(iii) Prof. P.K. Tandon
Department of Chemistry
University of Allahabad, Allahabad
Mobile No: 09415310942
E-Mail: ptandonk@yahoo.co.in
E-Mail: pktandon123@radiffmail.com

(iv) Three external members have been co-opted by the Board.

7.

(i) The external member of BOS has pointed out, that practical hour for M.Sc. Chemistry has been very-very low than actually it needs, and he has recommended that in view of number of practical hours given to M.Sc. practicals in other universities the practical hours should be doubled to the existing ones. His recommendation has been appended herewith in support of the point.

(ii) BOS suggests that the admission in M.Sc. Chemistry course be made through the merit of entrance examination.

The meeting ended with a vote of thanks to the Chair.

Verified

Offg. Secretary
Banasthali Vidyapith
P.O. Banasthali Vidyapith
Distt. Tonk (Raj.)-304022

MINUTES OF MEETING OF BOARD OF STUDIES IN CHEMISTRY HELD ON DECEMBER 27, 2018 AT 11:00 AM IN CONFERENCE ROOM, VIGYAN MANDIR, BANASTHALI VIDYAPITH

PRESENT

1.	Dr. Anamika Srivastava	Internal Member
2.	Dr. Ankita Dhillon	Internal Member
3.	Prof. D. Kishore	Internal Member
4.	Dr. Jaya Dwivedi	Convener
5.	Dr. Manish Srivastava	Internal Member
6.	Dr. Navjeet Kaur	Internal Member
7.	Dr. Nirmala Kumari Jangid	Internal Member
8.	Dr. Rajendra	Internal Member
9.	Dr. Shurti	Internal Member
10.	Dr. Sonika Jain	Internal Member
11.	Dr. Sudhanshu Sharma	Internal Member
12.	Dr. Sudesh Kumar	Internal Member
13.	Dr. Ved Prakash Verma	Internal Member
14.	Dr. Vivek Sharma	Internal Member

Note: Prof. P. K. Tandon, the external member and Dr. Kavita Poonia the internal member could not attend the meeting.

Before proceeding to discuss the Agenda of the meeting, the Convenor on behalf of the Department of Chemistry, Banasthali Vidyapith accorded a cordial welcome to all the external and internal members of the BOS.

1. BOS took up the confirmation of the minutes of its last meeting held on April 25, 2016 and as no comments were received from the members, the Board resolved that the minutes of its last meeting be confirmed.

2. BOS updated the existing panel of examiners in each paper of Undergraduate and Postgraduate examinations of Chemistry in accordance to the Byelaws 15.03.2002 of the Vidyapith. Panel of examiners has been updated in the provided format keeping in view that all the examiners are fulfill the criteria for appointment as an examiner. The updated list of examiners has been sent to the examination and secrecy section.

3. The Board reviewed the Courses of Study, Curricula and Scheme of Examinations of the following undergraduate and postgraduate examinations of Chemistry:

3 I. B.Sc. (Biotechnology) / B.Sc. (Bioscience) / B.Sc. (Geology)/ B.Sc. B.Ed. Examination:

i.	First Semester Examination, December 2019	No Change
ii.	Second Semester Examination, April/May 2020	Change[a]
iii.	Third Semester Examination, December 2020	Minor Change[b]
iv.	Fourth Semester Examination, April/May 2021	Minor Change[c]
v.	Fifth Semester Examination, December 2021	Minor Change[d,e]
vi.	Sixth Semester Examination, April/May 2022	Minor Change[d,f]

The Board reviewed the objectives, syllabi, learning outcomes of the B.Sc. (Biotechnology) / B.Sc. (Bioscience) / B.Sc. (Geology)/ B.Sc. B.Ed. programmes.

(a). In B.Sc. II Semester, the syllabus of *Organic Chemistry-I* and *Organic Chemistry-I Lab* (Course Code: CHEM 103 and CHEM 103L, respectively) has been reviewed. It has been found that some topic of syllabus is advanced at this level, BOS suggested to remove these topics. Board also recommended implementing the proposed revision in syllabus of *Organic Chemistry-I* and *Organic Chemistry-I Lab* by II Semester Examination, April/May, 2020.

(b). In B.Sc. III Semester, minor revision in the syllabus of *Physical Chemistry-I* and *Physical Chemistry-I Lab* (Course Code: CHEM 202 and CHEM 202L, respectively) has been proposed. Board discussed the revision proposed and agreed upon the suggested syllabus. Board also recommended implementing the proposed revision in syllabus of *Physical Chemistry-I* and *Physical Chemistry-I Lab* by III Semester Examination, December, 2020.

(c). In B.Sc. IV Semester, minor revision in the syllabus of *Inorganic Chemistry-II* and *Inorganic Chemistry-II Lab* (Course Code: CHEM 201 and CHEM 201L, respectively) has been proposed. Board discussed the revision proposed and agreed upon the suggested syllabus. Board also recommended implementing the proposed revision in syllabus of *Inorganic Chemistry-II* and *Inorganic Chemistry-II Lab* by IV Semester Examination, April/May, 2021.

(d). In the fifth and sixth semester, elective courses along with their practical exercises specific to Chemistry disciplines are proposed to be offered as "Discipline Elective". The course "Organic Chemistry-II" and Physical Chemistry II are already offered as a core course in the fifth and sixth semester but now it is proposed to be offered as a discipline elective course. Two elective courses of Chemistry discipline "Molecular Modeling and Drug Design" and "Analytical Methods in Chemistry" are proposed to be included for the first time in B.Sc Bioscience, B.Sc. Biotechnology B.Sc. Geology and B.Sc B.Ed. programme.

The elective courses of Chemistry discipline which are proposed to be offered are as follows

- Organic Chemistry-II
- Physical Chemistry II
- Molecular Modeling and Drug Design (Newly introduced)
- Analytical Methods in Chemistry (Newly introduced)

(e). Minor revision in the syllabus of *Organic Chemistry-II* and *Organic Chemistry-II Lab* (Course Code: CHEM 302 and CHEM 302L, respectively) has been proposed. Board discussed the revision proposed and agreed upon the suggested syllabus. Board also recommended implementing the proposed revision in syllabus of *Organic Chemistry-II* and *Organic Chemistry-II Lab* by V Semester Examination, December, 2021.

(f). Minor revision in the syllabus of *Physical Chemistry-II* (Course Code: CHEM 303) has been proposed. Board discussed the revision proposed and agreed upon the suggested syllabus. Board also recommended implementing the proposed revision in syllabus of *Physical Chemistry-II* by VI Semester Examination, April/May, 2022.

The vocational course "Analytical Lab Practice-II" is proposed to be discontinued from the sixth semester.

Additionally, it is proposed that a student can opt for at most 2 additional Open (Generic) audit/credit Elective from other disciplines opting at most 1 per semester in Semesters III, IV, V or VI with prior permission of respective heads and time table permitting.

The BOS reviewed the programme specific outcomes for B.Sc. (Biotechnology)/ B.Sc. (Bioscience)/ B.Sc. (Geology)/ B.Sc. B.Ed. programmes and scheme of examinations marked as **Annexure-I**.

The revised syllabus, learning outcomes, list of recommended books and e-Sources of the B.Sc. (Biotechnology)/ B.Sc. (Bioscience)/ B.Sc. (Geology)/ B.Sc. B.Ed. programmes is attached and marked as **Annexure-II**.

3 II. B. Tech. (BT/CE/CS/IT/ECE/EEE/EIE/MCTR) Examination:

i.	First Semester Examination, December 2019	No Change
ii.	Second Semester Examination, April/May 2020	No Change
iii.	Sixth Semester Examination, December 2020	No Change

Learning outcomes, Recommended books and suggested e-Sources of the B.Tech. (BT/CE/CS/IT/ECE/EEE/EIE/MCTR) courses is attached and marked as **Annexure-III**.

3 III. M.Sc. Chemistry Examination:

i.	First Semester Examination, December 2019	Change[a]
ii.	Second Semester Examination, April/May 2020	Change[b]
iii.	Third Semester Examination, December 2020	Change[c,d & e]
iv.	Fourth Semester Examination, April/May 2021	Change[e & f]

(a). Board reviewed the syllabi of M.Sc. Chemistry I Semester. Board recommended introduction of some advanced analytical techniques to the syllabus of *Analytical Chemistry* (Course Code: CHEM 401). Board considered that it is relevant to teach "Symmetry and Group Theory" in CHEM 405 Inorganic Chemistry of M.Sc. I Semester instead of M.Sc. III Semester CHEM 507 Group theory and Photo-Inorganic Chemistry and suggested to shift the topic to I Semester. Board also recommended implementing the proposed revision in syllabi by M.Sc. Chemistry I Semester Examination, December, 2019.

(b). BOS reviewed the syllabi of M.Sc. Chemistry II Semester. Board considered the shifting of "Special Topics in Physical Chemistry" from M.Sc. III Semester to M.Sc. II Semester with some modifications and suggested to introduce a new course "Photoinorganic Chemistry" in place of "Computer Applications in Chemistry". Board recommended implementing the proposed revision in syllabi by M.Sc. Chemistry I Semester Examination, April/May, 2020.

(c). BOS reviewed the syllabi of M.Sc. Chemistry III Semester. In order to improve the writing skills and to orient the students towards research, the BOS suggested introducing a new course on Literature Dissertation. BOS advised to merge *Bio-Inorganic Chemistry*, CHEM 503 and *Bio-Organic Chemistry*, CHEM 504 courses into one with a new nomenclature "Bioinorganic and Bioorganic Chemistry". Syllabus of course *Cyclic Voltammetry and Spectroscopic Techniques*, CHEM 404 has been modified and shifted to III Semester with a new nomenclature *Physical Spectroscopy*.

(d). Board has also proposed electives and open elective courses in curricula of M.Sc. Chemistry III & IV Semester. The elective courses of Chemistry discipline which are proposed to be offered are as follows:

- Environmental Chemistry
- Nanaomaterials
- Polymer Chemistry
- Photo-organic and Heterocyclic Chemistry

(e). Board has also proposed reading electives in curricula of M.Sc. Chemistry III and IV Semesters. The elective courses of Chemistry discipline which are proposed to be offered are as follows:

Reading Electives

- Renewable Energy Resources

- Metals in Medicine
- Forensic Science
- Bio Ethics, Bio Safety and IPR
- Pharmaceutical Chemistry
- Nanocatalysis
- ICT in Teaching and Learning

(f). The BOS reviewed the Programme objectives and programme specific outcomes for M.Sc. Programme and scheme of examinations marked as **Annexure-I**.
The revised syllabus, learning outcomes, list of Recommended books and e-Sourses of the M.Sc. Chemistry programme is attached and marked as **Annexure-IV**.

4. BOS considered the reports of the examiners of various examinations of 2017-2018 and observed that in all the cases examiners were satisfied with the performance of the students.
5. The board evaluated the semester examination papers and found that most of them were analytic, descriptive and application based depending on the nature of course. The analysis of question papers is enclosed in **Annexure-V.**

The meeting ended with a vote of thanks to the Chair.

Annexure –II

Name of Programme: B.Sc.(Bio Science/Bio Technology/Geolgogy)/B.Sc. BEd

Course Details: (To be provided in the below mentioned table)

S. No.	Course List	Learning Outcomes	Existing Syllabus	Recommended Syllabus	Remarks
	B.Sc. I Sem.		**Existing Syllabus in December 2018**	**Proposed Syllabus for December 2019**	
1.	CHEM 102: Inorganic Chemistry–I	On completion of course, the students will be able to: • derive Schrodinger wave equation and quantum numbers, predict shapes of orbital from probability curves and apply Slater's rule for calculating Z_{eff}. • explain periodic properties like atomic and ionic radii, ionization energy, electron affinity and electronegativity. • demonstrate bonding theories including valence bond theory, valence shell electron pair repulsion and molecular orbital theory and its applications. • determine ionic structure of solids with the help of radius ratio values for coordination numbers 3, 4 and 6 and have brief knowledge of metallic bond. • acquire knowledge of characteristic properties of 3d series elements and it's comparison with 4d and 5d series. • apply the Werner's coordination theory and its experimental verification; to solve numerical problems based on effective atomic number concept.	**Unit 2** **Chemical Bonding:** Covalent bond: resonance, valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions, valence shell electron pair repulsion (VSEPR) theory with reference to BF_3, BF_4^-, NH_3, H_2O, H_3O^+, PCl_5, SF_4, CIF_3, I_3^-, SF_6, IF_7, ICI_2^-, and $POCl_3$; MO theory, simple LCAO theory; sigma, pi and delta molecular orbitals; homonuclear and heteronuclear (CO and NO) diatomic molecules and their ions, multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference. **Ionic Solids:** Ionic structure, radius ratio effect and coordination number, calculation of limiting radius ratio values for CN 3, 4 and 6; limitations of radius ratio rule, lattice defects, semi-conductors, lattice energy, Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarisability of ions, Fajan's rule, metallic bond: free electron, valence bond and band theories; weak interactions: hydrogen bonding, Van der Waals interactions.	**Unit 2** **Chemical Bonding:** Covalent bond: resonance, valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions, valence shell electron pair repulsion (VSEPR) theory with reference to BF_3, BF_4^-, NH_3, H_2O, H_3O^+, PCl_5, SF_4, CIF_3, I_3^-, SF_6, IF_7, ICI_2^-, and $POCl_3$; MO theory, simple LCAO theory; sigma, pi and delta molecular orbitals; homonuclear and heteronuclear (CO and NO) diatomic molecules and their ions, multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference. **Ionic Solids:** Ionic structure, radius ratio effect and coordination number, calculation of limiting radius ratio values for CN 3, 4 and 6; limitations of radius ratio rule, lattice defects, semi-conductors, lattice energy (excluding mathematical derivation), Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarisability of ions, Fajan's rule, metallic bond: free electron, valence bond and band theories; weak interactions: hydrogen bonding, Van der Waals interactions.	Topic lattice energy has been more specified.
				Recommended Books: 1. Lee, J. D. (1998). *Concise Inorganic Chemistry* (5th ed.). United Kingdom:	Recommended Books have been reviewed

				Wiley/Oxford Publications. 2. Puri, B.R., Sharma, L.R. &. Kalia, K.C. (2017). *Principles of Inorganic Chemistry* (33rd ed.). India: Vishal Publications. 3. Cotton, F. A., & Wilkinson, G. (1994). *Basic Inorganic Chemistry* (3rd ed.). United Kingdom: John Wiley Publications**.** 4. Bhagchandani, P. (2017)**.** *Inorganic Chemistry*. India: Sahitya Bhawan Publications. 5. Malik, W. U., Tuli, G.D., & Madan, R. D.(2010). *Selected Topics in Inorganic Chemistry*. (Revised ed.).India: S. Chand Publications**.**	and some new books have been added.
				Recommended e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
	B.Sc. I Sem.		**Existing Syllabus in December 2018**	**Proposed Syllabus for December 2019**	
2.	CHEM 102L: Inorganic Chemistry–I Lab	On completion of course, the students will be able to: • understand the principles of working with laboratory equipments and ability to properly use them during chemistry experiments. • prepare standard solution of various secondary standard salts. • process purification of impure compounds by crystallization. • calibrate lab equipments like pipettes and burettes. • analyze, separate and identify inorganic ions from various groups.	1. **Semi-micro Analysis**: anion analysis; cation analysis-separation and identification of ions from groups Zero, I, II, III, IV, V and VI. 2. **Calibration**: fractional weights, pipettes and burettes, preparation of standard solutions; Dilution-0.1 M to 0.001 M solutions. 3. **Volumetric Analysis** (a) Determination of acetic acid in commercial vinegar using NaOH. (b) Determination of alkali content-antacid tablet using HCl. (c) Estimation of calcium content in chalk as calcium oxalate by permanganometry. (d) Estimation of copper using thiosulphate.	1. **Semi-micro Analysis**: Anion and cation analysis, separation and identification of ions from groups Zero, I, II, III, IV, V and VI. 2. **Calibration**: fractional weights, pipettes and burettes, preparation of standard solutions (0.1 M to 0.001 M). 3. **Volumetric Analysis** (a) Determination of acetic acid in commercial vinegar using NaOH. (b) Determination of alkali content in antacid tablet using HCl. (c) Estimation of calcium content in chalk as calcium oxalate by permanganometry. (d) Estimation of copper using thiosulphate.	Green highlighted content has been modified.
				Recommended Books:	Recommended

				1. Gurdeep, R (2016), *Advanced Practical Inorganic Chemistry*, revised Ed., Krishna Prakashan publication. 2. Svehla, G. (2010), Vogel's *Qualitative Inorganic Analysis*, 7th Edition, Prentice Hall. 3. Gurtu, J. N. and Gurtu , A (2011), *Physical Chemistry Vol – I*, Pragati Prakashan publication.	Books have been added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
	B.Sc. II Sem.		**Existing Syllabus in April/May 2019**	**Proposed Syllabus for April/May 2020**	
3.	CHEM 103: Organic Chemistry-I	On completion of course, the students will be able to: • explain the organic reactions and their mechanisms • explain the stereochemistry of the organic compounds including their optical activity, conformations and configurations • explain physical and chemical properties of the hydrocarbons, alcohols, carbonyl compounds and carboxylic acids • understand the basics of chemistry of aromatic compounds	**Unit 4** **Aromaticity:** Nomenclature of benzene derivatives, aromatic nucleus, side chain, aryl group, structure of benzene:-Kekule structure, MO diagram; aromaticity: -Huckel rule, aromatic, anti-aromatic and non-aromatic compounds. **Aromatic Electrophilic Substitution Reactions:** General mechanism, role of σ- and π-complexes, mechanism of nitration, halogenation, sulphonation, Friedal-Crafts reaction and ~~Birch reduction~~; activating and deactivating substituents, ortho/para ratio, orientation and methods of determination of the orientation. **Alky Halides and Aryl Halides:** **Alkyl Halides:** Nomenclature, classification and methods of preparation, chemical reactions-nucleophilic substitution and elimination reactions. **Aryl Halides:** Nomenclature, classification, methods of preparation, chemical reactions:-nucleophilic aromatic substitution reactions, low reactivity of vinyl and aryl halides, high reactivity of	**Unit 4** **Aromaticity:** Nomenclature of benzene derivatives, aromatic nucleus, side chain, aryl group, structure of benzene: Kekule structure, MO diagram; aromaticity: Huckel rule, aromatic, anti-aromatic and non-aromatic compounds. **Aromatic Electrophilic Substitution Reactions:** General mechanism, role of σ- and π-complexes, mechanism of nitration, halogenation, sulphonation, and Friedel-Crafts reaction; activating and deactivating substituents, *ortho*/*para* ratio, orientation and methods of determination of the orientation. **Alky Halides and Aryl Halides:** **Alkyl Halides:** Nomenclature, classification and methods of preparation, chemical reactions: nucleophilic substitution and elimination reactions. **Aryl Halides:** Nomenclature, classification, methods of preparation, chemical reactions: nucleophilic aromatic substitution reactions, low reactivity of vinyl and aryl halides, and high reactivity of allyl and benzyl halides; DDT and BHC. **Alcohols and Phenols:**	Green highlighted content has been modified. Crossed content has been deleted.

			allyl and benzyl halides; DDT and BHC. **Alcohols and Phenols:** **Alcohols:** Nomenclature and classification, dihydric alcohols: - methods of preparation, physical properties, chemical reactions of vicinal glycols: - acidic nature, reaction with phosphorous halides, reaction with HCl, esterification, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] and pinacol-pinacolone rearrangement; trihydric alcohols- methods of formation, physical properties, chemical reactions of glycerol. **Phenols:** Nomenclature, classification, structure and bonding, preparation of phenols, physical properties, chemical reaction- acidic character, comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion, electrophilic aromatic substitution, acylation and carboxylation, Fries rearrangement, ~~Claisen rearrangement~~, Gatterman synthesis, ~~Hauben-Housch reaction,~~ Lederer-Manasse reaction and Reimer-Tiemann reaction.	**Alcohols:** Nomenclature and classification, dihydric alcohols: methods of preparation, physical properties, chemical reactions of vicinal glycols: acidic nature, reaction with phosphorous halides, reaction with HCl, esterification, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] and pinacol-pinacolone rearrangement; trihydric alcohols: methods of preparation, physical properties, chemical reactions of glycerol. **Phenols:** Nomenclature, classification, structure and bonding, preparation of phenols, physical properties, chemical reactions: acidic character, comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion, electrophilic aromatic substitution, acylation and carboxylation, Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Lederer-Manasse reaction and Reimer-Tiemann reaction.	
			<u>Unit 5</u> **Aldehydes and Ketones:** Nomenclature, structure of the carbonyl group, synthesis of aldehydes and ketones with particular reference to synthesis of aldehydes and ketones from acid chlorides, ~~synthesis of aldehydes and ketones using~~ 1, 3-dithianes, synthesis of ketones from nitrile and carboxylic acids; physical properties; mechanism of nucleophilic additions to carbonyl group with particular emphasis on ~~Benzoin~~, Aldol, Perkin, Cannizaro and Knoevenagel condensations; reactions with ammonia and its derivatives; Wittig reaction, Mannich reaction, reductions:- MPV, Clemmenson, Wolf Kishner~~, $LiAlH_3$ and $NaBH_4$~~; oxidation of aldehydes (reactions with Tollen's reagents, Fehling's solution	**<u>Unit 5</u>** **Aldehydes and Ketones:** Nomenclature, structure of the carbonyl group, synthesis of aldehydes and ketones with particular reference to synthesis of aldehydes and ketones using acid chlorides and 1, 3-dithianes, synthesis of ketones from nitrile and carboxylic acids; physical properties; mechanism of nucleophilic additions to carbonyl group with particular emphasis on aldol, Perkin, Cannizzaro and Knoevenagel condensations; reactions with ammonia and its derivatives; Wittig reaction, Mannich reaction, Clemmenson reduction and Wolf-Kishner reduction; oxidation of aldehydes (reactions with Tollen's reagents, Fehling's solution and Benedict's solution) and ketones (Baeyer-Villiger oxidation). **Carboxylic Acids:** Nomenclature, structure and bonding,	Green highlighted content has been modified. Crossed content has been deleted.

