Annexure - II

Faculty of Science

Ordinance, Curriculum & Syllabus

Master of Science (Chemistry)

(2019-20)

Shree Guru Gobind Singh Tricentenary University, Gurugram (Haryana)-122505, India

MASTER OF SCIENCE [M.Sc.]

COURSE ORDINANCE

1. PREAMBLE

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning process, examination and evaluation systems, besides governance and other matters.

The UGC has formulated various regulations and guidelines from time to time to improve the higher education system and maintain minimum standards and quality across the Higher Educational Institutions (HEIs) in India. The academic reforms recommended by the UGC in the recent past have led to overall improvement in the higher education system.
Faculty of Science. Shree Guru Gobind Singh Tercentenary University, Gurugram with the aim to enhance academic standards in quality of higher education has adopted the UGC guide lines as such in all PG courses.

The grading system is considered to be better than the conventional marks system and in order to facilitate student mobility across institutions with in India and across countries the community grade point average (CGPA) has been introduced in all the PG courses. The guidelines as follows,

CHOICE BASED CREDIT SYSTEM (CBCS):

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

Outline of Choice Based Credit System:

a. **Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

b. **Elective Course:** Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

   i. **Discipline Specific Elective (DSE) Course**: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The

University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

ii. **Dissertation/Project:** An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

c. **Skill Enhancement Course:** The course based upon the content that leads to Knowledge enhancement.

2. GOALS:

i. Employment prospects for post graduates are very good. The scientific knowledge and mathematical and analytic skills acquired help to place across a wide range of industries including aerospace, pharmaceutical, dyes, fabrics, electronics, semiconductors, petroleum, communications, computing, education, commerce, civil services and many more.

ii. The course will build a rich knowledge base to provide a foundation for the continued study of science.

iii. The theoretical and experimental skills necessary to analyze and solve a range of advances problems, providing an excellent foundation for leadership.

iv. Post-graduation leads to abundance of research opportunities.

3. OBJECTIVES

The postgraduate training should enable the student to:

i. Practice efficiently various investigative procedures backed by scientific knowledge including basic sciences and skills.

ii. Get expertise in his/her field of interest

iii. Play the assigned role in the implementation of required practical skills.

iv. Be a motivated 'teacher' - defined as one keen to share knowledge and skills with a colleague or a junior or any learner continue to evince keen interest in continuing education irrespective of whether he/she is in a teaching institution or is practicing and use appropriate learning resources.

v. Exercise empathy and a caring attitude and maintain professional integrity, honesty and high ethical standards.

vi. The student is expected to know his subject in depth; however, emphasis should be on the analytical techniques. Knowledge of recent advances and basic sciences as applicable to his/her specialty should get high priority.

vii. Competence in skills commensurate with the specialty (actual hands-on training) must be ensured.

4. Duration and Nomenclature of the Course:

The duration of M.Sc (Physics /Chemistry /Mathematics /Forensic Science/Environmental Science course shall be of two academic years consisting of four (4) semesters (15-17 weeks) under Choice Based Credit System(CBCS). On successful completion of all the four semesters, the student will be awarded M.Sc.Degree in the concerned course. The student

shall complete the course within a maximum period of 4 years from the date of admission to the first semester, failing which he/she will be disqualified from the course.

5. **Admission to the Course:**

   i. **Eligibility for Admission:**

   For admission to the 1st Semester of M.Sc. (Physics) course, the candidate must have passed B.Sc. (Pass) with Physics as one of the subjects/B.Sc. (Hons.) Physicswith 50% marks (45% marks in case of SC/ST candidates of Haryana only) in aggregate or equivalent grade from any university recognized by UGC

   For admission to the 1st Semester of M.Sc. (Chemistry) course, the candidate must have passed B.Sc. (Pass) with Chemistry as one of the subjects/B.Sc. (Hons.) Chemistry with 50% marks (45% marks in case of SC/ST candidates of Haryana only) in aggregate or equivalent grade from any university recognized by UGC.

   For admission to the 1st Semester of M.Sc. (Mathematics) course, the candidate must have passed B.Sc. (Pass) with Mathematics as one of the subjects/B.Sc. (Hons.) Mathematics /B.A (Pass) with Mathematics/ as one of the subjects/ B.A (Hons.) Mathematicswith 50% marks (45% marks in case of SC/ST candidates of Haryana only) in aggregate or equivalent grade from any university recognized by UGC.

   For admission to the 1st Semester of M.Sc. (Forensic Science) course, the candidate must be graduate with Physics, Chemistry & Mathematics, Physics, Chemistry & Biology OR Agricultural sciences OR BCA OR B.Pharm. OR B.Sc.(Nursing) OR Engineering sciences OR B.Sc.(Forensic Sciences) OR Medical sciences with 50% marks (45%marks in case of SC/ST candidates of Haryana only) in aggregate or equivalent grade from any university recognized by UGC.

   For admission to the 1st Semester of M.Sc. (Environmental Science) course, the candidate must have passed B.Sc(Non Medical/ Environmental Sciences/Life Sciences/Bio Sciences/ Agriculture) with 50% marks (45% marks in case of SC/ST candidates of Haryana only) in aggregate or equivalent grade from any university recognized by UGC.

   ii. **Schedule of admission and payment of fees:**

   The admission schedule, along with last date for the submission of admission forms and payment of fees, shall be fixed by the Vice-Chancellor from time to time.

6. **Mode of Selection of Candidates for Admission:**

   The admissions will be made as per the following criteria:

Sr.No.	Criteria	Condition
1	On the Basis of the Merit of the qualifying Examination.	If the no. of applicants is up to 3 times of the intake
2	On the Basis of the Merit of the Entrance Examination.	If the no. of applicants is more than 3 times of the intake

7. **Syllabus:**

The syllabus is based on Choice Based Credit System (CBCS) and is recommended by Board of Studies and approved by Academic Council from time to time.

8. Scheme of Examination, distribution of marks, credit system and Syllabus:

The Scheme of examination, distribution of marks in various papers along with the credit system and the syllabus of the course shall be as approved by Board of Studies/Academic Council from time to time.

9. Medium of Instruction and Examination:

The medium of the instruction and the examination shall be English only.

10. Attendance Requirements/Eligibility to Appear in Examination:

The student should fulfill the following criteria to be eligible for appearing in the End Term Semester Examinations:

i. He/she should bear a good moral character.

ii. He/she should be on the rolls of the Dept./Faculty of the University during the semester.

iii. He/she should have 75% of the attendance during the respective semester. Twenty five per cent (25%) of attendance relaxation shall account for illness and contingencies of serious and unavoidable nature.

iv. The Dean of the Faculty of his own or on the recommendation of the HOD shall have the power to give relaxation upto 5% on genuine grounds over the minimum 75% attendance.

v. Further, the Vice Chancellor of his own or on the recommendation of the Dean shall have the power to give further relaxation upto 5% on genuine grounds over the above mentioned minimum attendance.

vi. He/she should not be a defaulter in payment of any dues of the SGT University and no disciplinary action is pending against the student.

11. Exemption from Attendance / Shortage of attendance to be condoned:

The shortage of lecture to the maximum limit as under can be condoned by the competent authority:

Sr. No	Exemptable No. of Lecture	Ground of Exemption	Competent Authority
1	All periods of the days of blood donation	Voluntarily blood donation to the Blood Bank.	Dean of the Faculty
2	All periods of the day of Examination	For appearing in the supplementary examinations(Theory /Practical/Viva-voce)	-do-
3	10 days attendance during a semester	For participation in University or Inter-Collegiate Sports Tournaments/ Youth Festivals, NCC/NSS Camps/University Educational Excursions/ Mountaineering Courses	-do-

4	15days attendance during a semester	For participation in Inter-University Sports Tournaments/ Youth Festivals	-do-

Provided:

i. that he/she has obtained prior approval of the Dean, Faculty of Science;

ii. that credit may be given only for the days on which lectures were delivered or tutorials or practical work done during the period of participation in the aforesaid events.