			and Benedict's solution) and ketones (Baeyer-Villiger oxidation). **Carboxylic Acids:** Nomenclature, structure and bonding, preparation, physical properties, ~~acidity of carboxylic acids~~, effects of substituents on acid strength, chemical reactions of carboxylic acids: salt formation, formation of acid derivatives, reduction, reaction with Grignard reagent, decrboxylation and halogenation (Hell-Volhard-Zelinsky reaction); ~~hydroxy acids: - malic acid, tartaric acid and citric acid.~~	preparation, physical properties, effects of substituents on acid strength, chemical reactions of carboxylic acids: salt formation, formation of acid derivatives, reduction, reaction with Grignard reagent, decrboxylation and halogenation (Hell-Volhard-Zelinsky reaction).	
				Recommended Books: 1. Clayden, J., Greeves, N., Warren, S., & Wothers, P., (2001). *Organic Chemistry.* (2nd ed.).Oxford University Press. 2. Sykes, P. (1986). *A guide book to mechanism in organic chemistry* (6th ed.). Pearson. 3. Ingold, C. K. (1970). *Structure and mechanism in organic chemistry*. Cornell University Press. 4. Morrison, R.T., Boyd, R.N. (2002). *Organic chemistry* (6th ed.). PrentlceHall: Englewood Cliffs, NJ. 5. Nasipuri, D. (1994). *Stereochemistry of organic compounds.* (2nd ed.). New Age International 6. Singh, M.S. (2005). *Advanced organic chemistry-reactions and mechanisms*. Pearson Education (Singapore) Pvt. Ltd. 7. Wade, L.G., Singh, M.S. (2008). *Organic chemistry*. Pearson Education, Dorling Kindersley Pvt. Ltd. 8. Singh, M.S. (2014). *Reactive intermediates in organic chemistry-structure, mechanism and reactions*. Wiley, VCH, & Weinheim. 9. Eliel E. L., Wilen S. H., Manden L. N. (2005). *Stereochemistry of Carbon compounds*. Wiley & sons.	Recommended Books have been reviewed and some new books have been added.
				Suggested e-Sources: 1. National Programme on Technology	Suggested e-Sources have been added.

				Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	
	B.Sc. II Sem.		**Existing Syllabus in April/May 2019**	**Proposed Syllabus for April/May 2020**	
4.	CHEM 103L: Organic Chemistry-I Lab	On completion of course, the students will be able to: • determine melting point and boiling point of organic compounds. • understand concept of purification of impure compounds by crystallization and distillation. • determine R_f value and separation of analytes by paper chromatography. • identify functional groups of organic analytes.	~~**Laboratory techniques:**~~ **Calibration of Thermometer** • Naphthalene (80-82^{O}C), Acetanilide (113.5-114^{O}C), Urea (132.5- 133^{O}C), Distilled Water (100^{O}C). **Determination of boiling point** • Ethanol (78^{O}), Cyclohexane (81.4^{O}), Toluene (110.6^{O}), Benzene (80^{O}). **Mixed melting point determination** Urea-cinnamic acid mixture of various compositions (1:4, 1:1, 4:1). **Distillation** • Simple distillation of ethanol-water mixture using water condenser. • Distillation of nitrobenzene and aniline using air condenser. **Crystallization** • Concept of introduction of crystallization • Phthalic acid from hot water (using fluted filter paper and steamless funnel) • Acetanilide from boiling water • Naphthalene from ethanol • Benzoic acid from water **Decolorisation and crystallization using charcoal** • Decolorisation of brown sugar (sucrose) with animal charcoal using gravity filtration. • Crystallization and decolorisation of impure naphthalene ~~(100 g of naphthalene mixed with 0.3 g of Congo Red using 1 g decolorizing~~	• To calibrate the thermometer using naphthalene (80-82□C), acetanilide (113.5-114□C), urea (132.5-133□C), water (100□C) as reference materials. • To Determe the boiling point of ethanol, cyclohexane, toluene, benzene. • To determine the mixed melting point of Urea-cinnamic acid mixture of various compositions (1:4, 1:1, 4:1). **Distillation** • Simple distillation of ethanol-water mixture using water condenser. • Distillation of nitrobenzene and aniline using air condenser. **Crystallization** • Concept of introduction of crystallization • Phthalic acid from hot water (using fluted filter paper and steamless funnel) • Acetanilide from boiling water • Naphthalene from ethanol • Benzoic acid from water **Decolorisation and Crystallization using Charcoal** • Decolorisation of brown sugar (sucrose) with animal charcoal using gravity filtration. • Crystallization and decolorisation of impure naphthalene **Sublimation (Simple and Vacuum)** **Qualitative Analysis:** • **Part-I** Detection of extra elements (N, S and halogens) and functional groups (carboxylic, alcoholic, phenolic, carbonyl, ester, carbohydrate, amine, amide and nitro) in simple organic	Green highlighted content has been modified. Crossed content has been deleted.

			~~carbon) from ethanol.~~ **Sublimation (Simple and Vacuum)** **Qualitative Analysis:** • **Part-I** Detection of extra elements (N, S and halogens) and functional groups (carboxylic, alcoholic, phenolic, carbonyl, ester, carbohydrate, amine, amide and nitro) in simple organic compounds • **Part-II** Identification of an organic compound through the functional group analysis, determination of melting points and preparation of suitable derivatives. **Stereochemical Study of Organic Compounds via Models:** • R and S configuration of optical isomers. • E, Z configuration of geometrical isomers. • Conformational analysis of cyclohexanes and substituted cyclohexanes. **Paper Chromatography: Ascending and Circular:** • Determination of R_f values and identification of organic compounds. • Separation of monosaccharides-a mixture of D-galactose and D-fructose using n-butanol: acetone: water (4:5:1), spray reagent-aniline hydrogen phthalate.	compounds • **Part-II** Identification of an organic compound through the functional group analysis, determination of melting points and preparation of suitable derivatives. **Stereochemical Study of Organic Compounds via Models:** • R and S configuration of optical isomers. • E and Z configuration of geometrical isomers. • Conformational analysis of cyclohexanes and substituted cyclohexanes. **Paper Chromatography: Ascending and Circular:** • Determination of R_f values and identification of organic compounds. • Separation of monosaccharides (a mixture of D-galactose and D-fructose) using n-butanol, acetone and water in 4:5:1 ratio, and spray reagent (aniline hydrogen phthalate).	
				Recommended Books: 1. Leonard, J., Lygo, B., Procter, G. (2013). *Advanced Practical Organic Chemistry* (3rd ed.). CRC Press, Taylor & Francis Group. 2. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. (1989). *Practical Organic Chemistry* (5th ed.). New York, John Wiley & Sons, Inc.	Recommended Books have been added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning	Suggested e-Sources have been added.

				https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	
	B.Sc. III Sem.		**Existing Syllabus in December 2018**	**Proposed Syllabus for December 2020**	
5.	CHEM 202: Physical Chemistry –I	On completion of course, the students will be able to: • explain the basic principles of thermodynamics and thermochemistry. • describe the states of matter. • explain the concepts of chemical kinetics and catalysis. • apply the concept of thermodynamics to determine the heat of neutralization of chemical reaction. • explain the concept of colloids.	**Unit 2** **Thermodynamics-I:** Definition, significance and limitations, classical versus statistical thermodynamics, definition of thermodynamic terms: system, surroundings etc., types of systems, intensive and extensive properties, state and path functions and their differentials, Eular reciprocity relation and cyclic rule, thermodynamic process, concept of heat and work. First law of Thermodynamics: statement, definition of internal energy and enthalpy, heat capacity- heat capacities at constant volume and pressure and their relationship, Joule's law, Joule-Thomson coefficient and inversion temperature, calculation of w, q, dU & ΔH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process, application of first law of thermodynamics, zeroth law of thermodynamics and the absolute temperature scale. **Thermo-chemistry:** Standard state, standard enthalpy of formation-Hess's law of heat summation and its applications, heat of reaction at constant pressure and at constant volume, various types of enthalpies of reaction-enthalpy of formation, enthalpy of combustion, enthalpy of solution, dilution and hydration, enthalpy of neutralization, ~~bond enthalpy and~~ bond dissociation energy and its calculation from thermochemical data, calculation of lattice energies from Born-Haber's cycle,	**Unit 2** **Thermodynamics-I:** Definition, significance and limitations, classical versus statistical thermodynamics, different thermodynamic terms: system, surroundings, types of systems, intensive and extensive properties, state and path functions, and their differentials, Eular reciprocity relation and cyclic rule, thermodynamic process, concept of heat and work. First law of Thermodynamics: statement, definition of internal energy and enthalpy, heat capacity: heat capacities at constant volume and pressure and their relationship, Joule's law, Joule-Thomson coefficient and inversion temperature, calculation of w, q, dU and ΔH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process, application of first law of thermodynamics, zeroth law of thermodynamics and the absolute temperature scale. **Thermo-Chemistry:** Standard state, standard enthalpy of formation: Hess's law of heat summation and its applications, heat of reaction at constant pressure and at constant volume, various types of enthalpies of reaction: enthalpy of formation, enthalpy of combustion, enthalpy of solution, enthalpy of dilution, enthalpy of hydration and enthalpy of neutralization, bond dissociation energy and its calculation from thermochemical data, calculation of lattice energy from Born-Haber's cycle, temperature dependence of enthalpy, Kirchhoff's equation, adiabatic flame temperature.	Green highlighted content has been modified. Crossed content has been deleted.

			temperature dependence of enthalpy, Kirchhoff's equation, adiabatic flame temperature.		
			Unit 3 **Thermodynamics-II:** Second law of thermodynamics: need for the law, different statements of the law, Carnot cycle and its efficiency, Carnot theorm, thermodynamic scale of temperature and its identity with ideal gas temperature scale. Concept of entropy: - entropy as a state function, characteristics of entropy function and Maxwell relations, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change, Clausius inequality and its application to an isolated system, entropy as a criteria of spontaniety and equilibrium, entropy change in ideal gases, temperature and volume, temperature and pressure variations, standard entropy of an ideal gas and mixing of gases. **Chemical Equilibrium:** Free energy of spontaneous reactions and the role of temperature, equilibrium constant and free energy, thermodynamic derivation of law of mass ~~of~~ action, Van't Hoff reaction isotherm, factors that alter the state of equilibrium, Le Chatelier's principle and its applications to physical and chemical equilibrium, reaction isotherm and reaction isochore-Clapeyron ~~equation~~ and Clausius-Clapeyron equation, applications for lquid-vapor, solid-vapor and solid-liquid equilibrium.	**Unit 3** **Thermodynamics-II:** Second law of thermodynamics: need for the law, different statements of the law, Carnot cycle and its efficiency, Carnot theorm, thermodynamic scale of temperature and its identity with ideal gas temperature scale. Concept of entropy: entropy as a state function, characteristics of entropy function and Maxwell relations, entropy as a function of V and T, entropy as a function of P and T, entropy change in physical change, Clausius inequality and its application to an isolated system, entropy as a criteria of spontaneity and equilibrium, entropy change in ideal gases, temperature and volume, temperature and pressure variations, standard entropy and entropy of mixing of ideal gases. **Chemical Equilibrium:** Free energy of spontaneous reactions and the role of temperature, equilibrium constant and free energy, thermodynamic derivation of law of mass action, Van't Hoff reaction isotherm, factors affecting the state of equilibrium, Le-Chatelier's principle and its applications to physical and chemical equilibrium, reaction isotherm and reaction isochore, Clapeyron and Clausius-Clapeyron equations and its applications for lquid-vapor, solid-vapor and solid-liquid equilibrium.	Green highlighted content has been modified. Crossed content has been deleted.
				Recommended Books: 1. Atkins, P., Julio, P. D. (2014). *Physical Chemistry* (10th Ed.), United Kingdom: Oxford University Press. 2. Castellan, G.W.(1983). *Physical Chemistry* (3rd Ed.), United State of America: Addision-Wesley Publishing Company.	Recommended Books have been reviewed and some new books have been added.

				3. West, A. R. (2014). *Solid State Chemistry and its Applications* (2nd Ed.), John Wiley &Sons Ltd. 4. Puri, B.R., Sharma, L.R., Pathania, M.S.(2016). *Principle of Physcial Chemistry* (47th Ed.), India: Vishal Publishing Company. 5. Laider, K.J.(1965). *Chemical Kinetics* (2nd Ed.), New York: McGraw Hill Book Company.	
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
	B.Sc. III Sem.		**Existing Syllabus in December 2018**	**Proposed Syllabus for December 2020**	
6.	CHEM 202L: Physical Chemistry-I Lab	On completion of course, the students will be able to: • determine the percentage composition of unknown mixture by viscosity and surface tension methods. • measure kinetics parameters of chemical reaction. • evaluate the enthalpy of neutralization. • calculate the lattice energy of $CaCl_2$ and solubility of benzoic acid at different temperatures.	**Surface Tension and Viscosity:** 1. To determine the percentage composition of a given mixture (non-interacting systems) by viscosity method. 2. ~~To determine the viscosity of amyl alcohol in water at different concentrations and calculate the excess viscosity of these solutions~~. 3. To determine the percentage composition of given binary mixture by surface tension method (acetone and ethyl/methyl ketone). **Chemical Kinetics:** 1. To determine the specific reaction rate of the hydrolysis of methyl acetate/ethyl acetate catalyzed by hydrogen ions at room temperature. 2. To study of the effect of acid strength on the hydrolysis of an ester. 3. To compare the strengths of HCl and H_2SO_4 by studying the kinetics of ethyl acetate. 4. To study kinetically the reaction rate of decomposition of iodide by H_2O_2.	**Surface Tension and Viscosity:** 1. To find the relative and absolute viscosity of the given liquid at room temperature. 2. To determine the percentage composition of given mixture (non-interacting systems) by viscosity method. 3. To find the surface tension of given liquid by drop number method at room temperature. 4. To determine the percentage composition of given binary mixture by surface tension method (acetone and ethyl/methyl ketone). **Chemical Kinetics:** 1. To determine the specific reaction rate of the hydrolysis of methyl acetate/ethyl acetate catalyzed by hydrogen ions at room temperature. 2. To study the effect of acid strength on the hydrolysis of an ester. 3. To compare the strengths of HCl and H_2SO_4 by studying the kinetics of ethyl acetate.	Grey Shaded content has been added. Crossed content has been deleted. Green highlighted content has been modified.

			Colloids: 1. To prepare arsenious sulfide sol and compare the precipitating power of mono, bi and trivalent anions. **Transition Temperature:** 1. Determination of the transition temperature of the given substance by thermometric/ ~~dialometric~~ method (e.g. $MnCl_2.4H_2O$/ $SrBr_2.2H_2O$). **Thermo-chemistry:** 1. To determine the solubility of benzoic acid at different temperatures and to determine ΔH of the dissolution process. 2. To determine the enthalpy of neutralization of a weak acid/base versus strong base/acid and determine the enthalpy of ionization of the weak acid/weak base. 3. To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born-Haber cycle. 4. Determination of heat of reaction and verification of Hess's Law.	4. To study the reaction rate of decomposition of iodide by H_2O_2 kinetically **Colloids:** 1. To prepare arsenious sulfide sol and compare the precipitating power of mono-, bi- and trivalent anions. **Transition Temperature:** 1. Determination of the transition temperature of given substance by thermometric method (e.g. $MnCl_2.4H_2O$/ $SrBr_2.2H_2O$). **Thermo-Chemistry:** 1. To determine the solubility and heat of reaction of benzoic acid at different temperatures. 2. To determine the enthalpy of neutralization of strong acid and strong base. 3. To determine the enthalpy of neutralization of weak acid and strong base. 4. To determine the enthalpy of solution of solid calcium chloride and calculate it's lattice energy using Born-Haber cycle. 5. Determination of heat of reaction and verification of Hess's law. **Partition Coefficient**: 1. To find the partition coefficient of I_2 between CCl_4 and H_2O.	
				Recommended Books: 1. Gurtu, G.N., Gurtu, A. (2014). *Avanced Physical Chemistry*, India: Pragati Prakashan . 2. Sindhu, P.S. (2005). *Practicals in Physical Chemistry*, India: Macmillan Publishers.	Recommended Books have been added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses	Suggested e-Sources have been added.

				https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	
	B.Sc. IV Sem.		**Existing Syllabus in April/May 2019**	**Proposed Syllabus for April/May 2021**	
7.	CHEM 201: Inorganic Chemistry -II	On completion of course, the students will be able to: • apply crystal field theory on different geometries and correlate it with stability. • elucidate the nomenclature, structures, magnetic properties and reactivity of transition metal complexes. • apply the concept of L-S coupling for the determination of term symbols of different spectroscopic states and appreciate its utility. • elaborate the thermodynamic and kinetic stability of metal complexes. • demonstrate the structure, bonding and reactivity of organometallic compounds. • discuss a concise treatment of the important inorganic non-aqueous solvents and its application in various known reactions. • apply HSAB principle on stability of molecules.	**Unit 5** **Bio-inorganic Chemistry:** Essential and trace elements in biological processes, metalloporphyrins:- hemoglobin, myoglobin, hemocyanin and hemerythrin; biological role of alkali and alkaline earth metal ions with special reference to Ca^{2+} in muscle contraction, nitrogen fixation-~~introduction, *in vitro* and *in vivo*.~~ **Organometallic Chemistry:** Definition, nomenclature and classification of organometallic compounds, preparation, properties, bonding and applications of alkyls and aryls of Li, Al, Hg, Sn and Ti, a brief account of metal-ethylenic complexes, mononuclear carbonyls and the nature of bonding in metal carbonyls.	**Unit 5** **Bio-Inorganic Chemistry:** Essential and trace elements in biological processes, metalloporphyrins: hemoglobin, myoglobin, hemocyanin and hemerythrin; biological role of alkali and alkaline earth metal ions with special reference to Ca^{2+} in muscle contraction, nitrogen fixation. **Organometallic Chemistry:** Definition, nomenclature and classification of organometallic compounds, preparation, properties, bonding and applications of alkyls and aryls of Li, Al, Hg, Sn and Ti, a brief account of metal-ethylenic complexes, mononuclear carbonyls and the nature of bonding in metal carbonyls.	Grey Shaded content has been added. Crossed content has been deleted.
				Recommended Books: 1. Lee, J.D (1998). *Concise Inorganic Chemistry*, (5th ed.). Oxford Publications. 2. Puri, B.R, Sharma, L.R., Kalia, K.C. (2017). *Principles of Inorganic Chemistry*, (3rd ed.). Vishal Publications. 3. Cotton, F. A., Wilkinson, G. (1994). *Basic Inorganic Chemistry*, (3rd ed.). John Wiley Publications 4. *Huheey, J.E., Keiter, J.A.* & *Keiter, R.L. (*1997*), Inorganic Chemistry: Principles of Structure and Reactivity*, 4th (ed.) Pearson Publications. 5. Bhagchandani, P. (2017), *Inorganic Chemistry*, Sahitya Bhawan Publications. 6. Malik, W.U., Tuli, G.D. & Madan, R.D. (2010), *Selected Topics in Inorganic Chemistry*, Revised Ed., S. Chand Publications.	Recommended Books have been reviewed and some new books have been added.