12. Attendance Shortage Warning:

Attendance shortage warning will be displayed on the Faculty's Notice Board and University Website by 10th day of every month.

13. Detained students

A student,who does not fulfill the criteria prescribed in Clauses10-11, will not be eligible for appearing in the End Term Semester Examination in that particular paper and will be deemed as Detained in that paper.Such student will repeat the course/paper alongwith the regular students of the subsequent batchto fulfill the prescribed conditions to appear in the "End Term" examination of the course/ paper.

14. Submission of Examination Forms and Payment of Examination Fee:

The Dean, Faculty of Science shall submit the examination admission forms of thosestudents who satisfy the eligibility criteria to appear in the examinations to the Controller of Examinations as per schedule of examination circulated by him from time to time.

15. University Examinations:

i. End Term Semester Examinations:

The examination for the 1st and 3rd semesters (Odd Semesters) shall ordinarily be held in the month of December and of the 2nd and 4th semesters (Even Semesters) in the month of May/June. The examination dates are fixed by the controller of examination with the approval of Vice Chancellor.

ii. Fail/ Reappear candidates:

Fail / re-appear candidate of the odd semesters (1st& 3rd) will take re-appear exams as an ex-student in the subsequent exams of the odd semesters(1st&3rd). Similarly, for the even semesters (2nd&4th), he/she will take re-appear exams. in the subsequent exams of the even semesters (2nd&4th). However, a candidate appearing in the 4th semester examination (Regular) may appear simultaneously in his/her re-appear paper(s) of lower semesters.

16. Improvement Examination:

The student may be permitted to improve his/her result subject to the following conditions:

i. The student will be permitted to appear in improvement examination as an ex-student with regular batches.

ii. The student will be permitted to improve his/her CGPA in one or all papers in which he/she has obtained CGPA less than 'First Division' in aggregate.

iii. Only one chance per paper will be given. The chance must be availed within a year of initially passing of every semester examination.

iv. The candidate will be required to apply and allowed to appear only for theory examinations.

v. If the status/nature of the student's result does not improve by five (05) or more per cent, his/her improvement result will be declared "PRS" (Previous Result Stands).

vi. The candidate shall be allowed to appear in the improvement examination(s) along with regular candidates as and when the course is offered. No separate examination will be held for improvement of result. In case of change of syllabi, the student shall have to appear for improvement in accordance with the changed syllabi of the concerned course applicable to the regular students of that exam.

17. Setting of Question Papers:

i. The Head of the Department/Dean of the Faculty shall supply the panel of internal and external examiners duly approved by the Board of Studies to the Controller of Examinations. The paper(s) will be set by the examiner(s) nominated by the Vice-Chancellor from the panel of examiners.

ii. An examiner shall be allowed to set not more than two papers in a semester examination.

iii. The examiner(s) will set the question papers as per criteria laid down in the Scheme of Examinations as approved by the Board of Studies/Academic Council of the University.

18. Evaluation Process – Theory and Practical:

Evaluation of Answer Books:

The answer books may be evaluated either by the paper setter or any other internal or external examiner to be nominated by the Controller of Examiners with the approval of the Vice-Chancellor from the panel of examiners approved by the Board of Studies.

Re-evaluation of Answer Books:

Re-evaluation/ rechecking of any paper is allowed. The students can apply for Re-evaluation/ Re-checking of any paper to the Controller of Examinations through the HoD/Dean of the Faculty within 10 days of the declaration of result by paying prescribed fee.

Practical Examinations - Appointment of Examiner:

a. The practical examinations shall be conducted by a Board of two Examiners consisting of one internal and one external examiner to be nominated by the Vice-Chancellor from the panel of examiners.

Marks Distribution:

The distribution of marks in examination of the practical paper will be as per the criteria given below:

a. Experimental performance = 60% marks
b. Viva-Voce = 30% marks
c. Laboratory work report = 10% marks

19. External Assessment (Summative Assessment):

Sixty per cent marks shall be assigned to each theory and practical paper as Summative Assessment. The distribution of marks in theory as well as practical papers will be in accordance to IQAC guidelines.

20. Internal Assessment(Formative Assessment):

i. (Theory Papers)

a. Based on 40 Marks:

1	Assignment	5 marks
2	Mid Term Test (10 Marks each)	20 marks
3	Synergy / Project	10 marks
4	Attendance	5 marks
	Marks distribution for Attendance in % age	
	95<=Attendance=100	5 marks
	90<=Attendance<95	4 marks
	85<=Attendance<90	3 marks
	80<=Attendance<85	2 marks
	75<=Attendance<80	1 marks

b. Based on 20 Marks:

1	Assignment	5 marks
2	Mid Term Test	10 marks
3	Attendance	5 marks
	Marks distribution for Attendance in % age	
	95<=Attendance=100	5 marks
	90<=Attendance<95	4 marks
	85<=Attendance<90	3 marks
	80<=Attendance<85	2 marks
	75<=Attendance<80	1 marks

ii. (Practical/Project/Dissertation)

i. Based on 40 Marks:

S.no.	40 Marks Internal		60 Marks External
1	Attendance	10 marks	
2	Practical/Project	10 marks	

	File/Dissertation		30 marks for Practical examination (Conduction/ Demonstration)/Project File/Dissertation + 30 marks for Viva-Voce in End-term Examination by External Experts.
3	Internal Viva-Voce	20 marks	
	Marks distribution for Attendance in % age		
	97.5<=Attendance=100	10 marks	
	95<=Attendance<97.5	9 marks	
	92.5<=Attendance<95	8 marks	
	90<=Attendance<92.5	7 marks	
	87.5<=Attendance<90	6 marks	
	85<=Attendance<87.5	5 marks	
	82.5<=Attendance<85	4 marks	
	80<=Attendance<82.5	3 marks	
	77.5<=Attendance<80	2 marks	
	75<=Attendance<77.5	1 Marks	

ii. Based on 20 Marks:

s.no.	20 Marks Internal		30 Marks External
1	Attendance	5 marks	15 marks for Practical examination (Conduction/ Demonstration)/Project file/Dissertation + 15 marks for Viva-Voce in End-term Examination by External Experts.
2	Practical/Project File/Dissertation	5 marks	
3	Internal Viva-Voce	10 marks	
	Marks distribution for Attendance in % age		
	95<=Attendance=100	5 marks	
	90<=Attendance<95	4 marks	
	85<=Attendance<90	3 marks	
	80<=Attendance<85	2 marks	
	75<=Attendance<80	1 Marks	

iii. In case of ex-students, those appearing for re-appear / improvement examination in any semester, their previous Internal Assessment marks will be counted.If there is any change in Scheme of Examination, then Internal Assessment marks will be modified accordingly.

iv. The concerned teacher shall preserve records on the basis of which the Internal Assessment has been awarded and shall make the same available to the Controller of Examinations whenever required.

v. The Head of the Department/ Dean of the Faculty shall ensure:

a. That the internal assessment marks are displayed for information of the students at least seven (07) days before the commencement of the examinations of each semester

b. That the internal assessment marks are submitted to the Controller of Examinations at least seven (07) days before the commencement of the examinations of each semester.

21. Criteria for Promotion to Higher Semester:

The student shall be promoted to 2nd and 4th semester automatically without any condition of passing minimum number of papers. For promotion from 2ndto 3rd Semester, the student shall have to clear at least 50% papers of 1st and 2nd semesters taken together.