				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
	B.Sc. IV Sem.		**Existing Syllabus in April/May 2019**	**Proposed Syllabus for April/May 2021**	
8.	CHEM 201L: Inorganic Chemistry–II Lab	On completion of course, the students will be able to: • perform the proper procedures and have the knowledge of regulations for safe handling and use of chemicals. • predict chemical bonding or molecular geometry of various complexes based on accepted models. • synthesize various transition metal complexes. • Handle instruments like calorimeter and potentiometer.	**Analysis of the following by volumetrically/gravimetrically (any four):** 1. Estimation of Barium (as sulphate) 2. Estimation of Lead (as sulphate) ~~3. Estimation of Silver (as Chloride)~~ 4. Estimation of Zinc (as ammonium sulphate) 5. Estimation of Magnesium (as magnesium hydrogen phosphate) 6. Estimation of Copper (as thiocynate) 7. Estimation of Nickle (as nickel dimethyl glyoximate) **Complexometric titrations using disodium salt of EDTA:** 1. Estimation of Mg^{2+}, Zn^{2+} 2. Estimation of Ca^{2+} by substitution method **Preparation and analysis of following complexes:** 1. Sodium trioxalatoferrate (III). 2. Tetraamminecopper (II) sulphate. 3. Sodium trioxalatochromate (III). ~~4. Dimethylglyoximatonickel (II) ion.~~ 5. cis- and trans-diaquadioxalatochromate (III) ion. ~~**Instrumentation**~~ **Colorimetric** 1. Job's method 2. Mole-ratio method **Adulteration Analysis** (any one of the following)**:** 1. Food stuffs 2. Effluent analysis **Solvent Extraction:** 1. Separation and estimation of Mg (II)	**Analysis of the following by Volumetrically/Gravimetrically:** 1. Estimation of Barium (as sulphate) 2. Estimation of Lead (as sulphate) 3. Estimation of Zinc (as ammonium sulphate) 4. Estimation of Magnesium (as magnesium hydrogen phosphate) 5. Estimation of Copper (as thiocynate) 6. Estimation of Nickle (as nickel dimethyl glyoximate) **Complexometric Titrations using Disodium Salt of EDTA:** 1. Estimation of Mg^{2+} and Zn^{2+} 2. Estimation of Ca^{2+} by substitution method **Preparation and Purification of following Complexes:** 1. Sodium trioxalatoferrate (III) 2. Tetraamminecopper (II) sulphate 3. Sodium trioxalatochromate (III) 4. cis- and trans-diaquadioxalatochromate (III) ion **Colorimetric Estimation:** 1. Job's method 2. Mole-ratio method **Adulteration Analysis** (any one of the following)**:** 1. Food stuffs 2. Effluents **Solvent Extraction:** 1. Separation and estimation of Mg (II) and Fe (II)	Grey Shaded content has been added. Crossed content has been deleted. Green highlighted part has been modified.

			and Fe (II)		
				Recommended Books: 1. Gurdeep, R. (2016*). Advanced Practical Inorganic Chemistry*, Krishna Prakashan publication. 2. Svehla, G. (2010). Vogel's *Qualitative Inorganic Analysis*, (7th ed.). Prentice Hall. 3. Gurtu, J. N. and Gurtu, A(2011), *Physical Chemistry Vol – I*, Pragati Prakashan publication.	Recommended Books have been added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
B.Sc. III Year (V Semester and VI Semester): Electives					
				Proposed Syllabus for December 2021 and April/May 2022	
9.	CHEM 302: Organic Chemistry-II	On completion of course, the students will be able to: • explain the structures and properties of biomolecules: carbohydrates, amino acids, proteins and nucleic acids. • explain the structures, synthesis and properties of different class of organic compounds: nitro compounds, amines, diazonium salts, enolates, pyrrole, thiophene, furan, pyridine, indole, quinoline and isoquinoline. • discuss the basic principles of UV-visible, IR and NMR spectroscopy. • elucidate the structure of organic compounds using UV-visible, IR and NMR spectral data.	**Unit 2** **~~Ultraviolet~~ Spectroscopy:** Introduction to electromagnetic spectrum, basic principle, types of electronic transitions, factors affecting the position of UV bands: conjugation and solvent; concept of chromophore and auxochrome; bathochromic, hypsochromic, hyperchromic and hypochromic shifts; UV spectra of conjugated enes and enones: Woodward and Fieser rules, calculation of λ_{max} of simple molecules; applications: strength of hydrogen bond, geometrical isomerism, keto-enol tautomerism.	**Unit 2** **UV-visible Spectroscopy:** Introduction to electromagnetic spectrum, basic principle, types of electronic transitions, factors affecting the position of absorption bands: conjugation and solvent; concept of chromophore and auxochrome; bathochromic, hypsochromic, hyperchromic and hypochromic shifts; UV-visible spectra of conjugated enes and enones: Woodward and Fieser rules, calculation of λ_{max} of simple molecules; applications: strength of hydrogen bond, geometrical isomerism, keto-enol tautomerism. **Infrared Spectroscopy:** Basic principle, molecular vibrations, Hooke's law, selection rule, intensity and position of IR bands, factors affecting vibrational frequencies: coupled vibrations, Fermi resonance, electronic effects, hydrogen bonding and angle strain; fingerprint region, characteristic absorptions of various	Grey Shaded contents have been added.

				functional groups, interpretation of IR spectra of simple organic compounds, applications of IR spectroscopy.	
			<u>Unit 3.</u> **Organic Compounds of Nitrogen:** **(a) Nitro Compounds:** Nomenclature, preparation of nitroalkanes and nitroarenes, physical properties, chemical reactions of nitroalkanes: acidic character, mechanism of nucleophilic and electrophilic substitution, reduction; chemical reactions of nitroarenes: mechanism of nucleophilic and electrophilic substitution, reduction in acidic, neutral and alkaline media; picric acid: methods of preparation, physical properties and chemical reactions; halonitroarenes: methods of preparation and reactivity. **(b) Amines:** Nomenclature and structure, stereochemistry, separation of mixture of amines, preparation of amines:- reduction of nitro compounds, Gabriel-phthalimide reaction, Hofmann bromamide reaction, Curtius, Schmidt and Lossen rearrangements; physical properties, chemical reactions: - structural features affecting basicity of amines, amine salts as phase-transfer catalysts, electrophilic aromatic substitution, diazotization. **(c) Diazonium salts:** Nomenclature and structure, preparation, physical properties, chemical reactions: replacement of diazo group by H, OH, F, Cl, Br, I, NO_2, CN and aryl group; synthetic applications. ~~**Synthetic Dyes:**~~ ~~Classification (according to their mode of application on the fiber), colour and constitution (electronic concept), synthesis of methyl orange, congo red, malachite green, crystal violet, phenolphthalein, fluorescein, alizarin and indigo.~~	**<u>Unit 3</u>** **Organic Compounds of Nitrogen:** **(a) Nitro Compounds:** Nomenclature, preparation of nitroalkanes and nitroarenes, physical properties, chemical reactions of nitroalkanes: acidic character, mechanism of nucleophilic and electrophilic substitution, reduction; chemical reactions of nitroarenes: mechanism of nucleophilic and electrophilic substitution, reduction in acidic, neutral and alkaline media, picric acid: methods of preparation, physical and chemical properties, halonitroarenes: methods of preparation and reactivity. **(b) Amines:** Nomenclature and structure, stereochemistry, separation of mixture of amines, preparation of amines: reduction of nitro compounds, Gabriel-phthalimide reaction, Hofmann bromamide reaction, Curtius, Schmidt and Lossen rearrangements, physical properties, chemical reactions: structural features affecting basicity of amines, amine salts as phase-transfer catalysts, electrophilic aromatic substitution, diazotization. **(c) Diazonium Salts:** Nomenclature and structure, preparation, physical properties, chemical reactions: replacement of diazo group by H, OH, F, Cl, Br, I, NO_2, CN and aryl group; synthetic applications.	Crossed content has been deleted.

				Recommended Books: 1. Clayden, J., Greeves, N., Warren, S., & Wothers, P. (2001). *Organic chemistry*. (2nd ed.). Oxford University Press. 2. Sykes, P. (1986). *A guide book to mechanism in organic chemistry* (6th ed.).Pearson. 3. Ingold, C. K.(1970). *Structure and mechanism in organic chemistry*. Cornell University Press. 4. Morrison, R.T., & Boyd, R.N. (2002). *Organic chemistry* (6th ed.). Prentlce Hall. 5. Nasipuri, D. (1994). *Stereochemistry of organic compounds*. (2nd ed.). New Age International 6. Singh, M.S. (2005). *Advanced organic chemistry-reactions and mechanisms*. Pearson Education, Singapore. 7. Wade, L.G., & Singh, M. S. (2008). *Organic chemistry*. Pearson Education. 8. Singh, M.S. (2014). *Reactive intermediates in organic chemistry-structure, mechanism and reactions*. Wiley, VCH & Weinheim 9. Kemp, W. (1991). *Organic Spectroscopy*. (3rd ed.).Palgrave Houndmills. New York. 10. Mohan, J. (2001). *Organic Spectroscopy:* Principles and Applications. Narosa Publication, New Delhi. 11. Kalsi, P. S., (2016). *Organic Spectroscopy*. (7th ed.). New Age International Publishers, New Delhi *12.* Silverstein, R. M., Webster, F. X. & Kiemle, D., (2005). *Spectrometric Identification of Organic Compounds*. (7th ed.). John Wiley & Sons.	Recommended Books have been reviewed and some new books have been added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses	Suggested e-Sources have been added.

				https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	
	B.Sc. Elective			**Proposed Syllabus for December 2021 and April/May 2022**	
10	CHEM 302L: Organic Chemistry-II Lab	On completion of course, the students will be able to: • separate compounds by steam distillation. • understand concept of chromatography (TLC) by separation of green leaf pigment, mixture of dyes and organic compounds. • separate organic mixture containing two solid components and their qualitative analysis. • synthesize organic compounds by synthetic methods: acetylation, benzoylation, diazotization or coupling reaction and electrophilic substitution.	**Steam Distillation (any one of the following)** 1. Naphthalene from its suspension in water. 2. Clove oil from clove. 3. Separation of o and p-nitrophenols. **Thin Layer Chromatography** Determination of R_f values and identification of organic compounds: 1. Separation of green leaf pigment (spinach leaves may be used). 2. Preparation and separation of 2,4-dinitrophenyl hydrazones of acetone, 2-butanone, hexan-2 and 3-one using toluene and light petroleum (40:60). 3. Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5). **Qualitative Analysis** Analysis of an organic mixture containing two solid components using water, $NaHCO_3$, NaOH for separation and preparation of suitable derivatives. **Synthesis of Organic Compounds** (any two of the following) (i) Acetylation • Salicyclic acid • Aniline • Glucose • Hydroquinone ~~(ii) Benzoylation~~ ~~• Aniline~~ ~~• Phenol~~ (iii) Aliphatic Electrophilic Substitution • Preparation of iodoform from ethanol and acetone (iv) Aromatic Electrophilic Substitution	**Steam Distillation (any one of the following)** 1. Naphthalene from its suspension in water. 2. Clove oil from clove. 3. Separation of o and p-nitrophenols. **Thin Layer Chromatography** Determination of R_f values and identification of organic compounds: 1. Separation of green leaf pigment (spinach leaves may be used). 2. Preparation and separation of 2,4-dinitrophenyl hydrazones of acetone, 2-butanone, hexan-2 and 3-one using toluene and light petroleum (40:60). 3. Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5). **Qualitative Analysis** Analysis of an organic mixture containing two solid components using water, $NaHCO_3$, NaOH for separation and preparation of suitable derivatives. **Synthesis of Organic Compounds** (any two of the following) (i) Acetylation • Salicyclic acid • Aniline • Glucose • Hydroquinone (ii) Aliphatic Electrophilic Substitution • Preparation of iodoform from ethanol and acetone (iii) Aromatic Electrophilic Substitution • Nitration: Preparation of m-dinitrobenzene Preparation of p-nitroacetanilide • Halogenation: Preparation of p-bromoacetanilide Preparation of 2, 4, 6-	Grey Shaded content has been added. Crossed content has been deleted.

			• Nitration: Preparation of m-dinitrobenzene Preparation of p-nitroacetanilide • Halogenation: Preparation of p-bromoacetanilide Preparation of 2, 4, 6-tribromophenol (v) Diazoitization / Coupling • Preparation of methyl orange and methyl red (vi) Oxidation • Preparation of benzoic acid from toluene (vii) Reduction • Preparation of aniline from nitrobenzene • Preparation of m-nitroaniline from m-dinitrobenzene	tribromophenol (iv) Diazoitization / Coupling • Preparation of methyl orange and methyl red (v) Oxidation • Preparation of benzoic acid from toluene (viii)Reduction • Preparation of aniline from nitrobenzene • Preparation of m-nitroaniline from m-dinitrobenzene	
				Recommended Books: 1. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. (1989). *Practical Organic Chemistry* (5th ed.), John Wiley & Sons, Inc., New York.	Recommended Books have been added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
	B.Sc. Elective			**Proposed Syllabus for December 2021 and April/May 2022**	
11.	CHEM 303: Physical Chemistry-II	On completion of course, the students will be able to: • explain the basic principles of nuclear chemistry. • discuss the surface phenomenon, surface properties of solid and calculate the surface area of the adsorbent.	**Unit 1** **Nuclear Chemistry:** Nuclear particles, nuclear size, nuclear spin, nuclear magnetic moment, of a nucleus, discovery of radioactivity, decay processes-average life, half life; Rutherford and Soddy transformation, nuclear forces, packing fraction, binding energy, nuclear shell model, liquid drop	**Unit 1** **Nuclear Chemistry:** Nuclear particles, nuclear size, nuclear spin, nuclear magnetic moment, of a nucleus, discovery of radioactivity, decay processes-average life, half life; Rutherford and Soddy transformation, nuclear forces, packing fraction, binding energy, nuclear shell model, liquid drop model, applications of	Crossed content has been deleted.

		• discuss conductance, Arrhenius theory, Debye-Huckel-Onseger's equation and Nernst equation. • explain the concept of corrosion and factors affecting corrosion. • explain the colligative properties of solution. • Understand the congruent and non-congruent melting points, and azeotropic mixtures.	model, applications of radioisotopes, hot atom chemistry-Szilard-Chalmers reaction. **Surface Chemistry:** General terms used in adsorption, adsorption of gases by solids, factors effecting adsorption, mono~~molecular~~ and multi~~molecular~~ layer adsorption, heat of adsorption Freundlich adsorption isotherm, Langmuirs adsorption isotherm and its limitations, determination of surface area of adsorbents, change in enthalpy, entropy and free energy of adsorption, ~~BET theory and equation (no derivation) physical significance of constants, derivation of Langmuir equation from BET equation,~~ competitive adsorption, mechanism of surface reaction and activation energy.	radioisotopes, hot atom chemistry-Szilard-Chalmers reaction. **Surface Chemistry:** General terms used in adsorption, adsorption of gases by solids, factors effecting adsorption, mono and multi layer adsorption, heat of adsorption Freundlich adsorption isotherm, Langmuirs adsorption isotherm and its limitations, determination of surface area of adsorbents, change in enthalpy, entropy and free energy of adsorption, competitive adsorption, mechanism of surface reaction and activation energy.	
				Recommended Books: 1. Atkins, P., Julio, P. D. (2014). *Physical Chemistry* (10th Ed), United Kingdom: Oxford University Press. 2. Castellan, G.W. (1983). *Physical Chemistry* (3rd Ed), United State of America: Addision-Wesley Publishing Company. 3. West, A. R. (2014). *Solid State Chemistry and its Applications* (2nd Ed), John Wiley &Sons .Ltd 4. Puri, B.R., Sharma, L.R., Pathania, M.S. (2016). *Principle of Physcial Chemistry* (47th Ed). India: Vishal Publishing Company. 5. Arniker, H. J. (2005). *Essentials of Nuclear Chemistry* (4th Ed), India: New Age International Ltd. Publisher.	Recommended Books have been reviewed and some new books have been added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.

	B.Sc. Elective			**Proposed Syllabus for December 2021 and April/May 2022**	
12.	CHEM 303L: Physical Chemistry-II Lab	On completion of course, the students will be able to: • handle instruments like calorimeter, conductometer and potentiometer. • perform the proper procedures and have the knowledge of regulations for safe handling and use of chemicals. • evaluate physical properties of analytes viz. the molecular weight, conductivity, optical rotation.			
				Recommended Books: 1. Gurtu, G.N., Gurtu, A. (2014). *Avanced Physical Chemistry*, India: Pragati Prakashan . 2. Sindhu, P.S. (2005). *Practicals in Physical Chemistry*, India: Macmillan Publishers.	Recommended Books have been added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
	B.Sc. Elective			**Proposed Syllabus for December 2021 and April/May 2022**	
13.	**CHEM:** Molecular Modeling and Drug Design	On completion of course, the students will be able to: • describe and comprehend the fundamental concepts of molecular modeling and computational drug discovery. • understand the physicochemical properties of drugs including solubility, distribution, adsorption, and stability. • understand the molecular modeling and computer graphics • develop the theoretical and practical aspects of molecular modeling		**Unit 1** **Introduction to Molecular Modeling:** Useful Concepts in molecular modeling: Coordinate Systems, Potential Energy Surfaces, Molecular Graphics, Computer Hardware and Software. **Force Fields:** Fields, Bond Stretching, Angle Bending, Introduction to nonbonded interactions, Electrostatic interactions, van der Waals Interactions, Hydrogen bonding in Molecular Mechanics, Force Field Models for the Simulation of Liquid Water.	New Course has been Introduced
				Unit 2 **Energy Minimization and Computer Simulation:** Minimization and related methods for exploring the energy surface, Non-derivative method, First and second order minimization methods, Computer simulation methods, Simple thermodynamic properties and Phase Space, Boundaries, Analyzing the results of a simulation and estimating Errors.	

				Unit 3 **Molecular Dynamics and Monte Carlo Simulation:** Molecular Dynamics Simulation Methods, Molecular Dynamics using simple models, Molecular Dynamics with continuous potentials, Molecular Dynamics at constant temperature and pressure, Metropolis method, Monte Carlo simulation of molecules, Models used in Monte Carlo simulations of polymers.	
				Unit 4 **Structure Prediction and Drug Design:** Structure prediction - Introduction to comparative Modeling, Sequence alignment, Constructing and evaluating a comparative model, Predicting protein structures by 'Threading', Molecular docking, Structure based de novo ligand design, Drug Discovery - Chemoinformatics -QSAR.	
				Unit 5 **Pharmaceutical Compounds:** Structure and Importance Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis), artemisinin, An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).	
				Recommended Books: 1. Leach, A.R. (2001). *Molecular Modelling Principles and Application*, Longman. 2. Haile, J.M. (1997). *Molecular Dynamics Simulation Elementary Methods*, John Wiley and Sons. 3. Gupta, S.P. (2008). *QSAR and Molecular Modeling*, Springer - Anamaya Publishers.	
				Suggested e-Sources: **1.** National Programme on Technology Enhanced Learning https://nptel.ac.in	

				2. Online Chemistry Courses https://www.edx.org/learn/chemistry **3.** Free Online Education SWAYAM https://swayam.gov.in	
	B.Sc. Elective			**Proposed Syllabus for December 2021 and April/May 2022**	
14.	**CHEM:** Molecular Modeling and Drug Design Lab	On completion of course, the students will be able to: • optimize the C-C bond lengths • perform a conformational analysis • visualize the electron density and electrostatic potential maps of different diatomic molecules • compare the shapes of different molecules and to estimate their dipole moment • compute resonance energy of the molecules		1. Compare the optimized C-C bond lengths in ethane, ethene, ethyne and benzene. Visualize the molecular orbitals of the ethane σ bonds and ethene, ethyne, benzene and pyridine π bonds. 2. (a) Perform a conformational analysis of butane. (b) Determine the enthalpy of isomerization of cis and trans 2-butene. 3. Visualize the electron density and electrostatic potential maps for LiH, HF, N_2, NO and CO and comment. Relate to the dipole moments. Animate the vibrations of these molecules. 4. (a) Relate the charge on the hydrogen atom in hydrogen halides with their acid character. (b) Compare the basicities of the nitrogen atoms in ammonia, methylamine, dimethylamine and trimethylamine. 5. (a) Compare the shapes of the molecules: 1-butanol, 2-butanol, 2-methyl-1-propanol, and 2-methyl-2-propanol. Note the dipole moment of each molecule. (b) Show how the shapes affect the trend in boiling points: (118 ºC, 100 ºC, 108 ºC, 82 ºC, respectively). 6. Build and minimize organic compounds of your choice containing the following functional groups. Note the dipole moment of each compound: (a) alkyl halide (b) aldehyde (c) ketone (d) amine (e) ether (f) nitrile (g) thiol (h) carboxylic acid (i) ester (j) amide. 7. (a) Determine the heat of hydration of ethylene. (b) Compute the resonance energy of benzene by comparison of its enthalpy of hydrogenation with that of cyclohexene.	New Course has been Introduced