22. Credit Based Grading System:

i. Key Definitions:

Programme	An educational programme leading to award of a Degree, Diploma or Certificate.
Course	Usually referred to as 'paper' is a component of a programme. All courses need not carry the same weight.
Credit	A unit by which the course work is measured. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours for practical work/field work per week. A Research Based Paper /Project is equal to 6 credits.
Credit Point	It is the product of grade point and number of credits for a course i.e. Credit Point = No. of credits in a course X "grade value" of the grade obtained in the course.
Grade Point	There are two types of GPAs as given hereunder:
Average (GPA)	Semester Grade Point Average (SGPA) Cumulative Grade Point Average (CGPA) Every student earns a distinct SGPA and a distinct CGPA at the end of each specified semester.
SGPA	SGPA is a measure for performance of student in a Semester. It is the Point Average ratio of sum of the product of number of credits with the grade points scored by the student in all the courses taken by him/her and the sum of the number of credits of all the Courses undergone by the student i.e. SGPA (Si) =∑(CixGi) /∑Ci
CGPA	CGPA is a measure of performance up to any Grade Gradespecified semester Point Average beginning from the first Semester. It is also calculated in the same (CGPA) manner as SPGA taking into account all the courses undergone by a student over all the semesters of programme i.e. CGPA = ∑(Cix Si) / ∑Ci
Grade Point	Itis a numerical weight allotted to each letter grade on a 10-point scale.
Letter Grades	It is an index of the performance of a student in a said course. The Grades are denoted by letters O, A+, A, B+, B, C, P, F and Ab.

ii. Credits, Semesters, Courses and total Credit Points:

S.No	Course	Semesters	Core Courses	Discipline Specific elective Courses	Skill Enhancement Courses	Total Credits
1	M.Sc.(Physics)	4	72	16	12	100
2	M.Sc.(Chemistry)	4	74	12	14	100
3	M.Sc.(Mathematics)	4	78	12	10	100
5	M.Sc.(Forensic Sciences)	4	86	8	6	100
6	M.Sc.(Environmental Science)	4	60	24	16	100

Grading Table

Range of Percentage of Marks	Letter Grade	Grade Points	Range of Grade Points	Classification
90 and above	O (Outstanding)	10	9-10	Outstanding
80 & above but less than 90	A+ (Excellent)	9	8< 9	Excellent
70 & above but less than 80	A (Very Good)	8	7< 8	1st Div with Distinction
60 & above but less than 70	B+ (Good)	7	6< 7	1st Division
50 & above but less than 60	B (Above Average)	6	5<6	2nd Division
Above 40 but less than 50	C (Pass Average)	5	Above 4 <5	3rd Division
40	P(Pass)	4	4	Pass
Less than 40	F (Fail)	0	-	Fail

Formula for Calculating percentage of marks:

CGPA× 10 e.g. 6.53× 10 = 65.3

Formula for Grade Point calculation:

G = (Marks Obtained in Paper/Total marks of paper) x100.

Formula for Computation SGPA & CGPA

i. The SGPA is the ratio of sum of the product of the number of credits with the grad points scored by a student in all the courses taken by a students and the sum of the number of credits of all the courses taken by the students;

i.e SGPA (Si) = $\sum(Ci \times Gi) / \sum Ci$,

where Ci is the no of credits of the ith course and Gi is the grad point Scored by the student in the ith course

ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by the students over all the students over all the semesters of a programme , i.e

$$CGPA = \sum(Ci \times Si) / \sum Ci$$

where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

iii. The SGPA and CGPA shall be rounded up to 2 decimal points and reported in the transcripts. Result–Cum-Detailed Marks Card/ Transcript: Based on the above recommendations on letter grades, grade points and SGPA and CGPA, the DMC/ Transcript for each semester and a consolidated transcript in dictating the performance in all semester may be issued

iv. **1. Illustration of Computation of SGPA and CGPA and Format for Transcripts**

Course	Credit	Grade Letter	Grade Point	Credit Points (Credit × *Grad*)
Course 1	3	A	8	3×8 = 24
Course 2	4	B +	7	4×7 = 28
Course 3	3	B	6	3×6 = 18
Course 4	3	O	10	3×10 = 30
Course 5	3	C	5	3×5 = 15
Course 6	4	B	6	4×6 = 24
	20			**139**

Thus, SGPA = 139/20 = 6.95

Similarly, Suppose the SGPA for 2nd , 3rd and 4th semester are 7.85 , 5.6, and 6.0 with credits 22, 24 and 22, respectively, then for a two-year PG Programme, the CGPA will be computed as followed,

CGPA = (20× 6.95 + 22 × 7.85 + 24 × 5.6 + 22 × 6.0)/88 = 6.57

Course	Credits	Grade Letter	Grad Point Block	Range of Grad Points(Actual Grade Value as per marks obtained	Earned Credit Point(Credit × Actual *Grade Value*)
Course 1	3	O	10	9.2	3×9.2=27.6
Course 2	3	A+	9	8.2	3×8.2=24.6
Course 3	4	A	8	7	4×7=28
Course 4	3	B+	7	6.7	3×6.7=27.6
Course 5	3	B	6	5.6	3×5.6=16.8
Course 6	4	C	5	4.7	4×4.7=18.8
	20				**135.9**

Thus, SGPA= 135.9/20 = 6.79

Similarly suppose SGPA for 2nd , 3rd , and 4th semester are 7.85, 5.6 and 6.0 with credits 22, 24, and 22 respectively

CGPA = (20× 6.79 + 22 × 7.85 + 24 × 5.6 + 22 × 6.0)/88 = 6.53

Calculating percentage of marks

CGPA× 10 E.G.6.53× 10 = 65.3

23. Pass criteria:

The minimum percentage of marks to pass the examination in each subject/paper will be 40% each in theory paper, practical /field work/Research Project etc. examination & internal assessment. The student has to pass in summative and formative (Internal) assessment separately.

24. Declaration of Results:

i. The Controller of Examinations shall declare the results as early as possible after the conclusion of each examination, but before the start of teaching for the next academic session.

ii. Each successful student/ the student placed in reappear shall receive a copy of the Detailed Marks Certificate/ Grade Card Sheet of each semester examination.

iii. The student whose result is declared late without any fault on his/her part may attend classes for the next higher semester provisionally at his /her own risk and responsibility, subject to his /her passing the concerned semester examination. In case, the student fails to pass the concerned semester examination, his/her attendance/internal assessment in the next higher semester in which he / she was allowed to attend classes provisionally will stand cancelled.

25. Other Provisions:

i. Nothing in the Ordinance shall debar the University from amending the Ordinance and the same shall be applicable to all the students whether old or new.

ii. Any other provision not contained in the Ordinance shall be governed by the rules and regulations framed by the University from time to time.

iii. In case of any dispute, the Vice-Chancellor will be competent authority to interpret the rules and his interpretation shall be final.

UNIVERSITYS' COMMON COURSE ORDINANCE
POSTGRADUATE & UNDERGRADUATE PROGRAMS

1. Preamble :

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of the country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning process, examination and evaluation systems, besides governance and other matters.

The UGC has formulated various regulations and guidelines from time to time to improve the higher education system and maintain minimum standards and quality across the Higher Educational Institutions (HEIs) in India. The academic reforms recommended by the UGC in the recent past have led to overall improvement in the higher education system.

The Department of Chemistry, Faculty of Science, Shree Guru Gobind Singh Tricentenary University, Gurugram with the aim to enhance academic standards in quality of higher education has adopted the UGC guidelines in M.Sc. (Chemistry).

CHOICE BASED CREDIT SYSTEM (CBCS):

The CBCS provides an opportunity for the students to choose courses from the prescribed pool of courses comprising core, elective, skill and ability enhancement courses. The courses can be evaluated by a uniform grading system in the higher education system. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in the evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

Outline of Choice Based Credit System:

a. **Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.
b. **Elective Course:** Generally, a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

i. **Discipline Specific Elective (DSE) Course:** Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

ii. **Dissertation/Project:** An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

c. **Skill Enhancement Course:** The course based upon the content that leads to Knowledge enhancement.

d. **Ability Enhancement Compulsory Course:** The course based upon the content that leads to the development of a professional of ability.

2. Justification/Scope of the Course:

This course will build a rich knowledge base to provide a foundation for the continued study of Chemistry. The theoretical and experimental portion of subjects enhances thenecessaryskills to analyze and solve a range of advance problems and provides excellent foundation for the leadership.Post-graduation leads to abundance of research opportunities. Employment prospects for post graduates in this course are abundant. The scientific knowledge, practical and analytic skills acquired by the students to avail wide ranges of opportunities in academic and industry.

3. Duration of the Course:

Name of the Programme	Duration
Master of Science (Chemistry)	02 Years (4 Semesters)

4. Admission to the Course:

(a) Name of the Degree: Master of Science (Chemistry)

(b) Eligibility for Admission:

Name of the Programme	Eligibility
Master of Science (Chemistry)	For admission to the 1st Semester of M.Sc. (Chemistry) program, the candidate must have passed B.Sc. (Pass) with Chemistry as one of the subjects/B.Sc. (Hons.) Chemistry with 50% marks (45% marks in case of SC/ST candidates of Haryana only) in aggregate or

	equivalent grade from any university recognized by UGC.

Migration/Lateral entry admission in second year/third semester of an academic programme, wherever permitted, shall be considered on the basis of merit in the qualifying examination and subject to the availability of seats in the academic programme where admission is desired. Student who ever granted lateral entry admission is required to pay the requisite fee as admissible to the fresh batch.

(c) Migration Admission:

A student of any other University/Institute/College, recognized by the concerned regulatory/statutory body like UGC etc., shall be eligible for migration (admission) to the University. Migration will be allowed, if the seat is available in theprogrammeand cannot be claimed as a right by the candidate. Migration can only be allowed, if the student studied the programme in regular mode and is not having any backlog.

In addition to the Application Form for admission, student has to provide the following documents "

(i) Marksheets/result of all the examinations passed.

(ii) Detailed syllabi for all the courses studies till date.

(iii) The migration Certificate and Character Certificate stating that no disciplinary/academic action has been taken or pending.

(iv) All other relevant documents which are required for admission in the programme in which migration is sought.

Studies and Examinations passed by the candidate are recognized as equivalent to the corresponding examination of the University and he fulfills the minimum qualification and other eligibility laid down for admission to the programme to which he/she seeks migration in the University.

The migration case will be submitted to the University Equivalency Committee to verify all the relevant records and candidate will be admitted on the recommendations of the Committee only.

(d) **Student Exchange and Credit Transfer**

For a student exchange from or to a University, credit transfer from or to a University is possible only when there is an academic tie-up with the University and mutually agreed student exchange and credit transfer policy is approved by the Academic council. Student under the exchange programme shall not be considered as migrated.

The University may enter into collaboration with other Universities worldwide whereby students of those Universities can spent a semester or more at SGT University and study courses, accordingly to mutually agreed guidelines. Such students will be known as Associate Students of SGT University for the duration they spend at SGT University and will be governed for all academic matters of the University. Reciprocally, SGT

University students may be permitted to spend a semester or more and study courses in collaborating Universities with or without transfer of credits.

(e) Schedule of admission and payment of fees:

The admission schedule, along with last date for the submission of admission forms and payment of fees, shall be fixed and notified by the Registrar with the approval of the Vice-Chancellor from time to time duly approved by the Academic Council/Board of Management of the University.

Students detained due to shortage of attendance and re-admitted will attend regular classes with alternative batch and will be required to pay the Tuition Fee and Examination Fee and make over the attendance criteria as prescribed in the Ordinance. However, ex-students will be exempted from making up the deficiencies of the attendance criteria.

5. Mode of Selection of Candidates for Admission:

On the basis of the merit of the qualifying examination or as per the guidelines of the Statutory Bodies/Haryana Private Universities Act, 2006 as amended from time to time.

6. Medium of Instructions:

The medium of the instruction and the examination shall be English only.

7. University Examinations:

(a) **End Term Semester Examinations:**

The examination for all the Odd Semesters shall ordinarily be held in the month of November/December and of the Even Semesters in the month of May/June.

Fail/re-appear candidates of the Odd Semesters will re-appear in exams as an ex-student in the subsequent exams of the Odd Semesters. Similarly, for the Even Semesters he/she will re-appear in exams in the subsequent exams of the Even Semesters. However, candidates appearing in the Final Semester examination (Regular) may appear simultaneously in his/her re-appear paper(s) of lower semesters i.e. previous semesters as arranged by the Controller of Examinations.

(b) **Scheme of the Examinations/Distribution of Marks:**

The Scheme of examination, distribution of marks in various papers along with the credit system and the syllabus of the course shall be as prepared by the respective Board of Studies of the Faculty and duly approved by the Academic Council of the University from time to time.

(d) **Attendance Requirements/Eligibility to Appear in Examination:**

The student should fulfill the following criteria to be eligible for appearing in the End Term Semester Examination:

(i) He/she should have 75% attendance during the respective semester in each subject which is mandatory. Only 5% relaxation in the required attendance on account of illness and other contingencies by the Dean/Principal may be condoned. Further, the Vice Chancellor may also condone additional 5% of the required attendance in an extreme emergency case on merit basis. The relaxation of the attendance by the Dean/Principal/Vice Chancellor cannot be claimed as a matter of right by the students; it shall depend on facts and circumstances of individual case.

If a student does not meet the attendance criteria as mentioned above, he/she will not be permitted to appear in the End Term Examination. He/she can appear in the subsequent Odd/Even Semester examination after making up the deficiencies in the attendance.

(ii) He/she is not a defaulter in payment of any dues of the SGT University

(iii) No disciplinary action is pending against the student.

(iv) He/she should be on the rolls of the Faculty/College during the semester.

(v) The shortage of attendancecan be condoned by the competent authority as mentioned below in the table to the maximum limit and the same will be within the limit of the attendance criteria as mentioned in Point No. (i) above :

Sr. No	Exemptible attendance	Ground of Exemption	Dean of the Faculty is competent authority to condone shortage of lecture/ attendance.
1.	5%	For illness and contingencies of serious nature by the Dean & the Vice Chancellor	
2.	All periods of the day of donation	Voluntary blood donation to the Blood Bank.	
3.	All periods of the day of Examination.	For appearing in the supplementary examinations (Theory /Practical/Viva-voce	
4.	Maximum of 10 days attendance during a semester	For participation in University or Inter-Collegiate Sports Tournaments/ Youth Festivals, NCC/NSS Camps/University Educational Excursions, Mountaineering Courses	
5.	Maximum of 15 days attendance during a semester	For participation in Inter-University Sports Tournaments/Youth Festivals/Exhibition/ Symposium	

Provided that :

(i) He/she has obtained prior approval of the Dean of the Faculty.

(ii) Credit may be given only for the days on which lectures were delivered or tutorials or practical work done during the period of participation in the aforesaid events.

(e) **Attendance Shortage Warning :**

Attendance shortage warning will be regularly displayed on the Faculty's Notice Board every month and shall also be informed to the parents/guardians by the respective Course Coordinator.

In case, a student falls short of attendance during any semester, his result will be marked as "DETAINED" which can be removed subsequently after completing attendance requirement.

(e) **Submission of Examination Forms :**

All the students are required to submit their Examination Form through University ERP only before the last date as notified by the Controller of Examinations. The Examination Forms of the eligible students shall be validated by the Dean and will be forwarded to the Controller of Examinations within the prescribed date. In case, examination form is not submitted by scheduled last date, a late fee will be charged as prescribed by the University from time to time.

8. Setting of Question Papers:

The Dean of the Faculty shall supply the panel of internal and external examiners duly approved by the Board of Studies to the Controller of Examinations. The paper(s) will be set by the examiner(s) nominated by the Vice-Chancellor from the panel of examiners.

The question papers will be moderated by the Moderation Committee in the Chairmanship of Dean/Principal of the Faculty/College who is proficient in the subject in the office of the Controller of Examinations. The moderation will be done to see the difficulty level and that no question is out of syllabus and there is no mistake in the questions and the committee will amend/correct the paper accordingly.

The examiner(s) will set the question papers as per the criteria laid down in the Scheme of Examinations as approved by the Board of Studies/Academic Council.