				8. Arrange 1-hexene, 2-methyl-2-pentene, (E)-3-methyl-2-pentene, (Z)-3-methyl-2-pentene, and 2,3-dimethyl-2-butene in order of increasing stability. 9. (a) Compare the optimized bond angles H_2O, H_2S, H_2Se. (b) Compare the HAH bond angles for the second row dihydrides and compare with the results from qualitative MO theory. 10. Titrimetric estimation of drugs: Paracetamol, Ascorbic acid, Aspirin, etc.	
				Recommended Books: 1. Leach, A.R. (2001). *Molecular Modelling Principles and Application*, Longman. 2. Haile, J.M. (1997). *Molecular Dynamics Simulation Elementary Methods*, John Wiley and Sons. 3. Gupta, S.P. (2008). *QSAR and Molecular Modeling*, Springer - Anamaya Publishers.	
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry **3.** Free Online Education SWAYAM https://swayam.gov.in	
	B.Sc. Elective			**Proposed Syllabus for December 2021 and April/May 2022**	
15.	**CHEM:** Analytical Methods in Chemistry	On completion of course, the students will be able to: 1. apply the knowledge of basic statistics to validate the results of analysis. 2. Understand the various chromatographic techniques and it's applications in separation of mixtures, purification of samples, and qualitative and quantitative analysis. 3. understand the basic principles of optical, thermal and electro		**Unit 1** **Qualitative and Quantitative aspects of analysis:** Sampling, evaluation of analytical data, errors, accuracy and precision:, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q, and T test, rejection of data, and confidence intervals. Steps involved in chemical analysis, Principles of volumetric analysis: Theories of acid-base, redox, complexometric, iodometric and precipitation titrations - choice of indicators for these titrations,	New Course has been Introduced

		analytical methods and apply its concepts to interpretation of compounds. 4. explain the principle and applications of thermal methods of analysis and atomic spectroscopy		Principles of gravimetric analysis: precipitation, coagulation, peptization, coprecipitation, post precipitation, digestion, filtration and washing of precipitate, drying and ignition.	
				Unit 2 **Optical methods of analysis:** Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; Basic principle of quantitative analysis: estimation of metal ions from aqueous solution. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method. Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. Effect and importance of isotopic substitution	
				Unit 3 **Thermal and Atomic Absorption methods of analysis:** Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture. . Atomic Absorption Spectrometry: Introduction, Principal of AAS. Classification of atomic spectroscopic methods, Advantages and disadvantages of AAS. Measurement of atomic absorption, Instrumentation for atomic absorption spectrometer and application of AAS	
				Unit 4 **Electro analytical methods**: Classification of electroanalytical methods, Types of reversible electrodes:-gas-metal ion, metal-metal ion, metal-insoluble salt-anion and redox electrode reactions, basic principle	

				of pH metric: determination of streingth of unknown acids (Strong, Weak and mixture), potentiometric: principle, instrumrntation and application (determination of transport number. Detternimation of valency of an ions in doubtful cases, solubility, solubility product and activity coefficient, acid-base, precipitation and redox titrations), definition of pH and $pK_{a,}$ determination of pH by potentiometric methods and conductometric titrations. Electrophoreses: principle, instrumentation and types of electrophoreses methods. Electro osmosis: principle and instrumentation.	
				Unit 5 **Separation Techniques:** Chromatography: Classification of chromatography methods, principles of differential migration adsorption phenomenon, Nature of adsorbents, solvent systems, Rf values, factors effecting Rf values. Paper Chromatography: Principles, Rf values, experimental procedures, choice of paper and solvent systems, developments of chromatogram - ascending, descending and radial. Two dimensional chromatography, applications. Thin layer Chromatography (TLC): Advantages. Principles, factors effecting Rf values. Experimental procedures. Adsorbents and solvents. Preparation of plates. Development of the chromatogram. Detection of the spots. Applications. Column Chromatography: Principles, experimental procedures, Stationary and mobile Phases, Separation technique and Applications	
				Recommended Books: 1. Christian, G. D., *Analytical Chemistry*, John wiley; 6th edition. 2. Skoog, D. A., West, D. M., Hollar, F. J. & Crouch S. R.; *Fundamentals of analytical chemistry*, cengage learning; 9 ed. 3. Willard, H. L., Merritt, l. , dean, j.a. &	

				settle, f.a.(2004) *instrumental methods of analysis*; hcbs publishing new delhi: 7th ed. 4. Ewing, g. W. Ewing, *instrumental methods of chemical analysis*, mcgraw-hill int 5th ed. 5. holler, f. J., skoog, d. A. & crouch, s. R. *Priniciples of instrumental analysis*, thomson books/cole , 6thed.. 6. Willard, h.h., merritt, j.a. Dean, l.l. & settle, f.a. *Instrumental methods of analysis*, cbs publishing new delhi, 7th ed. 7. Kaur, H.,(2010). Spectroscopy, Pragati Prakashan, India.	
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry **3.** Free Online Education SWAYAM https://swayam.gov.in	
	B.Sc. Elective			**Proposed Syllabus for December 2021 and April/May 2022**	
16.	**CHEM:** Practical Lab: Analytical Methods In Chemistry	On completion of course, the students will be able to: 1. develop their skills for qualitative and quantitative research in different fields. 2. perform various analytical operations to qualify and quantify different analytes. 3. outline synthetic strategies for important chemicals. 4. check the purity of synthesized compounds through TLC, UV, FT-IR spectral data 5. analysis of soil through determination pH, estimation of ions and by total dissolve salts. 6. able to determine the Chemical and biological oxygen demand by spectroscopic techniques.		**Separation Techniques** **1. Chromatography:** (a) Separation of mixtures (i) Paper chromatographic separation of Fe3+, Al3+, and Cr3+. (ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the Rf values. (b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their Rf values. (c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC. **2. Solvent Extractions:** (a) To separate a mixture of Ni2+ & Fe2+ by	New Course has been Introduced

				complexation with DMG and extracting the Ni2+- DMG complex in chloroform, and determine its concentration by spectrophotometry. (b) Solvent extraction of zisconium with amberliti LA-1, separation from a mixture of irons and gallium. (c) Determine the pH of the given aerated drinks fruit juices, shampoos and soaps. (d) Determination of Na, Ca, Li in cola drinks and fruit juices using fame photometric techniques. (e) Analysis of soil: (i) Determination of pH of soil. (ii) Total soluble salt (iii) Estimation of calcium, magnesium, phosphate, nitrate (f) Ion exchange: (i) Determination of exchange capacity of cation exchange resins and anion exchange resins. (ii) Separation of metal ions from their binary mixture. (iii) Separation of amino acids from organic acids by ion exchange chromatography. **Spectrophotometry** 1. Determination of pKa values of indicator using spectrophotometry. 2. Structural characterization of compounds by infrared spectroscopy. 3. Determination of dissolved oxygen in water. 4. Determination of chemical oxygen demand (COD). 5. Determination of Biological oxygen demand (BOD). 6. Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method.	
				Recommended Books: 1. Gurdeep, R (2016*), Advanced Practical Inorganic Chemistry*, revised Ed., Krishna Prakashan publication. 2. Svehla, G. (2010), Vogel's *Qualitative*	

				Inorganic Analysis, 7th Edition, Prentice Hall. 3. Gurtu, J. N. and Gurtu, A(2011), *Physical Chemistry Vol – I*, Pragati Prakashan publication. 4. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. (1989). *Practical Organic Chemistry* (5th ed.). New York, John Wiley & Sons, Inc. 5. Christian, Gary D. (2004*), Analytical Chemistry*, New York, 6th Ed. John Wiley & Sons. 6. Khopkar, S.M. (2009), *Basic Concepts of Analytical Chemistry*, New Age, International Publisher. 7. Christian, Gary D. (2004), *Analytical Chemistry*, New York , 6th Ed. John Wiley & Sons.	
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry **3.** Free Online Education SWAYAM https://swayam.gov.in	

Annexure –III

Name of Programme: B.Tech.(CSE/IT/EC/EE/EI/MCTR/BT/CE)

Course Details: (To be provided in the below mentioned table)

S. No.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
	B. Tech. I Sem.			**Proposed Syllabus for December 2019**	
1.	CHEM 101: Chemistry	On completion of course, the students will be able to: • explain the basics of atomic structure and chemical bonding. • explain the behavior of the system through phase, degree of freedom and component. • explain the basics of electrochemistry, different type of corrosion and their prevention. • differentiate nanoscience, nanotechnology, nanochemistry, conventional and non-conventional energy sources and their applications.			
				Recommended Books: 1. B.R. Puri and L.R. Sharma & K.C. Kalia (2017), *Principles of Inorganic Chemistry*, 33rd Ed.,Vishal Publications. 2. L.R Sharma, M.S Pathania B.R Puri and Navjot Kaur (2018), A Textbook of Physical Chemistry, Vishal Publications. 3. W. U. Malik, G.D.Tuli & R. D. Madan (2010), *Selected Topics in Inorganic Chemistry*, Revised Ed., S. Chand Publications. 4. Gurdeep Raj(2014), Advanced Physical Chemistry, goel publications. 5. J.D. Lee (1998), *Concise Inorganic Chemistry*,5th Ed, Oxford Publications. 6. F. A. Cotton and G. Wilkinson (1994), *Basic Inorganic Chemistry*,3rd Ed., John Wiley Publications. 7. P. Bhagchandani (2017), *Inorganic* Chemistry, Sahitya Bhawan Publications. 8. S.S. Dara and S.S.Umare (2004), Textbook of Engineering Chemistry, S. Chand Publications.	Recommended books have been reviewed and some new books have been added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM	Suggested e-Sources have been added.

				https://swayam.gov.in	
	B.Tech. VI Sem			**Existing Syllabus for April/May 2022**	
2.	CHEM 301: Analytical Techniques	On completion of course, the students will be able to: • understand the principle and various types of chromatography. • understand and apply the concept and application of electrophoresis. • understand the principles of NMR, UV-visible and IR spectroscopy. • perform theoretical calculations related to the techniques discussed.			
				Recommended Books: 1. Christian ,G. D., *Analytical Chemistry*, John Wiley; 6th Edition. 2. Skoog, D.A., West, D.M., Hollar, F.J.& Crouch S.R.; *Fundamentals of Analytical Chemistry*, Cengage learning; 9 Ed. 3. .Willard, H. L., Merritt, L. , Dean, J.A. & Settle, F.A.(2004) *Instrumental methods of Analysis*; HCBS Publishing New Delhi: 7th Ed. 4. Ewing, G. W. Ewing, *Instrumental Methods of Chemical Analysis*, McGraw-Hill Int 5th Ed. 5. .Holler, F. J., Skoog, D. A. & Crouch, S. R. *Priniciples of Instrumental Analysis*, Thomson Books/Cole , 6thEd. 6. Mendham, J., Denney, R.C. , Barnes ,J.D. & Thomas, M. *Text Book of Quantitative Inorganic Analysis*, Pearson Education Asia,6th Ed. 7. Willard, H.H., Merritt, J.A. Dean, L.L. & Settle, F.A. *Instrumental Methods of Analysis*, CBS Publishing New Delhi, 7th Ed.	Recommended books have been reviewed and some new books have been added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.

Annexure –IV

Name of Programme: M.Sc. Chemistry

Course Details: (To be provided in the below mentioned table)

S. No.	Course List	Learning Outcomes	Existing Syllabus	Suggested Syllabus	Remarks
	M.Sc. I Sem.		**Existing Syllabus in December 2018**	**Proposed Syllabus for December 2019**	
1.	CHEM 401: Analytical Chemistry	On completion of course, the students will be able to: • apply knowledge of basic statistics to validate the results of analysis. • understand various chromatographic techniques and it's applications in separation of mixtures, purification of samples, and qualitative and quantitative analysis. • apply the concept of electrophoresis. • explain the principle and applications of thermal methods of analysis and atomic spectroscopy	**Section-A** General introduction to principles and types of chromatography according to shape of chromatographic bed, physical sate of mobile phase, mechanism of separation and techniques involved. **Paper Chromatography:** Principle, types, choice of paper, visualization, applications. **Thin Layer Chromatography (TLC):** principle, advantage over paper chromatography, types, preparation of thin layer, choice of sorbent and solvent, development, detection and applications. **High Performance Thin Layer Chromatography (HPTLC):** principle, advantage over TLC, instrumentation, choice of sorbent and solvent, development, detection and applications. **Column Chromatography:** principle, column efficiency, factors influencing column efficiency, experimental set up and applications.	**Section-A** Error: types of errors, measurement, accuracy and precision, significant figure, Mean, median and standard deviation, Correlation and regression. General introduction to principles and types of chromatography according to shape of chromatographic bed, physical sate of mobile phase, mechanism of separation and techniques involved. **Paper Chromatography:** Principle, types, choice of paper, visualization, applications. **Thin Layer Chromatography (TLC):** Principle, advantage over paper chromatography, types, preparation of thin layer, choice of sorbent and solvent, development, detection and applications. **High Performance Thin Layer Chromatography (HPTLC):** Principle, advantage over TLC, instrumentation, choice of sorbent and solvent, development, detection and applications. **Column Chromatography:** Principle, column efficiency, factors influencing column efficiency, experimental set up and applications.	Grey Shaded content has been added.
			Section-B **Gas Chromatography (GC):** principle, instrumentation, column efficiency, solvent efficiency, solid supports, liquid phase, liquid phase percentage, column temperature, detectors, chromatographic identification, applications. **High Performance Liquid Chromatography (HPLC):** principle,	**Section-B** **Gas Chromatography (GC):** Principle, instrumentation, column efficiency, solvent efficiency, solid supports, liquid phase, liquid phase percentage, column temperature, detectors, chromatographic identification, applications. **High Performance Liquid Chromatography (HPLC):** Principle, types:	Crossed content has been deleted.

			types-partition, adsorption, ion-exchange, size-exclusion or gel; instrumentation, **Ion-exchange Chromatography:** principle, types of ion-exchangers, regeneration, ion-exchange capacity, applications. ~~**Electrophoresis:** principle, techniques.~~	partition, adsorption, ion-exchange, size-exclusion or gel; instrumentation, **Ion-Exchange Chromatography:** Principle, types of ion-exchangers, regeneration, ion-exchange capacity, applications. **Electrophoresis:** Principle, techniques.	
			Section-C ~~**Diffraction Method:**~~ ~~X-ray diffraction: theories, Bragg's law, van Laue condition, structure factor and phase problem; light scattering: fundamental concepts, scattering from number of small particles: Rayleigh scatterring, scatterring from particles that are small compared to wavelength of radiation, low angle X-ray scattering and ORD.~~ ~~**Instrumentation & Basic Principle:**~~ ~~Electron probe methods: scanning electron microscopy, transmission electron microscopy; Scanning probe methods: scanning transmission microscopy, atomic force microscopy, Optical probe methods: Dynamic light scattering; Photon probe methods: UV-VIS-NIR, FT-IR, surface plasma résonance (SPR), surface enhanced Raman scattering (SERS).~~	**Section-C** **Molecular Fluorescence, Phosphorescence and Chemiluminescence:** a) Principles of luminescence b) Instrumentation for fluorescence and phosphorescence c) Chemiluminescence d) Applications of luminescence techniques **Atomic Absorption Spectroscopy** a) Principles b) Atomization process i) Flame atomization ii) Electrothermal atomization c) Atomic line widths and radiation sources for AA d) Instrumentation e) Interferences f) Background correction methods g) Merits, demerits, and applications **Atomic Emission Spectroscopy** a) Atomic spectra b) Population distribution with temperature c) Sources: arc, spark and plasma for atomic emission d) Spectrometers e) Merits, demerits, and applications	Crossed content has been deleted. Grey Shaded content has been added which is more relevant to the course.
				Recommended Books: 1. Christian, G. D. (2004). *Analytical Chemistry*, 6th Ed., New York: John Wiley. 2. Skoog, D. A., West, D. M., Hollar, F. J. & Crouch S. R. (2014). *Fundamentals of Analytical Chemistry*, 9th Ed., U.S.: Cengage Limited. 3. Willard, H. L., Merritt, L., Dean, J.A. & Settle, F.A. (2004). *Instrumental Methods of Analysis*, 7th Ed., India: CBS	Recommended Books have been reviewed and some new books have been added.

				Publishing. 4. Ewing, G.W. (1985). *Instrumental Methods of Chemical Analysis*, 5th Ed., U.S.: McGraw-Hill College. 5. Holler, F.J., Skoog, D. A. & Crouch, S. R. (2007). *Principles of Instrumental Analysis*, 6th Ed., New York: Belmont, CA: Thomson Brooks/Cole. 6. Mendham, J., Denney, R.C., Barnes, J.D. & Thomas, M. (2000). *Text Book of Quantitative Inorganic Analysis*, 6th Ed., U.S.: Prentice Hall	
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Resources have been added.
	M.Sc. I Sem.		**Existing Syllabus in December 2018**	**Proposed Syllabus for December 2019**	
2.	CHEM 402L: Chemistry Lab-I	On completion of course, the students will be able to: • develop their skills for qualitative and quantitative research in different fields. • perform various analytical operations to qualify and quantify different organic and inorganic samples. • present information and write reports in a clear, effective and scientific manner.		**Recommended Books:** 1. Gurdeep, R. (2016). *Advanced Practical Inorganic Chemistry*, Revised Ed., India: Krishna Prakashan Publication. 2. Svehla, G. (2010). Vogel's *Qualitative Inorganic Analysis*, 5th Ed., U.S.: Prentice Hall. 3. Gurtu, J. N. & Gurtu, A. (2011). *Physical Chemistry Vol. I*, India: Pragati Prakashan Publication. 4. Leonard, J., Lygo, B. & Procter, G. (2013). *Advanced Practical Organic Chemistry*, 3th Ed., U.K.: CRC Press, Taylor & Francis Group. 5. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. (1989). *Practical Organic Chemistry*, 5th Ed., New York: John Wiley & Sons, Inc. 6. Gurtu, G.N., Gurtu, A. (2014). *Avanced Physical Chemistry*, India: Pragati Prakashan Publication. 7. Sindhu, P.S. (2005). *Practicals in Physical Chemistry*, India: Macmillan	Recommended Books have been added.

				Publishers.	
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
	M.Sc. I Sem.		**Existing Syllabus in December 2018**	**Proposed Syllabus for December 2019**	
3.	CHEM 405: Inorganic Chemistry	On completion of course, the students will be able to: • appreciate the role of molecular orbital theory in explaining geometry of molecules. • analyze the bonding and structural aspects of chemical species of main group elements. • explain the mechanistic aspects of metal complex reactions and relate it to the stability of metal complexes. • determine the symmetry operations of molecules. • apply group theory to study the hybridization and vibrational modes of molecules.	**Section-C** ~~**Inorganic Polymers:**~~ ~~Classification, types of inorganic polymerization, comparison with organic polymers, boron-oxygen and boron-nitrogen polymers, silicones, coordination polymers, phosphorus-nitrogen, sulfur-nitrogen, sulfur-nitrogen-fluorine compounds. Chalcogenide clusters – binary and multi-component systems, homolytic inorganic systems.~~	**Section-C** **Symmetry and Group Theory in Chemistry:** Symmetry operations, symmetry elements, group, subgroup, relation between order of a finite group and its subgroup, similarity transformation and classes, molecular point groups and their classification, representations of groups by matrices (representation for the Cn, Cnv and Dnh only), characters and properties of representation, relationship between reducible and irreducible representations, great orthogonality theorem, character table (C_{2v} and C_{3v} only). **Applications of Group Theory in Chemistry:** Formation of hybrid orbitals: σ-bonding in trigonal planar (BF_3), tetrahedral (CH_4), square pyramidal (BrF_5) and square planar (XeF_4), prediction of infrared and Raman active vibrational modes in H_2O and BF_3 molecules **Ligand Field Theory:** Splitting of levels and terms in a chemical environment, energy level diagrams and construction of energy level diagrams.	Grey Shaded content has been added, which is more appropriate to teach in I semester. Crossed content has been deleted.
				Recommended Books: 1. Bhattacharya, P., *Group theory and its chemical applications*. India: Himalaya Prakashan. 2. Cotton, F.A., *Group theory and its chemical applications*. New York :	Recommended Books have been reviewed and some new books have been

				Wiley. 3. Cotton F.A., Wilkinson G., Murillo C.A., Bochmann M. (1999). *Advanced Inorganic Chenmistry, 6th Ed.*, New York : John Wiley & Sons. 4. Huheey J.E., Harpes, Row. (1997). *Inorganic chemistry, Principles of Structure and Reactivity, 4th Ed.*, India: Pearson Publications. 5. Greenwood N.N., Earnshaw A. (1997), *Chemistry of the element, 2nd Ed.*, Amsterdam, Netherlands : Elsevier. 6. Carlin R.L., (1986). *Magnetochemistry*, New York : Springer Verlag. 7. McCleverty J.A., Meyer T.J. (2003). *Comprehensive coordination chemistry II, 2nd Ed.*, Amsterdam, Netherlands : Elsevier.	added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
	M.Sc. I Sem.		**Existing Syllabus in December 2018**	**Proposed Syllabus for December 2019**	
4	CHEM 406: Organic Chemistry	On completion of course, the students will be able to: • understand the concept of aromaticity, nonaromaticity and antiaromaticity in organic compounds. • explain the reaction mechanism, preparation, reactivity and stability of reaction intermediates. • understand and apply the concepts of stereochemistry • explain the aliphatic nucleophilic substitution reactions.			
				Recommended Books: 1. Smith M. B., March J. (2007). *March's Advanced Organic Chemistry Reaction Mechanism and Structure. (6th ed.)*. New York : John Wiley & Sons. 2. Carey, F. A., Sundberg, R. J. (2007). *Part A: Structure and Mechanism. (5th ed.)*. Berlin, Germany: Springer. 3. House, H. O., Benjamin, W. A. (1965). *Modern Organic Reactions.* Publisher: New York. 4. Clayden, J., Greeves, N., Warren, S., Wothers, P. (2001). *Organic chemistry. (2nd ed.)*. Publisher: Oxford University	Recommended Books have been reviewed and some new books have been added.

				Press. 5. Sykes, P. (1986). *A guide book to mechanism in organic chemistry (6th ed.)*. Singapore: Pearson Education Pvt. Ltd. 6. Ingold, C. K. (1970). *Structure and mechanism in organic chemistry*. New York : Cornell University Press. 7. Morrison, R.T., Boyd, R.N. (2002). *Organic chemistry (6th Ed.)*. Prentice Hall: Englewood Cliffs, NJ. 8. Nasipuri, D. (1994). *Stereochemistry of organic compounds. (2nd ed.)*. India: New Age International. 9. Singh, M.S. (2005). *Advanced organic chemistry-reactions and mechanisms*. Singapore: Pearson Education Pvt. Ltd. 10. Wade, L.G., Singh, M.S. (2008). *Organic chemistry*. Singapore: *Pearson Education*, (Dorling Kindersley Pvt. Ltd. 11. Singh, M.S. (2014). *Reactive intermediates in organic chemistry-structure, mechanism and reactions*. Germany: Wiley, VCH, & Weinheim. 12. Eliel E. L., Wilen S. H., Manden L. N. (2005). *Stereochemistry of Carbon compounds*. New York : Wiley & sons.	
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
	M.Sc. I Sem.		**Existing Syllabus in December 2018**	**Proposed Syllabus for December 2019**	
5.	CHEM 408: Physical Chemistry	On completion of course, the students will be able to: • calculate the energy of one dimensional, three dimensional box, harmonic oscillator, rigid rotor and hydrogen atom, and			
				Recommended Books: 1. Atkin's, P., Julio, P. D., (2014). *Physical Chemistry* (10th ed.), U. K., Oxford University Press. 2. Castellan, G.W., (1983). *Physical Chemistry* (3rd ed.), USA, Addision-	Recommended Books have been reviewed and some new books

		explain the variation and perturbation theory and it's application for hydrogen atom. • apply the concept of nuclear reactions and calculate the fission product yield. • understand the radioactive techniques: neutron activation analysis, GM counter, ionization counter and tracer techniques. • derive the relationship between thermodynamic equations and solve the numerical problems. • explain the collision theory, activated complex theory and Lindemann's theory of reaction rates.		Wesley Publishing Company. 3. Chandra, A. K., (2006). *Introduction to Quantum Chemistry* (4th ed.), India, Tata McGraw Hill Publishing Company Ltd. 4. Levine, I. N., (2014). *Quantum Chemistry* (7th ed.), USA, Pearson Education. 5. Laider, K.J., (1965) *Chemical Kinetics* (2nd ed.), New York, McGraw Hill Book Company. 6. Rajaraman, J., Kuriacose, J. C., (1993). *Kinetics and Mechanism of Chemical Transformations*, India, Macmillan Publishers India Limited. 7. Arniker, H. J., (2005). *Essentials of Nuclear Chemistry* (4th ed.), India, New Age International Ltd. Publisher. 8. Puri, B.R., Sharma, L.R., Pathania, M.S. (2016). *Principle of Physcial Chemistry* (47th ed.), India, Vishal Publishing Company.	have been added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
	M.Sc. II Sem.		**Existing Syllabus in April/May 2019**	**Proposed Syllabus for April/May 2020**	
6.	CHEM 403L: Chemistry Lab - II	On completion of course, the students will be able to: • develop their skills for qualitative and quantitative research in different fields. • perform various analytical operations to qualify and quantify different analytes. • outline synthetic strategies for important chemicals. • check the purity of synthesized compounds through TLC, conductance and magnetic	**Inorganic Chemistry** **Organic Chemistry** Preparation, purification and structural studies (magnetic, electronic and IR) of inorganic complex compounds: (i). trans-potassium diaquabis(oxalato)chromate(III), trans-$K[Cr(ox)_2(H_2O)_2]$ (ii). vanadyl bis(acetylacetonate) $[VO(acac)_2]$. (iii). sodiumdiamminetetrathiocyanatochromate(III), $Na[Cr(NH_3)_2(SCN)_4]$ (iv). bis(acetate)chromate(II),	**Inorganic Chemistry** **Organic Chemistry** Preparation, purification and structural studies (magnetic, electronic and IR) of inorganic complex compounds: (i). trans-potassium diaquabis(oxalato)chromate(III), trans-$K[Cr(ox)_2(H_2O)_2]$ (ii). vanadyl bis(acetylacetonate) $[VO(acac)_2]$. (iii). sodiumdiamminetetrathiocyanatochromate(III), $Na[Cr(NH_3)_2(SCN)_4]$ (iv). bis(acetate)chromate(II),	Grey Shaded content has been added.

		susceptibility measurements, and UV, FT-IR spectral data.	$[Cr(OAc)_2].2H_2O$. (v). cis-potassium diaquabis(oxalato)chromate(III), cis-$K[Cr(ox)_2(H_2O)_2]$ (vi). tris(acetylacetonato)manganese(III), $[Mn(acac)_3]$ (vii). potassium trioxalatoferrate(III) trihydrate, $K_3[Fe(C_2O_4)_3].\ 3H_2O$. (viii). Prussian blue, $Fe_3[Fe(CN)_6]_3$. (ix). sodium hexanitritocobaltate(III), $Na_3[Co(ONO)_6]$. (x). pentaamminemonochlorocobalt(III) chloride, $[CoCl(NH_3)_5]Cl_2$. (xi). pentaammineaquacobalt(III) chloride, $[Co(H_2O)(NH_3)_5]Cl_3$ by using $[CoCl(NH_3)_5]Cl_2$ as the starting material. (xii). pentaamminenitritocobalt(III) chloride, $[Co(ONO)(NH_3)_5]Cl_2$ by using $[CoCl(NH_3)_5]Cl_2$ as the starting material. (xiii). pentaamminenitrocobalt(III) chloride, $[Co(NO_2)(NH_3)_5]Cl_3$ by using $[Co(ONO)(NH_3)_5]Cl_2$ as the starting material. **Quantitative Analysis** (i). Determination of the percentage of number of hydroxyl groups in an organic compound by acetylation method (ii). Estimation of amines/phenols using bromate-bromide solution or acetylation method (iii). Determination of iodine and saponification values of an oil sample (iv). Determination of DO, COD and BOD of water sample. **Two-steps Organic Synthesis** (i) Anthranilic acid from phthalic anhydride (Phthalic anhydride □ Phthalimide □ Anthranilic acid).	$[Cr(OAc)_2].2H_2O$. (v). cis-potassium diaquabis(oxalato)chromate(III), cis-$K[Cr(ox)_2(H_2O)_2]$ (vi). tris(acetylacetonato)manganese(III), $[Mn(acac)_3]$ (vii). potassium trioxalatoferrate(III) trihydrate, $K_3[Fe(C_2O_4)_3].\ 3H_2O$. (viii). Prussian blue, $Fe_3[Fe(CN)_6]_3$. (ix). sodium hexanitritocobaltate(III), $Na_3[Co(ONO)_6]$. (x). pentaamminemonochlorocobalt(III) chloride, $[CoCl(NH_3)_5]Cl_2$. (xi). pentaammineaquacobalt(III) chloride, $[Co(H_2O)(NH_3)_5]Cl_3$ by using $[CoCl(NH_3)_5]Cl_2$ as the starting material. (xii). pentaamminenitritocobalt(III) chloride, $[Co(ONO)(NH_3)_5]Cl_2$ by using $[CoCl(NH_3)_5]Cl_2$ as the starting material. (xiii). pentaamminenitrocobalt(III) chloride, $[Co(NO_2)(NH_3)_5]Cl_3$ by using $[Co(ONO)(NH_3)_5]Cl_2$ as the starting material. **Green Methods of Preparation** (i). bis(acetyltacetonato)copper(II) (ii). tris(acetylacetnato)iron(III) (iii). tris(acetylacetnato)manganese(III) **Quantitative Analysis** (v). Determination of the percentage of number of hydroxyl groups in an organic compound by acetylation method (vi). Estimation of amines/phenols using bromate-bromide solution or acetylation method (vii). Determination of iodine and saponification values of an oil sample (viii). Determination of DO, COD and BOD	

			(ii) Hydroquinone to 2,5-dihydroxyacetophenone (Hydroquinone □ Hydroquinone diacetate □ 2,5-dihydroxyacetophenone). (iii) 2,4-dinitrophenylhydarazine from Chlorobenzene (Chlorobenzene □ 2,4-dinitrochlorobenzene □ 2,4-dinitrophenylhydarazine). (iv) Anthroquinone from phthalic anhydride (phthalic anhydride □ o-benzoyl benzoic acid □ Anthroquinone). (iv) Acridone from *o*-chlorobenzoic acid (*o*-chlorobenzoic acid □ *N*-Phenylanthanilic acid □ Acridone) **Physical Chemistry** **Solutions:** (i) Determination of molecular weight of non-volatile and non-electrolyte/electrolyte by cryoscopic method and to determine the activity coefficeint of an electrolyte. (ii) Determination of the degree of dissociation of weak electrolyte and to study the deviation from ideal behaviour that occurs with a strong eletrolyte. **Electrochemistry** **A. Conductometry:** (i) Determination of the velocity constant, order of the reaction and energy of activation for saponification of ethyl acetate by sodium hydroxide conductometrically (ii) Determination of solubility and solubility product of sparingly soluble salts (e.g. $PbSO_4$, $BaSO_4$) conductometrically. (iii) Determination of the strength of strong and weak acids in a given mixture conductometrically. (iv) To study the effect of solvent on the conductance of $AgNO_3$ /acetic acid	of water sample. **Two-steps Organic Synthesis** (i). Anthranilic acid from phthalic anhydride (Phthalic anhydride □ Phthalimide □ Anthranilic acid). (ii). Hydroquinone to 2,5-dihydroxyacetophenone (Hydroquinone □ Hydroquinone diacetate □ 2,5-dihydroxyacetophenone). (iii). 2,4-dinitrophenylhydarazine from Chlorobenzene (Chlorobenzene □ 2,4-dinitrochlorobenzene □ 2,4-dinitrophenylhydarazine). (iv). Anthroquinone from phthalic anhydride (phthalic anhydride □ o-benzoyl benzoic acid □ Anthroquinone). (v). Acridone from *o*-chlorobenzoic acid (*o*-chlorobenzoic acid □ *N*-Phenylanthanilic acid □ Acridone) **Physical Chemistry** **Solutions:** (i). Determination of molecular weight of non-volatile and non-electrolyte/electrolyte by cryoscopic method and to determine the activity coefficient of an electrolyte. (ii). Determination of the degree of dissociation of weak electrolyte and to study the deviation from ideal behaviour that occurs with a strong electrolyte. **Electrochemistry** **A. Conductometry:** (i). Determination of the velocity constant, order of the reaction and energy of activation for saponification of ethyl acetate by sodium hydroxide conductometrically (ii). Determination of solubility and solubility product of sparingly soluble salts (e.g. $PbSO_4$, $BaSO_4$) conductometrically. (iii). Determination of the strength of strong and weak acids in a given mixture conductometrically.	

			and to determine the degree of dissociation and equilibrium constant in different solvents and in their mixtures (DMSO, DMF, dioxane, acetone and water) and to test the validity of Debye-Huckel-Onsager theory. (v) Determination of the activity coefficient of zinc ions in the solution of 0.002M zinc sulphate using Debye-Huckel's limiting law. **B. Potentiometry/pH metry** (i) Determination of strength of halides in a mixture potentiometrically. (ii) Determination of the valency of mercurous ions potentiometrically. (iii) Determination of the strength of strong and weak acids in a given mixture using a potentiometer/pH meter. (iv) Determination of temperature dependence of EMF of a cell. (v) Determination of the formation constant of silver-ammonia complex and stoichiometry of the complex potentiometrically. (vi) Acid-base titration in a non-aqueous media using a pH meter. (vii) Determination of activity and activity-coefficient of electrolyte. (viii) Determination of the dissociation constant of acetic acid in DMSO, DMF, acetone and dioxane by titrating it with KOH. (ix) Determination of the dissociation constant of monobasic/dibasic acid by Albert-Serjeant method. (x) Determination of thermodynamic constant ΔG, ΔS and ΔH for the reaction by EMF method. $Zn + H_2SO_4$ to $ZnSO_4 + 2H^+$ **C. Polarimetry** (i) Determination of rate constant for hydrolysis/inversion of sugar using a polarimeter.	(iv). To study the effect of solvent on the conductance of $AgNO_3$ /acetic acid and to determine the degree of dissociation and equilibrium constant in different solvents and in their mixtures (DMSO, DMF, dioxane, acetone and water) and to test the validity of Debye-Huckel-Onsager theory. (v). Determination of the activity coefficient of zinc ions in the solution of 0.002M zinc sulphate using Debye-Huckel's limiting law. **B. Potentiometry/pH metry** (i). Determination of strength of halides in a mixture potentiometrically. (ii). Determination of the valency of mercurous ions potentiometrically. (iii). Determination of the strength of strong and weak acids in a given mixture using a potentiometer/pH meter. (iv). Determination of temperature dependence of EMF of a cell. (v). Determination of the formation constant of silver-ammonia complex and stoichiometry of the complex potentiometrically. (vi). Acid-base titration in a non-aqueous media using a pH meter. (vii). Determination of activity and activity-coefficient of electrolyte. (viii). Determination of the dissociation constant of acetic acid in DMSO, DMF, acetone and dioxane by titrating it with KOH. (ix). Determination of the dissociation constant of monobasic/dibasic acid by Albert-Serjeant method. (x). Determination of thermodynamic constant ΔG, ΔS and ΔH for the reaction by EMF method. $Zn + H_2SO_4$ to $ZnSO_4 + 2H^+$ **C. Polarimetry** (i). Determination of rate constant for hydrolysis/inversion of sugar using a	

			(ii) Enzyme kinetics-inversion of sucrose	polarimeter. (ii). Enzyme kinetics-inversion of sucrose	
				Recommended Books: 1. Gurdeep, R**.** (20160. *Advanced Practical Inorganic Chemistry*, revised Ed., Krishna Prakashan publication. 2. Svehla, G. (2010). Vogel's *Qualitative Inorganic Analysis*, 7th Edition, Prentice Hall. 3. Gurtu , J. N. and Gurtu , A. (2011). *Physical Chemistry* Vol – I, Pragati Prakashan publication. 4. Leonard, J., Lygo, B., & Procter, G. (2013). *Advanced Practical Organic Chemistry* (3rd ed.). CRC Press, Taylor & Francis Group. 5. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. (1989). *Practical Organic Chemistry* (5th ed.). New York, John Wiley & Sons, Inc. 6. Gurtu, G.N., Gurtu, A. (2014). *Avanced Physical Chemistry*, India: Pragati Prakashan . 7. Sindhu, P.S. (2005). *Practicals in Physical Chemistry*, India: Macmillan Publishers.	Recommended Books have been added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
	M.Sc. II Sem.		**Existing Syllabus in April/May 2019**	**Proposed Syllabus for April/May 2020**	
7.	CHEM 513: Special Topics in Physical Chemistry	On completion of course, the students will be able to: • understand the principles and theory of corrosion • understand the mechanism and kinetics of corrosion • calculate the surface area of	**Section-A** **Corrosion:** Scope and economics of corrosion, causes and types of corrosion, electrochemical theories of corrosion, kinetics of corrosion (corrosion current and corrosion potential). Corrosion measurements (weight loss, OCP measurement, and polarization methods), passivity and its breakdown.	**Section-A** **Corrosion:** Scope and economics of corrosion, causes and types of corrosion: Dry corrosion, electrochemical theories of corrosion, Galvanic cell corrosion and Pitting corrosion. Kinetics of corrosion: corrosion current and corrosion potential. Corrosion measurements: weight loss, OCP measurement, and linear	"Special Topics in Physical Chemistry" paper has been shifted from M.Sc. III Semester to M.Sc. II

		adsorbents • calculate molecular mass of polymers • understand the various theory of magnetism and differentiate material on the basis of theory	Corrosion prevention (electrochemical, inhibitor, and coating methods). **Cyclic Voltammetry:** Instrumentation, current-potential relation applicable for Linear Sweep Voltammetry (LSV) and Cyclic Voltammetry (CV), interpretation of cyclic voltammograms and parameters obtainable from voltammograms.	polarization resistance methods. Corrosion prevention: electrochemical, inhibitor, and protective metallic coatings **Kinetics of Electrode Reactions:** Theoretical investigation of kinetics of an Electrode reactions, Diffusion over potential instrumentation, current-potential relation applicable for Linear Sweep Voltammetry (LSV) and Cyclic Voltammetry (CV), interpretation of cyclic voltammograms and parameters obtainable from voltammograms	Semester with some modifications" Grey Shaded content has been added.
			Section-B ~~**Rotational (Microwave) Spectroscopy:**~~ ~~Principal moment of inertia, classification of rotors: rigid rotor and non rigid rotor, selection rule (rigid rotor), effect of isotopic substitution frequencies, linear polyatomic molecules, non-linear polyatomic molecules, asymmetric Top molecules, relative intensities of spectral lines, stark effect, nuclear and electron spin interaction, instrumentation and application.~~ ~~**Raman Spectroscopy:**~~ ~~Raman Effect, theory of Raman Effect (quantum mechanical and classical), rotational Raman spectra, vibrational Raman spectra, rule of mutual exclusion and structure determination, instrumentation, presentation of spectra, determination of depolarization ratio (ρ_n) and application.~~	**Section-B** **Surface Chemistry:** Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapor pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, BET theory, mathematical derivation of BET equation, estimation of surface area using BET equation, surface films on liquids (Electro-kinetic phenomenon) **Polymer:** Polymer: definition, types of polymers, kinetics of polymerization, mechanism of polymerization, molecular mass, number and mass average molecular mass, molecular mass determination (osmometry, viscometry and diffusion), sedimentation, chain configuration of macromolecules, calculation of average dimensions of various chain structures.	Crossed content has been deleted and white font content in black background shifted from M.Sc. III Semester to M.Sc. II Semester due to accumulation of more advance topic in M.Sc. III Semester
			Section-C ~~**Photo Electron Spectroscopy (PES):**~~ ~~Principles of photoelectron spectroscopy, PES and Koopman's theorem, types of PES, photo ionization constant, chemical shift in Electron Spectroscopy for Chemical Analysis(ESCA), instrumentation, techniques of PES, atomic and molecular electron spectra, application of ESCA.~~ ~~**Electron Diffraction:**~~ ~~Principle, scattering intensity and~~	**Section-C** **Magneto Chemistry:** Magnetic susceptibility and its determination, susceptibility equivalents, Pascal's law and its applications, diamagnetism of elements, compounds and ions, Langevin's theory of paramagnetism, Curie's law, Weiss molecular field theory of paramagnetism, Curie-Weiss law, determination of Curie point. **Chemical Bonding: Molecular Quantum Mechanics**;	Crossed content has been deleted and white font content in black background shifted from M.Sc. III Semester to M.Sc. II Semester

			~~scattering angle, Wierl equation, measurement techniques, Elucidation of simple gas phase molecules, low energy electron diffraction(LEED)and structure surfaces, application of electron diffraction.~~ ~~**Neutron Diffraction:**~~ ~~Theory of neutron diffraction, scattering of neutron by solid and liquids, magnetic scattering, measurement techniques, Elucidation of Structure of Magnetically ordered unit cell, application of neutron diffraction.~~	Elementary concepts of MOT for homonuclear diatomic molecules, VBT theory Huckel theory of conjugated systems, bond order and charge density, calculations,applications on ethylene, butadiene, cyclopropenyl radical, cyclobutadiene and benzene; introduction to extended Huckel theory.	due to accumulation of more advance topic in M.Sc. III Semester Grey Shaded content has been added.
				Recommended Books: 1 Laider, K.J., (1965) *Chemical Kinetics* (2nd ed.), New York, McGraw Hill Book Company. 2 Gowarikar, V.R., Vishwanathan, N.V., & Sridhar, J., (1986) *Introduction to polymer science*, New York, John Wiley & Sons. 3 Atkin's, P., Julio, P. D., (2014). *Physical Chemistry* (10th ed.), U. K., Oxford University Press. 4 Selwood, P.W., (2013). *Magneto chemistry*, Swin burne Press. 5 Chandra, A. K., (2006). *Introduction to Quantum Chemistry* (4th ed.), India, Tata McGraw Hill Publishing Company Ltd. 6 Levine, I. N., (2014). *Quantum Chemistry* (7th ed.), USA, Pearson Education. 7 Puri, B.R., Sharma, L.R., Pathania, M.S. (2016). *Principle of Physcial Chemistry* (47th ed.), India, Vishal Publishing Company. 8 Gabor, A., Somorjai, Yimin L. (2010) *Introduction to Surface Chemistry & Catalysis*, New York, John Wiley & Sons.	Recommended Books have been reviewed and some new books have been added.
				Suggested e-Sources: 1. National Programme on Technology	Suggested e-Sources

				Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	have been added.
	M.Sc. II Sem.		**Existing Syllabus in April/May 2019**	**Proposed Syllabus for April/May 2020**	
8.	CHEM 407: Organic Reaction Mechanism	On completion of course, the students will be able to: • understand the aromatic electrophilic and nucleophilic substitution reactions, and free radical reactions. • explain the addition to C-C and C-X multiple bonds, and elimination reactions. • understand the pericyclic reactions.		**Recommended Books:** 1. Smith, M. B., March, J. (2007). *Advanced Organic Chemistry Reaction Mechanism and Structure.* 6th ed.).A John Wiley & Sons (2. Carey, F. A., Sundberg, R. J. (2007). *Part A : Structure and Mechanism*. (5th ed.). Springer 3. House, H. O., Benjamin, W. A.(1965). *Modern Organic Reactions*. W.A Benjamin New York. 4. Clayden, J., Greeves, N., Warren, S., Wothers, P. (2001). *Organic chemistry.* (2nd ed.).Oxford University Press. 5. Sykes, P. (1986). *A guide book to mechanism in organic chemistry* (6th ed.). Pearson. 6. Ingold, C. K.(1970). *Structure and mechanism in organic chemistry*. Cornell University Press. 7. Morrison, R.T., Boyd, R.N. (2002). *Organic chemistry* (6th Ed.). PrentlceHall: Englewood Cliffs, NJ. 8. Nasipuri, D. (1994). *Stereochemistry of organic compounds.* (2nd ed.). New Age International 9. Singh, M.S. (2005). *Advanced organic chemistry-reactions and mechanisms*. Pearson Education (Singapore) Pvt. Ltd. 10. Wade, L.G., Singh, M.S. (2008). *Organic chemistry*. Pearson Education, (Dorling Kindersley Pvt. Ltd. 11. Singh, M.S.(2014). *Reactive intermediates in organic chemistry-structure, mechanism and reactions*. Wiley, VCH, & Weinheim.	Recommended Books have been reviewed and some new books have been added.