9. Appointment of Examiners :

The examiners will be appointed as per the following guidelines with the approval of the Vice Chancellor by taking due care that his/her own relative is not appearing in the examination :

(a) An internal/external examiner should be of the level of an Assistant Professor/consultant/equivalent or above in the respective subject in a University/Institution/College/Hospital.

(b) One external and one internal examiner will jointly conduct the practical examination.

(c) External examiners shall not be from the same University and should preferably be from outside the University.

(d) External examiners shall be rotated at an interval of 3 years.

10. Evaluation Process – Theory, Practical & Internal Assessment:

(a) Evaluation of Answer Books:

The answer books may be evaluated either by the paper setter or any other internal or external examiner to be nominated by the Controller of Examinations with the approval of the Vice-Chancellor from the panel of examiners approved by the Board of Studies.

(b) Re-evaluation of Answer Books:

The students can apply for Re-evaluation/Re-checking of any paper through the HOD/Dean of the Faculty by paying fee as per re-evaluation rules of the university.

(c) Internal/Formative Assessment:

Formative assessment in each theory paper shall have the following distribution:

(i)	Attendance		=	5 Marks
	75 to 80	01		
	Above 80 to 85	02		
	Above 85 to 90	03		
	Above 90 to 95	04		
	Above 95 to 100	05		
(ii)	Midterm Class Tests (subjective & objective)		=	20 marks
(iii)	Assignment		=	05 marks
(iv)	Problems/Projects/Seminar/Case Study etc		=	10 marks

The concerned teacher shall make continual assessment weekly over the content covered during the week and also shall have record of the same. It shall preferably be displayed monthly and finally cumulatively before the start of the semester examination.**In case, any student fails to clear the Internal Examination, the Vice Chancellor may relax and permit for Re-examination considering the request of the student on merit with the recommendations of the respective Deans.**

(i) In case of ex-students, those appearing for re-appear/improvement examination in any semester, their previous Internal Assessment marks will be counted.

(ii) The concerned teacher shall submit records to the HoD/Dean on the basis of which the Internal Assessment has been awarded and HoD/Dean shall make the same available to the Controller of Examinations whenever required.

(iii) That the internal assessment marks are submitted tothe Controller of Examinations at least 7 (seven) days before the commencement of the end-term examinations of each semester.

(d) Practical Examinations:

(i) **Appointment of Examiners:**

The practical examinations shall be conducted by a Board of two Examiners consisting of one internal and one external examiner to be nominated by the Vice-Chancellor from the panel of examiners recommended by the Board of Studies.

(ii) **Distribution of Marks**: Practical examination for summative examination in all semesters will have the following distribution:

(aa) Summative assessment distribution (30 Marks):

Demonstration/conduction/presentation	=	20 marks
Viva Voce examination	=	10 marks

(ab) Formative assessment distribution (20 Marks):

Attendance = 5 marks

75 to 80	01
Above 80 to 85	02
Above 85 to 90	03
Above 90 to 95	04
Above 95 to 100	05

Laboratory work report	=	5 marks
Midterm oral examination/assessment	=	10 marks

(e) Project:

(i) Topic Selection and Appointment of Guide/Supervisor

Each student will be assigned a Teacher as Guide/ Supervisor from the Department. Topic of the Project will be approved by the Dean of the respective Faculty on the recommendations of the Teacher Guide/supervisor.

(ii) Evaluation:

The examination for Project shall be conducted by a Board of Two Examiners consisting of one internal and one external examiner to be nominated by the Vice-Chancellor from the panel of examiners recommended by the Board of Studies. Evaluation of the Project Report will be done by the External examiner or by Internal Examiner. The student will submit the project report in the form as specified by the department atleastbefore 15 days before the commencement of the examination, failing which it will be acceptable only with late fee of Rs. 2000/-

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(f) Field Training

Evaluation of the field training will be for the marks as prescribed in the Scheme of Examinations of the respective course/program. The formative assessment of field training shall be based on the presentation, case reports and log sheets as well as on the basis of viva voce and reports adjudged by the joint board of external and/or internal examiners.

(g) Re-appearance for Improvement :

A student may re-appear in any theory paper prescribed for a semester after making the prescribed Examination Fee as notified by the University from time to time, on foregoing in writing his/her previous performance in the paper/s concerned. This can be done in

the immediate subsequent semester examination only (for example, a student re-appearing in paper prescribed for 1st Semester examination may do so along with subsequent 3rd Semester examination and shall not be allowed to appear along with papers for 5th Semester.

A candidate who had cleared examination of Third Academic Year (Vth and VIth Semesters) may re-appear in any paper of Vth and VIth Semester only once at the immediate subsequent examinations on foregoing in writing her/her previous performance in the paper/s concerned, within the prescribed span period. Likewise will be applicable for the Fourth Academic Year also.

In the case of re-appearance in paper, the result will be prepared on the basis of candidate's current performance in the examination.

In the case of a candidate, who opts to re-appear in any paper/s under the aforesaid provisions,, on surrendering her/his earlier performance but fails to re-appear in the paper/s concerned, the marks previously secured by the candidate in the paper/s in which he/she has failed to re-appear shall be taken into account while determining his/her result of the examination held currently.

11. Criteria for Promotion to Higher Semester(s):

(a) **For programs of the duration of 4 Academic Years (8 Semesters).**

The student will be promoted to the next semesters irrespective of the number of papers cleared/passed in the lower semesters. But he/she will not be allowed to appear in the examination of the 4th Semester unless he/she has cleared atleast 50% papers of 1st and 2nd semesters taken together and further the students will not be allowed to appear in the examination of the 6th semester unless he/she has cleared 1st and 2nd semesters and 50% papers of 3rd and 4th semesters taken together. Furthermore, the students will not be allowed to appear in the examination of the 8th semester unless he/she cleared 1st, 2nd, 3rd and 4th semesters and 50% papers of 5th and 6th semesters taken together.

(b) **For programs of the duration of 3 Academic Years (6 Semesters).**

The student will be promoted to the next semesters irrespective of the number of papers cleared/passed in the lower semesters. But he/she will not be allowed to appear in the examination of the 4th Semester unless he/she has cleared atleast 50% papers of 1st and 2nd semesters taken together and further the students will not be allowed to appear in the examination of the 6th semester unless he/she has cleared 1st and 2nd semesters and 50% papers of 3rd and 4th semesters taken together.

(c) **For program of the duration of 2 Academic Years (4 Semesters).**

The student will be promoted to the next semesters irrespective of the number of papers cleared/passed in the lower semesters. But he/she will not be allowed to appear in the examination of the 4th Semester unless he/she has cleared 50% subjects of 1st and 2nd semesters taken together.

12. Pass % criteria and grading system:

(a) The minimum percentage of marks to pass a course/paper will be as given below. Each Faculty is required to adopt any one scheme out of the below mentioned and incorporate the same in their respective Scheme of Examinations.

(i) The pass percentage for each component i.e. End Term Examination (Theory/Practical) and Internal Assessment is 40% separately (for the courses adopting Table No. 3).

(ii) The pass percentage for Internal Assessment will be 40% to be eligible to appear in End Term Examination, whereas overall pass percentage will be 50%in the End Term Examination (Theory/Practical) including Internal Assessment (For all other courses) (for the courses adopting Table No. 1).

(iii) The pass percentage for each component i.e. End Term Examination (Theory/Practical) and Internal Assessment is 40% separately (for the courses adopting Table No. 2).

(iv) To qualify for award of degree, a Grade Point of **4.0, 5.0 and 6.0 respectively and minimum numbers of credits required for that degree as defined in the Scheme of Examinations of the concerned course.**

The Department of Chemistry has opted option no. ii for the assessment of MSc(Chemistry) students.

(b) **Credit Based Grading System:-**

Key Definitions :

Programme: An educational programme leading to award of a Degree, diploma or certificate.