				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
	M.Sc. II Sem.		**Existing Syllabus in April/May 2019**	**Proposed Syllabus for April/May 2020**	
9.	CHEM 409: Spectral Techniques in Inorganic Chemistry	On completion of course, the students will be able to: • explain the rules for predicting molecular structure of metal complexes with the help of electronic spectral study. • apply the knowledge of heteronuclear magnetic resonance spectroscopy for characterization of inorganic compounds. • characterize some iron and tin complexes with the help of Mössbauer spectroscopy. • explain the bonding and structures of paramagnetic metal complexes using ESR spectroscopy. • characterize inorganic compounds which have quadruple nucleus with the help of nuclear quadrupole resonance spectroscopy.			
				Recommended Books: 1. Lever, A.B.P. (1984). *Inorganic Electronic Spectroscopy*, Amsterdam: Elsevier 2. Ebsworth, E. A.O. (1991). *Structural Methods in Inorganic Chemistry*, Denmark: Blackwell Scientific Publications. 3. Drago, R. S. (1977). *Physical Methods in Chemistry*, U.K.: WB Saunders Co. 4. Carrington, A. & McLachlan, A. D. (1983). *Introduction to Magnetic Resonance*, New York: Chapman & Hall. 5. Parish, R.V. (1991). *NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry*, 1st Ed., U.S.: Ellis Hardwood Ltd.	Recommended Books have been reviewed and some new books have been added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
	M.Sc. II Sem.		**Existing Syllabus in April/May 2019**	**Proposed Syllabus for April/May 2020**	
10.	CHEM 410: Spectroscopy	On completion of course, the students will be able to: • explain the principle and instrumentation of UV-visible,			
				Recommended Books: 1. Pavia, D. L., Lampman, G. M. & Kriz, G. S. (2009). *Introduction to Spectroscopy*, (4th ed.): Thomson	Recommended Books have been reviewed

		IR, NMR and mass spectroscopy. • elucidate the structures of compounds using UV-visible, IR, NMR and mass spectral data. • understand the reaction mechanisms using NMR and mass spectral data. • characterize the chemical species using UV-visible and IR spectral data.		Learning. 2. Kemp, W. (1991). *Organic Spectroscopy*, (3rd ed.): Palgrave Houndmills. Basingstoke, Hampshire RG21 6XS and175 Fifth Avenue. New York. 3. Mohan, J. (2001). *Organic Spectroscopy: Principles and Applications*,India: Narosa Publication, New Delhi. 4. Kalsi, P. S. (2016*). Organic Spectroscopy*. (7th ed.), India: New Age International Publishers, New Delhi 5. Silverstein, R. M., Webster, F. X., & Kiemle, D., (2005). *Spectrometric Identification of Organic Compounds*, (7th. ed.): John Wiley & Sons. 6. Hoffmann, E. D., &Stroobant, V., (2007). *Mass Spectrometry: Principles and Applications*, (3rd ed.): John Wiley & Sons.	and some new books have been added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
	M.Sc. II Sem.		**Existing Syllabus in April/May 2019**	**Proposed Syllabus for April/May 2020**	
11.	**CODE: Photo Inorganic Chemistry**	On completion of course, the students will be able to: • understand the basic and fundamental concepts involved in photochemistry. • explain the physical and photochemical processes for the excitation of molecules using Jablonski diagram. • understand the optical properties, optical rotatory dispersion and its	**Section-A** ~~**Introduction to Computers:**~~ ~~Elements of a computer system block diagram of computer system and function of its components, concept of hardware and software, introduction to operating systems (DOS, Windows).~~ ~~**PC Software:**~~ ~~Word processing: creating and saving documents, formatting, inserting tables and pictures, mail merge, spread sheets,~~	**Section-A** **Photochemistry:** Interaction of radiation with matter, difference between thermal and photochemical processes, laws of photochemistry: Grothus-Drapper law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, internal conversion and intersystem crossing, quantum yield, photosensitized reactions, energy transfer	The course, Computer Applications in Chemistry including Lab, has been omitted and a new course, Photo Inorganic Chemistry,

		applications. • explain the types and mechanism of photochemical reactions of transition metal complexes. • describe the charge transfer transitions in transition metal complexes.	~~charts, graphs and use of functions, introduction to presentation packages, graphics and animation~~	process (simple examples). **Optical Rotation and Circular Dichroism:** Principles and fundamentals, optically active molecules, optically rotatory dispersion, circular dichroism, relationship between optically rotatory dispersion and circular dichroism curves and their use in coordination chemistry.	has been introduced. Crossed content has been deleted.
			Section-B ~~**Introduction to Computing:**~~ ~~Principles of programming language, compiler and interpreters, flow chart, algorithms and program design and development.~~ ~~**Programming in Chemistry (Programs to be developed with C):**~~ ~~Fundamentals of C: history of 'C', features of 'C', the 'C' character set, 'C' program structure, identifier, elements data types, constants, variables, keywords.~~ ~~Operator & Expressions: arithmetic operator, relational operator, unary operator, assignment operator, conditional operator.~~ ~~In put / out put: data, in put, out put, statement.~~ ~~Conditional statements: compound statements, control statements, if-else statement, switch-case statement, break, continue, go to statement.~~ ~~Loops: for loop, while loop, do while loop, functions, parameters.~~	**Section-B** **Photochemistry of Carbonyl Complexes:** Introdution, $Cr(CO)_6$, $Fe(CO)_5$ and $Ni(CO)_4$. **Photosubstitution Reactions:** Introduction, photosubstitution of d^3, low spin d^6 and d^8 complexes, sensitization and quenching of photosubstitution, photosubstitution mechanism, photoisomerisation, photoracemization and photoanation.	Crossed content has been deleted.
			Section-C ~~**Arrays and Files:**~~ ~~Arrays: declaration of array, multidimensional array, use of arrays; strings structure, assigning structure, organization of structure.~~ ~~Files: sequential, random access, index sequential files, creating a file in 'C'~~ ~~**Applications in Chemistry:**~~ ~~Simple formula in chemistry such as Van der walls equation, radioactive decay, lttice energy, Pauling's relation, linear simulation equations using Huckel MO~~	**Section-C** **Redox Reactions by Excited Metal Complexes:** Charge transfer spectra, ligand to metal charge transfer, metal to ligand charge transfer, intraligand and charge transfer to solvent state, metal complexes as redox reactants, reducing and oxidizing properties of $Ru(bipy)_3$, comparison with $Fe(bipy)_3$, role of spin-orbit coupling, applications of redox processes of low energy reactants into high-energy products and chemical energy into light.	Crossed content has been deleted.

			~~method, equilibrium constants, molecular weight of an organic compound, quantitative determination, resonance structure, bond angles and bond lengths.~~		
				Suggested Books: 1. Basolo, F., & Pearson, R. (1967). *Mechanism of organic reaction: a study of metal complexes in solution*, (2nd ed.): John Wiley & Sons. 2. Obe, M.L. (1972). *Inorganic reaction mechanism:* Nelson, London. 3. Purcell, K.F., & Kotz, J.C. (1980) *An introduction to inorganic chemistry:* Holt Sounder, Japan. 4. Adamson, A.W., & Fleischauer, P.D. (1977) *Concepts of inorganic photochemistry:* Wiley. 5. Porter, G.B. (1983).*Introduction to inorganic photochemistry: Principles and methods: J. Chem. Educ.* 60(10), p 785. 6. Balzari, V., & Carassiti, V. (1970). *Photochemistry of coordination compounds*: Academic Press. 7. Ferraudi, G.J. (1988). *Elements of inorganic photochemistry:* Wiley.	Recommended Books have been reviewed and some new books have been added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
	M.Sc. III Sem.		**Existing Syllabus in December 2018**	**Proposed Syllabus for December 2020**	
12.	**CODE:** Bioinorganic and Bioorganic Chemistry	On completion of course, the students will be able to: • discuss structures and properties of carbohydrates, amino acids and proteins. • understand metalloenzymes, mechanism of action of enzymes and their role in biological	**Section-A** **Metal Ions in Biological Systems:** ~~Fundamentals of inorganic biochemistry, essential and non-essential elements in bio-systems, role of alkali/alkaline earth metals in bio-systems,~~ Na^+ / K^+ pump, toxic metal ions and their detoxification, chelation therapy/chelating agents in medicine, recent advances in cancer	**Section-A** **Carbohydrates:** Isomerism, mutarotation, oxidation, reduction, glycoside formation, osazone formation, synthesis and degradation of monosaccharides, configuration of D-glucose, general discussion of disaccharides and polysaccharides, identification tests for carbohydrates	The contents of Bio-Inorganic Chemistry, CHEM 503 and Bio-Organic Chemistry, CHEM 504

		process. • explain the structures of haemoglobin, myoglobin and mechanism of dioxygen transport in living system. • elaborate electron transport chain and its role in energy generation, nitrogen fixation and photolysis of water. • explain the structures of different biomolecules through model complexes of iron, cobalt and copper.	chemotherapy using chelates. **Metalloenzymes:** Zinc enzymes: caboxypeptidase and carbonic anhydrase; copper enzyme:- superoxide dismutase; molybdenum oxatransferase enzymes:- xanthine oxidase, coenzyme vitamin B12.	Amino Acids and Proteins: Classification, identification, general methods of preparation and reactions of amino acids; primary, secondary, tertiary and quaternary structure of protein; analysis of polypeptides and proteins. **Metal Ions in Biological Systems:** Na^+ / K^+ pump, toxic metal ions and their detoxification, chelation therapy/chelating agents in medicine **Transport and Storage of Dioxygen:** Heme proteins and oxygen uptake, structure and function of hemoglobin, myoglobin, hemocyanin and hemerythrin, models of synthetic complexes of iron, cobalt and copper.	has been merged and nomenclature has been changed to Bioinorganic and Bioorganic Chemistry. Crossed content has been deleted. White font content in black background has been shifted from bioorganic chemistry.
			Section-B **Transport and Storage of Dioxygen:** Heme proteins and oxygen uptake, structure and function of hemoglobin, myoglobin, hemocyanin and hemerythrin, models of synthetic complexes of iron, cobalt and copper. Iron enzymes: - catalase, peroxidase and cytochrome P-450 **Electron Transfer in Biological Systems:** Structure and function of metalloproteins in electron transport processes, cytochromes and iron-sulphur proteins, ~~flavoprotiens~~ and synthetic models.	**Section-B** **Mechanism of Enzyme Action:** Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion, examples of some typical enzyme mechanisms for chymotrypsin, ribonuclease and lysozyme **Metalloenzymes:** Zinc enzymes: caboxypeptidase and carbonic anhydrase; copper enzyme: superoxide dismutase; xanthine oxidase, vitamin B12, Iron enzymes: catalase, peroxidase and cytochrome P-450,	Crossed content has been deleted. White font content in black background has been shifted from bioorganic chemistry.
			Section-C ~~**Metalloproteins in Energy Transmission:**~~ ~~Metal complexes in transmission of energy, structure and reactivity of chlorophylls, photosystem-I and photosystem-II in cleavage of water, model systems, DNA interaction with~~	**Section-C** **Electron Transfer in Biological Systems:** Structure and function of metalloproteins in electron transport processes, cytochromes and iron-sulphur proteins and synthetic models **Metalloproteins in Energy Transmission:** Metal complexes in transmission of energy,	Crossed content has been deleted. White font content in black background

			~~transition metal complex, DNA-protein interaction with special reference to zinc finger proteins.~~ **Biological Nitrogen Fixation:** Fixation of nitrogen biologically and non-biologically, spectroscopic and other evidences, transition metal sulphide models for nitrogenase sites, Fe-Mo-S cluster models for Fe-Mo-Co.	structure and reactivity of chlorophylls, photosystem-I and photosystem-II in cleavage of water, model systems. **Biological Nitrogen Fixation:** Fixation of nitrogen biologically and non-biologically, spectroscopic and other evidences, transition metal sulphide models for nitrogenase sites, Fe-Mo-S cluster models for Fe-Mo-Co.	has been shifted from bioorganic chemistry.
				Recommended Books: 1. Lippard, S.J. & Berg, L.M. (1994). *Principles of Bioinorganic Chemistry*. V.A.: University Science Books. 2. Bertini, I., Gray, H.B., Lippard S.J. & Valentine, J.S. (1994). *Bioinorganic Chemistry*. V.A.:University Science Books 3. Dugas, H., & Penny, C. (1981). *Bioorganic Chemistry: A Chemical Approach to Enzyme Action*. New York: Springer-Verlag. 4. Suckling, C.J. (1990). *Enzyme Chemistry: Impact and Application*. 2th Ed., London: Chapman & Hall. 5. Page, M.I. & Williams, A. (1987). *Enzyme Mechanisms*. London: Royal Society of Chemistry. 6. Price, N. & Stevens, L. (1999). *Fundamentals of Enzymology*. 3th Ed., Oxford: Oxford University Press. 8. Trevan, M.D. (1980). *Immobilized Enzyme: Introduction and Application in Biotechnology*. New York: John Wiley & Sons, Inc. 7. Walsh, C. (1981). *Enzymatic Reaction Mechanisms*. New York: WH Freeman & Co. 8. Fersht, A. (1985). *Enzyme Structure and Mechanism*. New York: WH Freeman & Co. 9. Lehninger, A.L. (1992). *Principles of Biochemistry*. India: CBS Publishers. 10. Voet, D., Voet, J.G. & Pratt, C.W. (1999). *Fundamentals of Biochemistry*. New York: John Wiley & Sons.	Recommended Books have been reviewed and some new books have been added.

				11. Mahler, H.R., & Cordes, E.H. (1971). *Biological Chemistry*, 3th Ed., New York: Harper and Row Publication. 12. Bruice, T.C., & Bentkovic, S. (1966). *Bioorganic Mechanisms, Vol.* I & II, New York: Benjamin WA.	
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
	M.Sc. III Sem.			**Proposed for December 2020**	
13.	**Course Code: Literature Dissertation**	On completion of course, the students will be able to • survey literature in systematic manner. • present information and write reports in a clear, effective and scientific manner. • develop their skills for future research.		**Topics will be allotted to students by concerned teacher/teachers.**	New course has been introduced.
	M.Sc. III Sem.		**Existing Syllabus in December 2018**	**Proposed Syllabus for December 2020**	
14.	CHEM 505L: Chemistry Lab - III	On completion of course, the students will be able to: • develop their skills for qualitative and quantitative research in different fields. • perform various analytical operations to qualify and quantify different analytes. • outline synthetic strategies for important chemicals. • check the purity of synthesized compounds through TLC, conductance and magnetic susceptibility measurements, and UV, FT-IR spectral data.	**Inorganic Chemistry** **I. Estimation and Separation:** 1. Estimation of Nitrogen by Kjeldahl's Method. 2. Estimation of Sulphur/Halogen by Fusion Method. 3. Separation of Cu, Co and Zn on paper strips. 4. Separation of Cu and Ni on cellulose column. 5. Separation and determination of Zn and Cd using Ion Exchanger. 6. Separation and determination of Co and Ni using Ion Exchanger. 7. Separation and determination of chloride and bromide using Ion Exchanger. ~~8. Evparation and determination of~~	**Inorganic Chemistry** **I. Estimation and Separation:** 1. Estimation of Nitrogen by Kjeldahl's Method. 2. Estimation of Sulphur/Halogen by Fusion Method. 3. Determination of boric acid in borax. 4. Determination of metals: copper in copper oxychloride and zinc in zineb fungicides. 5. Separation of Cu, Co and Zn on paper strips. 6. Separation of Cu and Ni on cellulose column. 7. Separation and determination of Zn and Cd using Ion Exchanger. 8. Separation and determination of Co	Crossed content has been deleted. Grey Shaded content has been added.