Course : Usually referred to, as 'papers' is a component of a programme. All courses need not carry the same weight

Credit: A unit by which the course work is measured. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours for Practical Work/Field Work/ Research Based Paper /Project per week.

Credit Point: Itis the product of grade point and number of credits for a course i,e, Credit Point = No. of credit in a course **x** "grade value" of the grade obtained in the course.

Semester Grade Point Average (SGPA): The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student andthe sum of the number of credits of all the Courses undergone by a student, i.e. SGPA(Si) =∑ (Cix Gi) /∑Ci

Cumulative Grade Point Average (CGPA):CGPA The is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of programme, i.e, CGPA =∑(Cix Si) / ∑Ci

Grade Point :**It** is a numerical weight allotted to each letter grade on a l0-point scale with 7/6/5LETTER GRADES: **It** is an index of the performance of students in a said course.

Grades are denoted by letters 0, A+, A, B+, B, C, P and F etc.

Grade and its corresponding values. (For the courses where the pass marks are 50%)

[Faculty of Engineering & Technology, Law, Behavioural Sciences (Except B. Sc. (Clinical Psychology) & BA (Hons.) (Psychology), Fashion & Design, Mass Communication & Media Technology, Agricultural Sciences (Except M. Sc. programs), Education, Hotel & Tourism Management, Commerce & Management, Science, Allied Health Sciences, Physiotherapy]

Range of Percentage of Marks	Letter Grade	Grade Points	Range of Grade Points	Classification
90% and above	O (Outstanding)	10	9-10	Outstanding
80% and above but less than 90%	A+ (Excellent)	9	8<9	Excellent
70% and above but less than 80%	A (Very Good)	8	7<8	1st Division with Distinction
60% and above but less than 70%	B+ (Good)	7	6<7	1st Division
Above 50% but less than 60%	B (Above Average)	6	>5<6	2nd Division
Minimum Pass Marks 50%	P (Pass Average)	5	5	Pass
Below minimum pass marks	F (Fail)	0	-	Fail

Grade and its corresponding values. (For the courses where the pass marks are 60%)

Faculty of Agricultural Sciences (M. Sc. programs)

Range of Percentage of Marks	Letter Grade	Grade Points	Range of Grade Points	Classification
90% and above	O (Outstanding)	10	9-10	Excellent
80% and above but less than 90%	A+ (Excellent)	9	8<9	1st Division with Distinction
70% and above but less than 80%	A (Very Good)	8	7<8	1st Division
Above 60% but less than 70%	B (Good)	7	>6<7	2nd Division
Minimum Pass Marks 60%	P (Pass)	6	6	Pass with 1st Division
Below minimum pass marks	F (Fail)	0	-	Fail

Grade and its corresponding values. (For the courses where the pass marks are 40%)

Faculty of Behavioural Sciences [B. Sc. (Clinical Psychology) & BA (Hons.) (Psychology)]

Range of Percentage of Marks	Letter Grade	Grade Points	Range of	Classification

			Grade Points	
90% and above	O (Outstanding)	10	9-10	Outstanding
80% and above but less than 90%	A+ (Excellent)	9	8<9	Excellent
70% and above but less than 80%	A (Very Good)	8	7<8	1st Division with Distinction
60% and above but less than 70%	B+ (Good)	7	6<7	1st Division
50% and above but less than 60%	B (Above Average)	6	5<6	2nd Division
Above 40% but less than 50%	P (Pass Average)	5	>4<5	3rd Division
Minimum Pass Marks 40%	P (Pass Average)	4	4	Pass
Below minimum pass marks	F (Fail)	0	-	Fail

Semester Grade Point Average (SGPA):

SGPA (Si)=**Σ(Ci ×Gi)/ΣCi**

Where Ci is the number of credits of the ith course and Gi is the grade point scored as per marks obtained by the student in the ith course. Further, G is calculated as given below:

G=[Marks obtained in paper/Total marks of paper]×10 (The multiplication factor)

Cumulative Grade Point Average (CGPA):

CGPA=**Σ(Ci ×Si)/ΣCi**

Where Si is the SGPA of the ith Semester and Ci is the total number of credits in that Semester.

Formula for calculating percentage of marks;

CGPA×10 (The multiplication factor)

(c) **Grace Marks** :

Maximum 1% of total marks (Maximum to 5 marks) excluding internal assessment marks can be awarded to a student in one academic year.

13. Declaration of Results:

(a) After the semester/year examinations are over, the Controller of Examinations shall publish the results of those students who had appeared in the examinationspreferably within 45 days of last paper of course examination.

(b) Each successful student/ the student placed in reappear shall receive a copy of the Detailed Marks Certificate/ Grade Card Sheet of each semester examination.

(c) The successful students after the 4th, 6thor 8thsemester examination shall be equated in seven ascending letter grade (P to O) and grade points from 4 to 10 on the basis of final CGPA obtained by him/her in the 1st to 4th, 1st to6th or 1st to 8th semester examinations.

14. Discharge of the students from the program

The student who does not clear all the papers with in the stipulated time frame span period i.e. duration of the program + 02 years will be discharged from the programme.

15. Re-admission

As per the chapter 2, Clause 2.4.5. of the First Ordinance of the University, if a student remains absent, without leave of absence, from his/her classes for a continuous period of seven working days without any valid reason, medical or otherwise, his/her name shall be struck off from the rolls of the University. However, the student may be re-admitted on payment of the prescribed fee by the University from time to time, if Dean/Principal is satisfied that re-admission of the student will not fall short of requisite percentage of the attendance.

If a student is re-admitted, all his previous records are revived under the current structure, regulations and scheduled of fees.

A student, who has been rusticated or expelled from University, cannot be re-admitted.

16. Simultaneously pursuing other degree

As per the guidelines of the University Grants Commission, students will not be permitted to pursue two degrees simultaneously. If at any time, it comes to the notice of the University, his/her degree will be cancelled without any prior notice.

17. Appearing for additional papers after award of degree

The student will be allowed to appear for additional papers available in that degree course after the completion of course within the span period subject to attendance requirement and internal assessment. A separate marksheet will be issued for such paper(s).

18. Other Provisions:

(a) Nothing in this Ordinance shall debar the University from amending the Ordinance and the same shall be applicable to all the students from the date of its implementation.
(b) Any other provision not contained in the Ordinance shall be governed by the rules and regulations framed by the University from time to time.
(c) In case of any interpretation, The Vice-Chancellor is empowered in this regard and his interpretation shall be the final.
(d) This ordinance will be effective from the AdmissionsSession 2019-20.

Name of the Program : M. Sc. (Chemistry) Session : 2019-20

Sr. No.	Semester/ Year	Course Code	Nomenclature	Theory/ Practical	Core/ AECC/ SEC/ DSE/ GE	Lecture	Tutorial	Practical	Credits	Theory Max	Theory Pass	Practical Experimental Performance	Practical Viva-voce	Practical Lab Work Report	Practical Max	Practical Pass	Internal Attendance	Internal Midterm/ Internal Viva - Voce	Internal Assignment	Internal Practical File/Project File/Seminar	Internal Max	Internal Pass	Oral Max	Oral Pass	Overall Pass Marks	Whether to be offered under CBCS (Yes/No)	Scheme of Examinations (Theory +Internal+ Practical+Oral/ Theory+Internal +Practical/ Theory+Practical
1	I/I	17060101	Transition Metal Chemistry	Theory	Core	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
2		17060102	Quantum Mechanics-I and Thermodynamics	Theory	Core	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
3		17060103	Stereo Chemistry and Organic Reaction Mechanism-I	Theory	Core	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
4		17060104	Inorganic Chemistry Practical-I	Practical	Core			6	3			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
5		17060105	Physical Chemistry Practical-I	Practical	Core			6	3			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
6		17060106	Organic Chemistry Practical-I	Practical	Core			6	3			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
7		17060107	Professional Ethics & Human Values	Theory	SEC	2			2	30	12						5	10	5		20	8			20	NO	Theory+Internal
8		17060108	Environmental Chemistry	Theory	SEC	2			2	30	12						5	10	5		20	8			20	NO	Theory+Internal
9	II/I	17060201	Organometallics and Bioinorganic Chemistry	Theory	Core	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
10		17060202	Chemical Kinetics and Electro Chemistry	Theory	Core	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
11		17060203	Organic Reaction Mechanism II & Natural Products	Theory	Core	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
12		17060204	Inorganic Chemistry Practical-II	Practical	Core			6	3			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
13		17060205	Physical Chemistry Practical-II	Practical	Core			6	3			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
14		17060206	Organic Chemistry Practical-II	Practical	Core			6	3			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
15		17060207	Techniques in Chemistry	Theory	SEC	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
16	III / II	17060301	Advanced Inorganic Spectroscopy	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
17		17060302	Coordination Chemistry	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
18		17060303	Inorganic Special Practical-I	Practical	DSE			6	3			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
19		17060304	Inorganic Special Practical-II	Practical	DSE			6	3			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
20		17060305	Inorganic Special Practical-III	Practical	DSE			6	3			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
21		17060306	Chemical Dynamics and Surface Chemistry	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
22		17060307	Statistical Thermodynamics and Quantum Mechanics-II	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
23		17060308	Physical Special Practical-I	Practical	DSE			6	3			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
24		17060309	Physical Special Practical-II	Practical	DSE			6	3			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
25		17060310	Physical Special Practical-III	Practical	DSE			6	3			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
26		17060311	Organic Spectroscopy	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
27		17060312	Heterocyclic Chemistry and Organic Synthesis	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
28		17060313	Organic Special Practical-I	Practical	DSE			6	3			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
29		17060314	Organic Special Practical-II	Practical	DSE			6	3			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
30		17060315	Organic Special Practical-III	Practical	DSE			6	3			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
31		17060316	Research Methodology and Technical Writing	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	
32		17060317	Nanoscience and Technology	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
33		17060318	Drug Design and Development	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
34		17060319	Metals in Medicine	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
35	IV / II	17060401	Organometallic Chemistry	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
36		17060402	Inorganic Materials and advanced analytical techniques	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
37		17060403	Inorganic Special Practical-IV	Practical	DSE			6	3			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
38		17060404	Solid State Chemistry and Polymers	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
39		17060405	Molecular Spectroscopy	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
40		17060406	Physical Special Practical-IV	Practical	DSE			6	3			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
41		17060407	Photo Chemistry and Pericyclic Reactions	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
42		17060408	Reagents and Rearrangements	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
43		17060409	Organic Special Practical-IV	Practical	DSE			6	3			18	9	3	30	12	5	10		5	20	8			20	NO	Practical+Internal
44		17060410	Project	Practical	DSE			12	6			45	45	90		36	15	30		15	60	24			60	NO	Practical+Internal
45		17060411	Medicinal Chemistry	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
46		17060412	Material Chemistry	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
47		17060413	Food science and Technology	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal
48		17060414	Nanotechnology for Medical Diagnostics and Therapy	Theory	DSE	4			4	60	24						5	20	5	10	40	16			40	NO	Theory+Internal

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Department of Chemistry
MSc (Chemistry)
Syllabus (2019-20)
Course Structure under Choice Based Credit System (CBCS)

SEMESTER	COURSE CODE	COURSE NAME	L	T	P	Contact hours/ week	Credits	Max. Marks	Formative Assessment	Summative Assessment
I	**Core Courses (CC)**									
	17060101	Transition Metal Chemistry	4	0	0	4	4	100	40	60
	17060102	Quantum Mechanics-I and Thermodynamics	4	0	0	4	4	100	40	60
	17060103	Stereo Chemistry and Organic Reaction Mechanism-I	4	0	0	4	4	100	40	60
	17060104	Inorganic Chemistry Practical-I	0	0	6	6	3	50	20	30
	17060105	Physical Chemistry Practical-I	0	0	6	6	3	50	20	30
	17060106	Organic Chemistry Practical-I	0	0	6	6	3	50	20	30
	Sill Enhancement Courses (SEC)									
	17060107	Professional Ethics & Human Values	2	0	0	2	2	50	20	30
	17060108	Environmental Chemistry	2	0	0	2	2	50	20	30
Total Credits			**16**	**0**	**18**	**34**	**25**	**550**	**220**	**330**
II	**Core Courses**									
	17060201	Organometallics and Bioinorganic Chemistry	4	0	0	4	4	100	40	60
	17060202	Chemical Kinetics and Electro Chemistry	4	0	0	4	4	100	40	60
	17060203	Organic Reaction Mechanism II & Natural Products	4	0	0	4	4	100	40	60
	17060204	Inorganic Chemistry Practical-II	0	0	6	6	3	50	20	30
	17060205	Physical Chemistry Practical-II	0	0	6	6	3	50	20	30
	17060206	Organic Chemistry Practical-II	0	0	6	6	3	50	20	30
	Skill Enhancement Course (SEC)									
	17060207	Techniques in Chemistry	4	0	0	4	4	100	40	60
Total Credits			**16**	**0**	**18**	**34**	**25**	**550**	**220**	**330**
III	**(Choose any one of the following specialization)**									
	Specialization : Inorganic Chemistry									
	Core Courses(CC)									
	17060301	Advanced Inorganic Spectroscopy	4	0	0	4	4	100	40	60
	17060302	Coordination Chemistry	4	0	0	4	4	100	40	60
	17060303	Inorganic Special Practical-I	0	0	6	6	3	50	20	30
	17060304	Inorganic Special Practical-II	0	0	6	6	3	50	20	30
	17060305	Inorganic Special Practical-III	0	0	6	6	3	50	20	30
	Specialization : Physical Chemistry									
	Core Courses(CC)									
	17060306	Chemical Dynamics and Surface Chemistry	4	0	0	4	4	100	40	60
	17060307	Statistical Thermodynamics and Quantum Mechanics-II	4	0	0	4	4	100	40	60
	17060308	Physical Special Practical-I	0	0	6	6	3	50	20	30
	17060309	Physical Special Practical-II	0	0	6	6	3	50	20	30
	17060310	Physical Special Practical-III	0	0	6	6	3	50	20	30
	Specialization : Organic Chemistry									

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	Core Courses(CC)									
	17060311	Organic Spectroscopy	4	0	0	4	4	100	40	60
	17060312	Heterocyclic Chemistry and Organic Synthesis	4	0	0	4	4	100	40	60
	17060313	Organic Special Practical-I	0	0	6	6	3	50	20	30
	17060314	Organic Special Practical-II	0	0	6	6	3	50	20	30
	17060315	Organic Special Practical-III	0	0	6	6	3	50	20	30
	Skill Enhancement Course (SEC) (Common for all the specializations)									
	17060316	Research Methodology and Technical Writing	4	0	0	4	4	100	40	60
	Discipline Specific Elective Courses (DSEC)(Common for all the specializations) (Choose any one of the following papers)									
	17060317	Nanoscience and Technology	4	0	0	4	4	100	40	60
	17060318	Drug Design and Development	4	0	0	4	4	100	40	60
	17060319	Metals in Medicine	4	0	0	4	4	100	40	60
Total Credits			**16**	**0**	**18**	**34**	**25**	**550**	**220**	**330**
	(The specialization will be continued which is adopted in the third semester)									
	Specialization : Inorganic Chemistry									
	Core Courses(CC)									
	17060401	Organometallic Chemistry	4	0	0	4	4	100	40	60
	17060402	Inorganic Materials and advanced analytical techniques	4	0	0	4	4	100	40	60
	17060403	Inorganic Special Practical-IV	0	0	6	6	3	50	20	30
	Specialization : Physical Chemistry									
	Core Courses(CC)									
	17060404	Solid State Chemistry and Polymers	4	0	0	4	4	100	40	60
	17060405	Molecular Spectroscopy	4	0	0	4	4	100	40	60
IV	17060406	Physical Special Practical-IV	0	0	6	6	3	50	20	30
	Specialization : Organic Chemistry									
	Core Courses(CC)									
	17060407	Photo Chemistry and Pericyclic Reactions	4	0	0	4	4	100	40	60
	17060408	Reagents and Rearrangements	4	0	0	4	4	100	40	60
	17060409	Organic Special Practical-IV	0	0	6	6	3	50	20	30
	Skill Enhancement Course (SEC) (Common for all the specializations)									
	17060410	Project	0	0	12	12	6	150	60	90
	Discipline Specific Elective Courses(DSEC) (Common for all the specializations) (Choose any two of the following papers)									
	17060411	Medicinal Chemistry	4	0	0	4	4	100	40	60
	17060412	Materials Chemistry	4	0	0	4	4	100	40	60
	17060413	Food science and Technology	4	0	0	4	4	100	40	60
	17060414	Nanotechnology for Medical Diagnostics and Therapy	4	0	0	4	4	100	40	60
Total Credits			**16**	**0**	**18**	**34**	**25**	**600**	**240**	**360**
		Grand Total	**64**	**0**	**72**	**136**	**100**	**2250**	**900**	**1350**