			~~chloride and iodide using Ion Exchanger.~~ 9. Separation and spectrophotometric determination of Cu, Fe, and Ni using Ion Exchanger. 10. Separation and determination of Cl− and I− (aqueous-acetone medium). **II. Solvent Extraction:** 1. Determination of Fe(III) by chloride extraction in ether. 2. Determination of Fe(III) as the 8-hydroxy quinolate (oxinate) by extraction in chloroform. **Organic Chemistry** **Qualitative Analysis** Separation, purification and identification of the components of a mixture of three organic compounds (three solids, two liquids and one solid, two solids and one liquid) using the chemical analysis. **Three-steps Organic Synthesis** The exercises should illustrate the use of organic reagents and may involve purification of the products by chromatographic techniques: ~~1. Benzene→Benzophenone→Benzpinacol → Benzpinacolone~~ 2. Benzophenone→Benzophenoneoxim → Benzanilide → Benzoic acid + Aniline ~~3. Benzaldehyde →Benzoin →Benzil →Benzilic acid~~ 4. Aniline → Acetanilide → *p*-nitroacetanilide → *p*-nitroaniline ~~5. Hydroquinone → Benzoquinone → Adduct → Dihdroxytriptycene~~ ~~6. Benezene 3 benzoyl propanoic acid 4 Phenyl butanoic acid α Tetralone~~ **Physical Chemistry** **Electrochemistry:** 1. Titrate a mixture of copper	and Ni using Ion Exchanger. 9. Separation and determination of chloride and bromide using Ion Exchanger. 10. Separation and spectrophotometric determination of Cu, Fe, and Ni using Ion Exchanger. 11. Separation and determination of Cl− and I− (aqueous-acetone medium). **II. Solvent Extraction:** 1. Determination of Fe(III) by chloride extraction in ether. 2. Determination of Fe(III) as the 8-hydroxy quinolate (oxinate) by extraction in chloroform. **Organic Chemistry** **Qualitative Analysis** Separation, purification and identification of the components of a mixture of three organic compounds (three solids, two liquids and one solid, two solids and one liquid) using the chemical analysis. **Three-steps Organic Synthesis** The exercises should illustrate the use of organic reagents and may involve purification of the products by chromatographic techniques: 1. Benzophenone→Benzophenoneoxim→ Benzanilide → Benzoic acid + Aniline 2. Aniline → Acetanilide → *p*-nitroacetanilide → *p*-nitroaniline 3. Glucose → D-glucosepentacetate → Glucose → 1-methylglucose **Physical Chemistry** **Electrochemistry:** 1. Titrate a mixture of copper sulphate, acetic acid and sulphuric acid with sodium hydroxide. 2. Titrate phosphoric acid potentiometrically against sodium hydroxide. 3. Determine the dissociation constant	

			sulphate, acetic acid and sulphuric acid with sodium hydroxide. 2. Titrate phosphoric acid potentiometrically against sodium hydroxide. 3. Determine the dissociation constant (pKa) of a weak acid using pH meter. 4. Determine the Hammett Constant of a given substituted benzoic acid by pH measurement. 5. Determine the acidic and basic dissociation constant of an amino acid and ~~hence~~ the isoelectric point of ~~the~~ acid. 6. To determine the hydrolysis constant of aniline hydrochloride by pH measurement. **Magneto Chemistry:** 1. To determine the magnetic susceptibility of a given compound and ~~hence~~ calculate unpaired electron present in it. 2. To verify the Weidemann's law using Nickel Chloride solution. **Colorimetric:** 1. To determine equilibrium quotient for the formation of monothiocynato iron III complex by colorometric measurement. 2. Investigate the reaction Kinetics between potassium persulphate and potassium iodide by colorometric measurement. 3. Determine the concentration of Cu^{2+} ions in given solutiontitrating with EDTA solution by colorometric measurement. **Phase Equilibrium:** 1. To draw the mutual solubility curve of two immiscible liquid and to find out the critical solution temperature of Phenol- water-system. 2. To obtain the phase diagram of	(pKa) of a weak acid using pH meter. 4. Determine the Hammett constant of a given substituted benzoic acid by pH measurement. 5. Determine the acidic and basic dissociation constant of an amino acid and the isoelectric point of an acid. 6. To determine the hydrolysis constant of aniline hydrochloride by *p*H measurement. **Magneto Chemistry:** 1. To determine the magnetic susceptibility of a given compound and calculate the number of unpaired electrons present in it. 2. To verify the Weidemann's law using nickel chloride solution. **Colorimetric:** 1. To determine equilibrium quotient for the formation of monothiocynato iron(III) complex by colorimetric measurement. 2. Investigate the reaction kinetics between potassium persulphate and potassium iodide by colorimetric measurement. 3. Determine the concentration of Cu^{2+} ions in given solution titrating with EDTA solution by colorimetric measurement. **Phase Equilibrium:** 1. To draw the mutual solubility curve of two immiscible liquid and find out the critical solution temperature of phenol-water system. 2. To obtain the phase diagram of water–ethanol-benzene system at room temperature. **Potentiometry:** 1. To find out the strength of cobalt sulphate solution by titrating it against a standard solution of potassium ferricyanide. 2. To determine the solubility and solubility product of sparingly soluble salt.	

			water – ethanol-benzene system at room temperature. ~~**Potentiometric:**~~ 1. To find out the strength of cobalt sulphate solution by titrating it against a standard solution of potassium ferricyanide, potentiometrically. 2. To determine the solubility and solubility product of spirangly soluble salt potentiometrically. ~~**Polarographic:**~~ 1. To plote a polarogram for amixed solution of Cd^{2+}, Zn^{2+} and Mn^{2+} ions in 0.1 M KCl. 2. To determine the half wave potential of Cd^{2+}, Zn^{2+} ion in 0.1 M KCl.	**Polarography:** 1. To plot a polarogram for a mixed solution of Cd^{2+}, Zn^{2+} and Mn^{2+} ions in 0.1 M KCl. 2. To determine the half wave potential of Cd^{2+}, Zn^{2+} ion in 0.1 M KCl.	
				Recommended Books: 1. Gurdeep, R (2016*), Advanced Practical Inorganic Chemistry*, revised Ed., Krishna Prakashan publication. 2. Svehla, G. (2010), Vogel's *Qualitative Inorganic Analysis*, 7th Edition, Prentice Hall. 3. Gurtu, J. N. and Gurtu , A(2011), *Physical Chemistry Vol – I*, Pragati Prakashan publication. 4. Leonard, J., Lygo, B. & Procter, G. (2013), *Advanced Practical Organic Chemistry* (3rd ed.). CRC Press, Taylor & Francis Group. 5. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. (1989). *Practical Organic Chemistry* (5th ed.). New York, John Wiley & Sons, Inc. 6. Gurtu, G.N., Gurtu, A. (2014). *Avanced Physical Chemistry*, India: Pragati Prakashan . 7. Sindhu, P.S. (2005). *Practicals in Physical Chemistry*, India: Macmillan Publishers.	Recommended Books have been added.
				Suggested e-Sources: 1. National Programme on Technology	Suggested e-Sources have been

				Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	added.
	M.Sc. III Sem.		**Existing Syllabus in December 2018**	**Proposed Syllabus for December 2020**	
15.	CHEM 509: Organic Chemistry (Chemistry of Natural Products)	On completion of course, the students will be able to: • explain the synthesis and biogenesis of terpenoids, carotenoids, alkaloids, steroids, porphyrins, prostaglandins and flavanoids. • elucidate the structures of terpenoids, alkaloids, steroids and flavonoids. • identify natural products and their probable biosynthetic pathways. • understand the key metabolic pathways.	**Section-C** **Steroids and Hormones:** Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry, isolation, identification (qualitative idea only), structure determination and synthesis of cholesterol, androsterone, testosterone, oestrone, progesterone. **Plant Pigments:** Occurrence, nomenclature and general methods of structure determination, isolation and synthesis of apigenin, luteolin, quercetin, ~~quercetin-3-glucoside,~~ cyanidin, ~~cyanidin-7-arabinoside,~~ hirsutidin. **Key Metabolism Pathway:** Acetate pathway, mevalonate pathway and shikimic acid pathway.	**Section-C** **Steroids and Hormones:** Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry, isolation, identification (qualitative idea only), structure determination and synthesis of cholesterol, androsterone, testosterone, oestrone, progesterone. **Plant Pigments:** Occurrence, nomenclature and general methods of structure determination, isolation and synthesis of apigenin, luteolin, cyanidin, daidzein, gennistein and hirsutidin. **Key Metabolism Pathway:** Acetate pathway, mevalonate pathway and shikimic acid pathway.	Crossed content has been deleted. Grey Shaded content has been added.
				Recommended Books: 1. Mann, J., Davidson, R.S., Hobbs, J.B., Banthrope, D.V., & Harborne, J.B. (1994). *Chemistry and Biological Significance*. New York : Wiley publication. 2. Finar, I. L. (1964). *Stereochemistry and the chemistry of natural product* (3rd ed.). London: Longmanns. 3. Hostettmann, E.K., Gupta, M.P., & Marston, A. (1999). *Chemistry, Biological & Pharmacological Properties of Medicinal Plants from the Americas*. The Netherlands: Harwood Academic Publishers. 4. Bohm, B.A. (1998). *Introduction to Flavonoids*. The Netherlands: Harwood Academic Publishers.	Recommended Books have been reviewed and some new books have been added.

				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
	M.Sc. III Sem.		**Existing Syllabus in December 2018**	**Proposed Syllabus for December 2020**	
16.	CHEM 513: Special Topics in Physical Chemistry (Nomenclature has been changed to Physical Spectroscopy)	On completion of course, the students will be able to: • understand the principles of advanced spectroscopic techniques. • understand the Raman effect and rotational vibrational Raman spectra used for the structure determination. • calculate the bond length of compounds and reduced mass by microwave spectroscopy • calculate binding energy of electrons . • explain the X-ray diffraction and measurements, and band theory of conductance.	~~**Section-A**~~ ~~**Surface Chemistry:**~~ ~~Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, estimation of surface area (BET equation), surface films on liquids (Electro-kinetic phenomenon).~~ ~~**Polymer:**~~ ~~Polymer: definition, types of polymers, kinetics of polymerization, mechanism of polymerization, molecular mass, number and mass average molecular mass, molecular mass determination (osmometry, viscometry and diffusion), sedimentation, chain configuration of macromolecules, calculation of average dimensions of various chain structures.~~	**Section-A** **Rotational (Microwave) Spectroscopy:** Principal moment of inertia, classification of rotors: rigid rotor and non rigid rotor, selection rule (rigid rotor), effect of isotopic substitution frequencies, linear polyatomic molecules, non-linear polyatomic molecules, asymmetric Top molecules, relative intensities of spectral lines, stark effect, nuclear and electron spin interaction, instrumentation and application. **Raman Spectroscopy:** Raman Effect, theory of Raman Effect (quantum mechanical and classical), rotational Raman spectra, vibrational Raman spectra, rule of mutual exclusion and structure determination, instrumentation, presentation of spectra, determination of depolarization ratio (ρ_n) and application.	Crossed content has been deleted. White font content in black background has been shifted from M.Sc. II semester.
			~~**Section-B**~~ ~~**Magneto Chemistry:**~~ ~~Magnetic susceptibility and its determination, susceptibility equivalents, Pascal's law and its applications, diamagnetism of elements, compounds and ions, Langevin's theory of paramagnetism, Curie's law, Weiss molecular field theory of paramagnetism, Curie-Weiss law, determination of Curie point.~~ ~~**Molecular Orbital Theory:**~~ ~~Huckel theory of conjugated systems, bond order and charge density, calculations,applications on ethylene, butadiene, cyclopropenyl radical,~~	**Section-B** **Photo Electron Spectroscopy (PES):** Principles of photoelectron spectroscopy, PES and Koopman's theorem, types of PES, photo ionization constant, chemical shift in Electron Spectroscopy for Chemical Analysis (ESCA), instrumentation, techniques of PES, atomic and molecular electron spectra, application of ESCA. **Electron Diffraction:** Principle, scattering intensity and scattering angle, Wierl equation, measurement techniques, Elucidation of simple gas phase molecules, low energy electron diffraction (LEED)and structure surfaces, application of electron diffraction.	Crossed content has been deleted. White font content in black background has been shifted from M.Sc. II semester.

			~~cyclobutadiene and benzene; introduction to extended Huckel theory.~~	**Neutron Diffraction:** Theory of neutron diffraction, scattering of neutron by solid and liquids, magnetic scattering, measurement techniques, elucidation of structure of magnetically ordered unit cell, application of neutron diffraction.	
			~~**Section-C**~~ ~~**Introduction of Nanochemistry:**~~ ~~Emergence and challenges in nanotechnology, types of nanomaterials: zero dimensional- quantum dots, cluster of spherical noble metal nano-particles and core shell (optical properties), One dimensional- nanowires and nanorods; two dimensional- thin films, advanced nanomaterials-Fullerenes, Carbon nanotubes and Graphene.~~ ~~**Fabrication methods:**~~ ~~Bottom up- molecular self-assembly, reduction method, sol-gel process, chemical vapour deposition and Top down- Ball milling, evaporation, template synthesis + evaporation, sonication, chemical etching and biological methods- microbial and biomolecules.~~ ~~**Stability of Nanomaterials:**~~ ~~Surface energy, electrostatic stabilization with special reference to DLVO theory, steric stabilization: solvent and polymer, interaction between polymer layers, mixed steric and electric interaction.~~	**Section-C** **Laser Spectroscopy:** Types of laser: solid-state laser, continuous-wave (cw) laser, neodymium laser, helium neon laser, carbon dioxide laser, argon-ion krypton ion laser, Chemical laser, frequency doubling application of laser: Raman spectroscopy, resonance–ionisation spectroscopy. **The Solid State:** Classification, Symmetry, point groups, Bravais Lattice, lattice energy (Born-lande equation), law of rational indices, Miller indices, X-ray diffraction and measurement (The Debye-Scherrer Method), band theory of conductors, semiconductors and insulators, extrinsic semiconductors, superconductivity, effect of temperature on superconductivity.	Crossed content has been deleted. Grey Shaded content has been added.
				Recommended Books: 1. Atkin's, P., Julio, P. D., (2014). *Physical Chemistry* (10th ed.), U. K., Oxford University Press. 2. Banwell, C.N., & Mc Cash, Elaine M., (1983) *Fundamental of molecular spectroscopy* (3rd ed.), UK. Mc Graw-Hill Companies. 3. Kaur, H., (2017) *Spectroscopy*, India, Pragati Prakashan. 4. Puri, B.R., Sharma, L.R., Pathania. M.S. (2016). *Principle of Physcial Chemistry* (47th ed.), India, Vishal	Recommended Books have been reviewed and some new books have been added.

				Publishing Company. 5. Barrow, G.M., (1962) *Introduction to molecular spectroscopy.*USA, Mc Graw-Hill Companies. 6. Hollas, J.M., (2004). *Modern spectroscopy* (4th ed.), USA, John Wiley & Sons Ltd. 7. Brown, J. M., (2003). *Rotational spectroscopy of diatomic molecules, UK, Cambridge University Press.* 8. West, A. R, (2014). *Solid State Chemistry and its Applications* (2nd ed.), John Wiley &Sons Ltd.	
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
	M.Sc. IV Sem.		**Existing Syllabus in April/May 2019**	**Proposed Syllabus for April/May 2021**	
17.	CHEM 501: Advanced Inorganic Chemistry	On completion of course, the students will be able to: • explain the principles and concepts of Green Chemistry. • minimize the use of organic solvents by using solvent-free reactions and supercritical fluids. • predict the structure, bonding of metal carbonyls, metal nitrtosyl, dinitrogen and dioxygen complexes, vibrational spectra of metal carbonyls for bonding and structural elucidation. • apply the principles of biomimetic chemistry in design and synthesis of receptors for recognition of various hosts: cationic, anionic and neutral; supramolecular reactivity, catalysis and supramolecular devices.	**Section-C** **Supramolecular Chemistry:** Molecular recognition, molecular receptors for different types of molecules including arisonic substrates, design and synthesis of co-receptor molecules and multiple recognition, supramolecular reactivity and catalysis, ~~transport processes and carrier design,~~ supramolecular devices: - elctronic, ionic and switching devices, ~~supramolecular photochemistry, some example of self assembly in supramolecular chemistry.~~	**Section-C** **Supramolecular Chemistry:** Molecular recognition, supra molecular interactions, molecular receptors for different types of molecules including cationic and anionic guests, crown ether and cyclodextrins receptors: synthesis and applications, design and synthesis of co-receptor molecules and multiple recognition, supramolecular devices: - photonic, electronic and ionic devices	Crossed content has been deleted.
				Recommended Books: 1. Lancaster, M., (2002) *Green chemistry: an introductory text:*Royal society of chemistry. 2. Paul, T. Anastas., Tracy, C. Williamson. (1998). *Green Chemistry: Frontiers in Benign Chemical Synthesis and Processes:*oxford university press. 3. Paul, T. Anastas., & Lauren G.	Recommended Books have been reviewed and some new books have been added.

				H.(2000).*Green Chemical Syntheses and Processes*: vol 767, ACS Symposium Series. 4. Cotton, F.A., & Wilkinson, G.(1999).*Advanced inorganic chemistry*,6th ed:John Wiley. 5. Huhey, J.E.*(*1978).*Inorganic Chemistry:* Harpes & Row. 6. Lippard.S.J., & Berg. J. M.*Principle of Bioinorganic Chemistry:* University Science Books, Mill Valley. 7. Bertini, I.H.B., Gray.S.J.V, *Bioinorganic Chemistry*: University Science Books, Mill Valley. 8. Eichhorn, G.L.(2007). *Inorganic Biochemistry,*Vols I, II. Ed: Elservier 9. Lehn, J.M (2006).*Supramolecular Chemistry*: Wiley and VCH	
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
	M.Sc. IV Sem.		**Existing Syllabus in April/May 2019**	**Proposed Syllabus for April/May 2021**	

18.	CHEM 502: Advanced Physical Chemistry	On completion of course, the students will be able to: • understand the oscillatory reactions, rate equations of different types of reactions, and thermodynamic excess function of non ideal solutions. • explain the Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein statistics. • explain the concept of entropy productions and Onsager's reciprocity relation. • understand the basics of electrochemistry and polarography. • explain the structure of electrified interface, and double layer parallel-plate condenser models.		**Recommended Books:** 1. Bard, A. J., Faulkner, L. R. (2002) *Electrochemical Methods: Fundamentals and Applications*, (2nd ed.), New York, John Wiley & Sons. 2. Bockris, J. O' M., Reddy, A. K. N. (1998) *Modern Electrochemistry 1: Ionics* (2nd ed.), USA, Springer. 3. Bockris, J. O' M., Reddy, A. K. N. & Gamboa-Aldeco, M. E. (2001). *Modern Electrochemistry 2-A: Fundamentals of Electrodics* (2nd ed.), USA Springer. 4. Bockris, J. O' M. & Reddy, A. K. N. (2001). *Modern Electrochemistry 2-B: Electrodics in Chemistry, Engineering, Biology and Environmental Science* (2nd ed.), USA, Springer. 5. Brett, C. M. A. & Brett, A. M. O. (1993). *Electrochemistry-Principle, methods and application*, UK, Oxford University Press. 6. Koryta, J., Dvorak, J. & Kavan, L. (1993). *Principles of Electrochemistry*, New York, John Wiley & Sons. 7. Pilling, M. J. & Seakins, P. W. (1997). Reaction Kinetics, UK, Oxford Press. 8. Laider, K.J., (1965) *Chemical Kinetics* (2nd ed.), New York, McGraw Hill Book Company. 9. Atkin's, P., Julio, P. D., (2014). *Physical Chemistry* (10th ed.), U. K., Oxford University Press. 10. Puri, B.R., Sharma, L.R., Pathania. M.S. (2016). *Principle of Physcial Chemistry* (47th ed.), India, Vishal Publishing Company. Groot, SR. de. , Mazur, P., (1962) Non-Equilibrium Thermodynamics, Amsterdam, North-Holland Publishing Company	Recommended Books have been reviewed and some new books have been added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry	Suggested e-Sources have been added.

				3. Free Online Education SWAYAM 1. https://swayam.gov.in	
	M.Sc. IV Sem.		**Existing Syllabus in April/May 2019**	**Proposed Syllabus for April/May 2021**	
19.	CHEM 506L: Chemistry Lab-IV	On completion of course, the students will be able to: • develop their skills for qualitative and quantitative research in different fields. • perform various analytical operations to qualify and quantify different organic and inorganic samples. • elucidate the structures of organic compounds by UV, FT-IR, Mass and NMR spectral data. • present information and write reports in a clear, effective and scientific manner.	**Inorganic Chemistry:** 1. Quantitative analysis of tri-component mixture of metal ions by gravimetrically, volumetrically and spectrophotometrically. (i) Mixed solution of Cu^{2+}- Ni^{2+}- Zn^{2+} (ii) Mixed solution of Cu^{2+}- Ni^{2+}- Fe^{3+} 2. Spectrophotometric determination: (i) Manganese / Chromium / Vanadium in steel sample. (ii) Iron-phenanthroline complex: Job's method of continuous variation. (iii) Zirconium-Alizarin red complex: Slope ratio method. (iv) Phosphate, Nitrite, Fluoride and Sulphate 3. Analysis of dolomite. 4. Analysis of brass. 5. Colorimetric determination of chromium (VI) (in ppm) using 1,5 diphenyl carbazide as a reagent for colour development. **Organic Chemistry:** 1 Column Chromatography Separation of typical binary solid mixtures of organic compounds by column chromatography. 2. Paper Chromatography Separation and identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper chromatography and determination of R_f values. 3. Spectroscopy Identification of organic compounds by the analysis of	**Inorganic Chemistry:** 1. Quantitative analysis of tri-component mixture of metal ions by gravimetrically, volumetrically and spectrophotometrically. (i). Mixed solution of Cu^{2+}- Ni^{2+}- Zn^{2+} (ii). Mixed solution of Cu^{2+}- Ni^{2+}- Fe^{3+} 2. Spectrophotometric determination: (i). Manganese / Chromium / Vanadium in steel sample. (ii). Iron-phenanthroline complex: Job's method of continuous variation. (iii). Zirconium-Alizarin red complex: Slope ratio method. (iv). Phosphate, Nitrie, Fluoride and Sulphate 3. Analysis of dolomite. 4. Analysis of brass. 5. Colorimetric determination of chromium (VI) (in ppm) using 1,5 diphenyl carbazide as a reagent for colour development. **Organic Chemistry:** 1 Column Chromatography Separation of typical binary solid mixtures of organic compounds by column chromatography. 2. Paper Chromatography Separation and identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper chromatography and determination of R_f values. 3. Spectroscopy Identification of organic compounds by the analysis of their spectral data (UV, IR, PMR, CMR & MS) 4. Spectrophotometric (UV/VIS) Estimations:	Crossed content has been deleted.

			their spectral data (UV, IR, PMR, CMR & MS) 4. Spectrophotometric (UV/VIS) Estimations: (i). Amino acids (ii). Proteins (iii). Carbohydrates (iv). Cholestrol (v). Ascorbic Acid ~~(vi). Caffein~~ **Physical Chemistry** **Chemical Kinetics:** 1. To find out the velocity constant of the reaction between potassium per sulphate and potassium iodide also calculate the activation energy and the influence of ions strength on the rate constant 2. To study the reaction between acetone and iodine in the presence of acid **Solution:** 1. To study the variation of solubility of Potassium hydrogen tartrate with ionic strength using a salt having common ion and determine the mean ionic activity coefficient. 2. To study the effect of ionic strength on the solubility of calcium sulphate and so determine its thermodynamics solubility product. **Adsorption:** 1. Adsorption of acetic acid on charcoal to verify freundlich and lamgmuir's isotherm.. 2. To study the adsorption of oxalic acid on charcoal and to prove th validity of freundlich and lamgmuir's isotherm. 3. To study the adsorption of iodine from alcoholic solution on charcoal. **Partition Coefficient and polarimetry:** 1. To find out the equilibrium	(i). Amino acids (ii). Proteins (iii). Carbohydrates (iv). Cholestrol (v). Ascorbic Acid **Physical Chemistry** **Chemical Kinetics:** 1. To find out the velocity constant of reaction between potassium per sulphate and potassium iodide and also calculate the activation energy, and the influence of ionic strength on rate constant. 2. To study the reaction between acetone and iodine in the presence of acid. **Solution:** 1. To study the variation of solubility of potassium hydrogen tartrate with ionic strength using a salt having common ion and determine the mean ionic activity coefficient. 2. To study the effect of ionic strength on the solubility of calcium sulphate and determine its thermodynamic solubility product. **Adsorption:** 1. Adsorption of acetic acid on charcoal to verify Freundlich and Lamgmuir's isotherm. 2. To study the adsorption of oxalic acid on charcoal and to prove the validity of Freundlich and Lamgmuir's isotherm. 3. To study the adsorption of iodine from alcoholic solution on charcoal. **Partition Coefficient** 1. To find out the equilibrium constant of tri-iodide formation. 2. To find out the dimerization constant of benzoic acid in benzene. 3. To find the formula of complex copperammonium ion or study the complex formation between copper sulphate and ammonia solution. 4. To study the complex formation and find the formula of silver amine complex by partition method.	

			constant of the tri-iodide formation. 2. To find out the dimerisation constant of benzoic acid in benzene medium 3. To determine the relative strength of acid. 4. To find the formula of complex copperammonium ion or study the complex formation between copper sulphate and ammonia solution. 5. To study the complex formation and find the formula of silver amine complex by Partition method.		
				Recommended Books: 1. Gurdeep, R(2016), *Advanced Practical Inorganic Chemistry*, revised Ed., Krishna Prakashan publication. 2. Svehla, G. (2010), Vogel's *Qualitative Inorganic Analysis*, 7th Edition, Prentice Hall. 3. Gurtu, J. N. and Gurtu , A(2011), *Physical Chemistry Vol – I*, Pragati Prakashan publication. 4. Leonard, J., Lygo, B. & Procter, G. (2013), *Advanced Practical Organic Chemistry* (3rd ed.). CRC Press, Taylor & Francis Group. 5. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. (1989). *Practical Organic Chemistry* (5th ed.). New York, John Wiley & Sons, Inc. 6. Gurtu, G.N., Gurtu, A. (2014). *Avanced Physical Chemistry*, India: Pragati Prakashan. 7. Sindhu, P.S. (2005). *Practicals in Physical Chemistry*, India: Macmillan Publishers	Recommended books have been added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses	Suggested e-Sources have been added.

				https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	
	M.Sc. IV Sem.		**Existing Syllabus in April/May 2019**	**Proposed Syllabus for April/May 2021**	
20.	CHEM 510: Organic Synthesis	On completion of course, the students will be able to: • understand the fundamentals of organic synthesis such as disconnection approach of 1,3-difunctional and 1,5-difunctional compounds • apply the concepts of microwave assisted synthesis in various organic reactions. • apply the mechanistic aspects of various name reactions in synthetic organic chemistry.	**Section-C** **Rearrangements:** General mechanistic considerations, nature of migration, migratory aptitude, memory effects, a detailed study of the following rearrangements:-pinacol-pinacolone, Wagner-Meerwein, Tiffeneu-Demjanov, Beckmann, Hofman, Curtius, Lossen, Schmidt, Baeyer-Villiger, 74enzyl-benzilic acid, Favorskii, Neber, benzidine and Fries rearrangement. **Name reactions:** Discuss in detail to following name reactions with reference to their application in the synthesis of some medicinal agents, where possible: - Friedel-Crafts reaction, Darzen's condensation, Dieckmann's condensation, Willegordt reaction and Arndt-Eistert synthesis. ~~**Polycyclic Aromatic Compounds:**~~ ~~General considerations, synthesis and reactions of anthracene, phenanthrene.~~	**Section-C** **Rearrangements:** General mechanistic considerations, nature of migration, migratory aptitude, memory effects, a detailed study of the following rearrangements:-pinacol-pinacolone, Wagner-Meerwein, Tiffeneu-Demjanov, Beckmann, Hofman, Curtius, Lossen, Schmidt, Baeyer-Villiger, 74enzyl-benzilic acid, Favorskii, Neber, benzidine and Fries rearrangement. **Name reactions:** Discuss in detail to following name reactions with reference to their application in the synthesis of some medicinal agents, where possible: - Friedel-Crafts reaction, Darzen's condensation, Dieckmann's condensation, Willegordt reaction and Arndt-Eistert synthesis. 1. Organoboron Compounds: Structure, synthesis and applications of organoboron compounds.	Crossed content has been deleted. Grey Shaded content has been added.
				Recommended Books: 1. Smith, M. B., March, J. (2007). *Advanced Organic Chemistry Reaction Mechanism and Structure*. A John Wiley & Sons (6th ed.). 2. Carey, F. A. Sundberg, R. J. (2007). *Part A: Structure and Mechanism*. Springer (5th ed.). 3. House, H. O., Benjamin, W. A.(1965). *Modern Organic Reactions*. W.A Benjamin New York. 4. Clayden, J., Greeves, N., Warren, S., Wothers, P.(2001). *Organic chemistry*. Oxford University Press (2nd ed.). 5. Sykes, P. (1986). *A guide book to mechanism in organic chemistry* (6th ed.).	Recommended Books have been reviewed and some new books have been added.

				6. Ingold, C. K.(1970). *Structure and mechanism in organic chemistry*. Cornell University Press. 7. Morrison, R.T.,Boyd, R.N. (2002). *Organic chemistry* (6th Ed.). 8. Nasipuri, D.(1994). *Stereochemistry of organic compounds*. New Age International (2nd ed.). 9. Singh, M.S, (2005). *Advanced organic chemistry-reactions and mechanisms*. Pearson Education (Singapore) Pvt. Ltd. 10. Wade, L.G., Singh, M.S. (2008). *Organic chemistry*. Pearson Education, (Dorling Kindersley Pvt. Ltd. Singh, M.S. (2014). *Reactive intermediates in organic chemistry-structure, mechanism and reactions*. Wiley, VCH, & Weinheim.	
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
	M.Sc. IV Sem.		**Existing Syllabus in April/May 2019**	**Proposed Syllabus for April/May 2021**	
21.	CHEM 511: Organotransition Metal Chemistry	On completion of course, the students will be able to: • use the basic principles of descriptive chemistry and molecular orbital theory to describe chemical bonding and structure of organometallic compounds. • explain and predict the chemical behavior and reactivity of organometallic compounds. • describe and explain catalytic processes using an organometallic compound as a catalyst. • show and explain how	**Section-C** **Homogeneous Catalysis:** Fundamental reaction steps of transition metal catalyzed reactions, stoichiometric reactions for catalysis, homogeneous catalytic hydrogenation, Zeigler-Natta polymerization of olefins, catalytic reactions involving carbon monoxide such as hydrocabonylation of olefins (oxo reaction), oxopalladation reactions, activation of C-H bond. **Fluxional Oraganometallic Compounds:** Fluxional and dynamic equilibria in compounds such as ~~π~~^{2}-olefin, η^3-allyl and dienyl complexes.	**Section-C** **Homogeneous Catalysis:** Fundamental reaction steps of transition metal catalyzed reactions, stoichiometric reactions for catalysis, homogeneous catalytic hydrogenation, Zeigler-Natta polymerization of olefins, catalytic reactions involving carbon monoxide such as hydrocabonylation of olefins (oxo reaction), oxopalladation reactions, activation of C-H bond. **Heterogeneous Catalysis:** Fischer Tropsch process: methanation reaction, synthesis of methanol, gasoline production, water gas shift reaction, role of ZnO/Cr_2O_3 in the reaction, acetic acid synthesis, role of CO catalyst.	Crossed content has been deleted. Grey Shaded content has been added.

		organometallic compounds are used as catalysts in organic synthesis. • describe physical characterization methods used to study the structure and behavior of organometallic compounds.		**Fluxional Oraganometallic Compounds:** Fluxional and dynamic equilibria in compounds such as η^1-olefin, η^3-allyl and dienyl complexes.	
				Recommended Books: 1. Collam, J.P., Hegedus, L.S., Norton, J.R., & Finke, R.G. (1988). *Principle and Application of Organotransition Metal Chemistry*. Oxford: Oxford university press. 2. Crabtree, R.H. ((2008).*The Organo metallic Chemistry of the Transition Metals* (6th ed.). New Jersey: John Wiley publications. 3. Mehrotra, R.C. & Singh, A.(2000) *Oraganometallic Chemistry* . New Delhi: New Age International.	Recommended Books have been reviewed and some new books have been added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
Electives (Proposed Syllabus for Session 2020-21)					
22.	ENVS 405 Environmental Chemistry				Syllabus pertains to ENVS 405 of Department of Environment Science
23.	CHEM: Nanomaterials			**Section-A** Introduction to nano, emergence and challenges in nanotechnology, properties of nanomaterials; classification of nanomaterials: one dimensional, two dimensional and three dimensional; quantum dots, core-shell nanostructures, nanocomposite, nanowires, nanorods, new	New course has been introduced.

				form of carbon (carbon nanotubes, grapheme and fullerenes).	
				Section-B **Fabrication of Nanomaterials:** Bottom-up approaches: Chemical reduction method, sol-gel process and chemical vapor deposition, and top-down approaches: ball milling, and lithography. **Stability of Nanomaterials:** Surface energy, surface area and surface area to volume ratio, stabilisation of nanoparticles: electrostatic stabilization with special reference to DLVO theory, steric stabilization and electrosteric stabilization.	
				Section-C **Characterization Techniques of Nanomaterials:** Principle and instrumentation of X-ray diffraction, small angle X-ray scattering, field emission scanning electron microscopy, transmission electron microscopy, surface area analyzer. **Applications of Nanomaterials: Representative Examples** In the field of health and medicine, environment, energy, catalysis and agriculture.	
				Recommended Books: 1. Cao, G. (2004). *Nanostructures and nanomaterials: synthesis, properties and application*. Empirical College Press. 2. Geoffrey, A. Ozin, (2005). *Nanochemistry: A chemical approaches to nanomaterials*. Royal Society of Chemistry. 3. Gabor, L. H., Harry, F. T., Dutta, J., Moore, J.J. (2008). *Introduction to nanosciences & nanotechnology.* CRC Press Taylor & Francic group. 4. Guozhong, C. (2011). *Nano structure & nanomaterials synthesis, properties & application*. Imperial College Press. 5. Pradeep, T. (2007). *Nano: The*	Suggested Books have been added.

				essentials. McGraw Hill Pvt. Ltd. 6. Shah, M.A., Shah, K.A. (2013). *Nanotechnology: The science of small.* Wiley Publication.	
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
				Proposed Syllabus for Session 2020-21	
24.	CHEM: Polymer Chemistry	On completion of course, the students will be able to: • explain the various polymerization processes. • understand the synthesis and properties of different polymers. • appreciate the importance of recycling and disposal of rubber and polyurethane waste. • differentiate the synthesis, properties and uses of various inorganic polymers.		**Section-A** **Organic Polymers:** Introduction, classification of polymers, types and mechanisms of polymerization: condensation polymerization, radical chain polymerization, ionic chain polymerization and copolymerization; molecular weight determination: principle, advantages and limitations; properties and applications of polymers.	New course has been introduced.
				Section-B **Synthesis and Properties of:** Polyethylene, polyimides, polyacrylanitriles, polyvinyl alcohol, polymethylmethacrylate, polyvinyl acetate, phenol formaldehyde resin. **Conducting Polymer**: Introduction and classification, polyacetylene, polyaniline, PEDOT, photo conducting polymers. **Recycling of Rubber Tyres and Polyurethane**: Recycling and disposal of polyurethane and rubber.	
				Section-C **Inorganic Polymers:** Classification, types of inorganic polymerization, comparison with organic polymers, co-ordination polymers, boron-oxygen and boron-nitrogen polymers, silicones, phosphorus-nitrogen, sulfur-nitrogen, sulfur-nitrogen-fluorine compounds.	
				Recommended Books: 2. Goowarikar, V.R., Viswanathan, N.V.,	Recommended Books

				Sridhar, J. (1986). *Polymer science*, Halsted Press (John Wiley & Sons), New York. 3. Billmeyer, Fred W. (1984). *Text book of polymer science*. 3rd edition, Wiley-Blackwell. 4. Fried, Joel R. (2014). *Polymer science & technology*. 3rd edition, Prentice Hall. 5. Ghosh, P. (2010). *Polymer science and technology*. 3rd edition, McGraw-Hill India.	have been added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
25.	CHEM 512: Photo-organic and Heterocyclic Chemistry	On completion of course, the students will be able to: • The students will be able to demonstrate advanced knowledge and understanding in aspect of photochemical reactions. • The students will be able to introduce about basic chemistry of the heterocyclic. • The students will get familiar with particular properties and reactions for the most important heterocyclic as well as different systems of nomenclature. • The students will develop fundamental theoretical understanding of heterocyclic chemistry. • The students will be able to fully comprehend the chemistry of many heterocyclic products, in use such as drugs and food.		**Recommended Books:** 1. Rohtagi, K.K., Mukherji (1978). *Fundamentals of Photochemistry*, India: Wiley-Eastern, New Delhi. 2. Gilbert, A., Baggott, J. (1991). *Essentials of Molecular Photochemistry*. Oxford: Blackwell Scientific Publication. 3. Coxon, J., Halton, B. (1974). *Organic Photochemistry*. UK: Cambridge University Press. 4. Gupta, R.R., Kumar, M., Gupta, V. (1999). *Heterocyclic Chemistry, Vol. 1-3*, Berlin, Germany: Springer Verlag. 5. Joule, J.A., Mills, K., Smith, G.F. (1995). *Heterocyclic Chemistry*, London : Chapman & Hall. 6. Gilchrist, T.L. (1992). *Heterocyclic Chemistry*, New York: Longman Scientific Technical, Wiley. 7. Acheson, R.M. (1967). *An Introduction to the Heterocyclic Compounds*, New York: John Wiley & Sons. 8. Katritzky, A.R., Rees, C.W. (1984).	Recommended Books have been reviewed and some new books have been added.

				Comprehensive Heterocyclic Chemistry, England : Pergamon Press	
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
Reading Electives (Proposed Syllabus for Session 2020-21)					
26.	Reading Elective I: BT 604R Renewable Energy Resources			**As this course is part of M.Sc. Bioscience programme, please take detailed syllabus and learning outcomes from BT 604R**	This course pertains to BT 604R of Department of Bioscience and Biotechnology.
27.	CHEM: Metals in Medicine	On completion of course, the students will be able to: • understand the role of metal complexes in the treatment of various disease. • develop their insights for heavy metal toxicities and detoxification through chelation therapy.		Historical introduction to metals in medicine and key areas, Chelation therapy: Bertrand diagram, metal poisoning, the chelate effect, ligands used in chelation therapy, biologic considerations , Cis-platin: history, structure-reactivity relationships, aquation, biologic targets , DNA damage on adduct formation, DNA repair systems, biotransformation, side-effects, modes of resistance, 2nd generation Pt drugs: Carboplatin, oxaliplatin and nedaplatin modes of operation and side-effects, 3rd generation Pt drugs: sterically hindered Pt complexes, Pt(IV) complexes, complexes with biologically active carrier ligands, water soluble complexes, multinuclear Pt complexes, trans-Pt complexes.	New course has been introduced.
				Recommended Books: 1. James, C. D. (2009) *Metals in medicine*. John Wiley & Sons, Ltd	Recommended Books have been added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning	Suggested e-Sources have been

				https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	added.
28.	CHEM: Forensic Science	On completion of course, the students will be able to: • appreciate the critical thinking and analysis abilities. • develop laboratory skills to exacting standards to precision and care. • apply diverse informations to solve real problems.		Forensic Science: Introduction and role of forensic science in crime investigation; types of cases/exhibits, preliminary screening, classification of physical evidence, presumptive test (colour and spot test), Examination procedures involving standard methods and instrumental techniques, analysis of beverages: alcoholic, nonalcoholic and drugs as constituents. Forensic document examination and finger print analysis.	New course has been introduced.
				Recommended Books: 1. James, S. H., Nordby, J. J. (2005) *Forensic science: an introduction to scientific and investigative techniques.* CRC Press. 2. Siegel, J. A., Sukoo, R. J, Knupfer, G.C.(2000). *Encyclopedia of forensic science.* volume (I, II & III). Academic Press. 3. Brown, R., Davenport, J. (2012). *Forensic science: advanced investigations.* Cengage Learning. 4. Chadha, P.V.(2004). *Hand book of forensic medicine and toxicology*, New Delhi. NY: Jaypee Brothers. 5. Parikh, C.K. (1999). *Text book of medical jurisprudence forensic medicines and toxicology*. New Delhi. ND: CBS Pub. 6. Curry, A.S. (1986). *Analytical methods in human toxicology.* (Part II). CRC Press Ohio.	Recommended Books have been added.
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry	Suggested e-Sources have been added.

				3. Free Online Education SWAYAM https://swayam.gov.in	
29.	BIO602R Bio Ethics, Bio Safety and IPR			**As this course is part of M.Sc. Bioscience programme, please take detailed syllabus and learning outcomes from BIO602R.**	This course pertains to BIO602R of Department of Bioscience and Biotechnology
30.	CHEM: Pharmaceutical Chemistry	On completion of course, the students will be able to: • Develop understanding of drugs and their uses. • Apply the concept of organic synthesis in drug synthesis.		**Drugs and Pharmaceuticals:** Drug discovery, design and development; basic retrosynthetic approach. Synthesis of representative drugs of following classes: analgesics agents, antipyretic agents, antiinflammatory agents (aspirin, paracetamol, lbuprofen); antibiotics (chloramphenicol); antibacterial and antifungal agents (sulphonamides; sulphanethoxazol, sulphacetamide, trimethoprim); antiviral agents (acyclovir), central nervous system agents (phenobarbital), cardiovascular (glyceryl trinitrate), HIV-AIDS related drugs (AZT-zidovudine). **Fermentation:** Aerobic and anaerobic fermentation. Production of (i) ethyl alcohol and citric acid, (ii) antibiotics; penicillin, cephalosporin, chloromycetin and streptomycin	New course has been introduced.
				Recommended Books: 1. Patrick, G.L. (2013). *Introduction to medicinal chemistry*, Oxford University Press, UK. 2. Singh, H.,Kapoor, V.K. (2012). *Medicinal and pharmaceutical chemistry*, New Delhi. ND: VallabhPrakashan, Pitampura. 3. Foye, W.O., Lemke, T.L., William, D.A.*Principles of Medicinal Chemistry*, (4th Ed.), New Delhi. ND: B.I. Waverly Pvt. Ltd. 4. El-Mansi, E.M.T., Bryce, C.F.A.,	Recommended Books have been added.

				Ddemain, A.L., Allman, A.R., *Fermentatias microbiology and biotechnology*, (2nd Ed.), Taylor & Francis. 5. Prescott & Dunn's (2004). *Industrial Microbiology*, CBS Publisher	
				Suggested e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Suggested e-Sources have been added.
31.	CHEM 601R Nanocatalysis				(This course pertains to CHEM 601R of Department of Physics)
32.	CHEM: ICT in Teaching and Learning	On completion of course, the students will be able to: • use learning assistance for learning and teaching. • develop new teaching and learning methods, techniques and tools.		Introduction of ICT, emerging views in using ICT, teacher directed learning and learner directed learning, roles and functions of e-tutor in online teaching and learning, benefits of ICT in teaching learning and educational management, smart classroom for content delivery, web-cast lecture delivery, techniques for various learning mode, open educational resources, integration of open educational resource, virtual lab, videos, interactive video tutorial and virtual reality in teaching and learning, integration of OER in research, integration of individualized, blended and flipped learning in teaching and learning.	New course has been added.
				Recommended e-Sources: 1. National Programme on Technology Enhanced Learning https://nptel.ac.in 2. Online Chemistry Courses https://www.edx.org/learn/chemistry 3. Free Online Education SWAYAM https://swayam.gov.in	Recommended e-Sources have been added.

Verified

Offg. Secretary
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