Category	Credits	%
Core Course(CC)	74	74%
Discipline Specific Elective Course(DSEC)	12	12%
Skill Enhancement Course (SEC)	14	14%
Total	100	100%

1. Name of the Department: Chemistry						
2. Course Name	Transition Metal Chemistry			**L**	**T**	**P**
3. Course Code	17060101			4	0	0
4. Type of Course (use tick mark)		**Core (✓)**		**DSE ()**		**SEC ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52		**Tutorials = Nil**		**Practical = Nil**		

8. Course Description:

This core paper in Chemistry will enable postgraduate students to understand and rationalize bondingin main group compounds and predict their basic shapes and structures.
Concepts involved in explaining metal-ligand equilibria in solution will be explained. These include stepwise and overall formation constants and their interactions, factors affecting stability of metal complexes.
Reaction mechanisms for ligand displacement in octahedral complexes via acid and base hydrolysis will be explained. Mechanism of ligand displacement reactions in square planar complexes will be explained along with Trans effect and its theories. Outer sphere and inner sphere electron transfer mechanisms will also be explained. Students will also be made familiar with metal clusters. Principles governing structures and bonding in boranes, carboranes and metal carbonyl clusters will be explained.
Structures of isopoly and heteropoly acids and salts of Mo and W will be explained.

9. Course Objectives:

The objectives of this course are to:
1. Introduce students to bonding theories in main group compounds
2. Explain to students shapes of main group compounds and their energetics of hybridization
3. Explain stepwise and overall formation constants; their interactions; and ways of determining them
4. Understand stability of metal complexes with respect to the metal ion and ligand
5. Explain mechanisms for ligand displacement reactions in octahedral and square planar complexes
6. Understand mechanism of electron transfer reactions
7. Explain isopoly and heteropoly acids and salts of Mo and W

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:
1. Explain bonding in main group compounds
2. Predict the shapes and determine the energetics of hybridization of main group compounds
3. Explain stepwise and overall formation constants and their interactions
4. Explain mechanisms of ligand displacement reactions in octahedral and square planar complexes
5. Understand the structures and properties of isopoly and heteropoly acids and salts.
6. Explain structure and bonding in selected metal clusters and transition metal-complexes

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Metal-Ligand Equilibria in Solution**

Bent rule and determination of energetics of hybridization, Stepwise and overall formation constants and their interactions, Trends in stepwise constants, Factors affecting stability of metal complexes with reference to the nature of metal ion and ligand, Chelate effect and its thermodynamic origin.		
Unit – 2	**Number of lectures = 13**	**Title of the unit: Reaction Mechanism of Transition Metal Complexes-I**
Inert and labile complexes, Mechanisms for ligand replacement reactions, Formation of complexes of aquo ions, Ligand displacement reactions in octahedral complexes- acid hydrolysis, base hydrolysis.		
Unit – 3	**Number of lectures = 13**	**Title of the unit: Reaction Mechanism of Transition Metal Complexes-II**
Mechanism of ligand displacement reactions in square planar complexes, Trans effect, Theories of trans effect, Mechanism of electron transfer reactions – types; Outer sphere electron transfer mechanism and inner sphere electron transfer mechanism, Electron exchange.		
Unit – 4	**Number of lectures = 13**	**Title of the unit: : Isopoly and heteropoly Acids and metal clusters**
Isopoly and Heteropoly acids and salts of Mo and W, Structures of isopoly and heteropoly anions. **Metal Clusters:** Structure and bonding in higher boranes, Wade's rules, Carboranes.		

12. Brief Description of self learning / E-learning component

1. http://textofvideo.nptel.ac.in/104105033/lec39.pdf.
2. http://nptel.ac.in/courses/104101006/downloads/lecture-notes/mod10/lec3.pdf
3. https://ocw.mit.edu/courses/chemistry/5-111sc-principles-of-chemical-science-fall-2014/unit-ii-chemical-bonding-structure/lecture-12/
4. https://www.youtube.com/watch?v=1jRo5fTg0KY
5. http://web.mit.edu/5.03/www/readings/polyhedral_boranes/006_cluster_bonding.pdf
6. http://www.macollege.in/app/webroot/uploads/department_materials/doc_560.doc.

13. Books Recommended

1. Selected Topics in Inorganic Chemistry by Malik, Tuli and Madan
2. Inorganic Chemistry by T. Moeller
3. Modern Aspects of Inorganic Chemistry by H.J. Emeleus and A.G. Sharpe
4. Chemical Binding by O.P. Agarwal
5. Inorganic Reaction Mechanism by Edberg
6. Inorganic Reaction Mechanism by Basolo Pearson
7. Structural Principles in Inorganic Compounds by W.E.A. Addison
8. Advanced Inorganic Chemistry by Cotton and Wilkinson
9. Concepts in Inorganic Chemistry, Vol. 2, Asim Das and Mahua Das
10. Inorganic Chemistry- Principles of Structure and Reactivity by James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi
11. Inorganic Chemistry by Shriver and Atkins
12. Polyoxometalate Molecular Science by Juan J. Borrás-Almenar, Eugenio Coronado, Achim Müller and Michael Pope

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1. Name of the Department: Chemistry						
2. Course Name	Quantum Mechanics and Thermodynamics			**L**	**T**	**P**
3. Course Code	17060102			4	0	0
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non- Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52		**Tutorials = Nil**		**Practical = Nil**		

8. Course Description:

Quantum Mechanics, Schrödinger wave equation for a particle in a three dimensional box and harmonic oscillator, Schrödinger wave equation for three dimensional Rigid rotator, Schrödinger wave equation for hydrogen atom, First and Second Law of thermodynamics, Free energy functions and their significance, Brief resume of first and second Law of thermodynamics, Phase Rule, Phase diagram for two completely miscible components systems.

9. Course Objectives:

1. To provide a firm foundation in the fundamentals and applications of quantum mechanics & thermodynamics.
2. To introduce importance & application of first & second law of thermodynamics
3. To introduce importance & application of Phase Rule, Phase diagram.

10. Course Outcomes (COs):

The students will acquire knowledge of :

1. Various concepts of quantum mechanics & wave mechanics
2. Detailed application & need of first & second law of thermodynamics
3. Describing systems of one component as well as multi-component systems.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit:Quantum Mechanics-I**

Postulates of Quantum Mechanics; Schrödinger wave equation; Max-Born interpretation of ψ and the Heisenberg's uncertainty principle; Operators and their algebra ,Linear and Hermitian Operators(linear momentum and angular momentum operators as Hermitian operators), commuting operators .

Schrödinger wave equation for a particle in one dimensional box; evaluation of average position, average momentum and determination of uncertainty in position and momentum , pictorial representation of the wave equation of a particle in one dimensional box and its influence on the kinetic energy of the particle in each successive quantum level, concept of zero point energy.

Unit – 2	**Number of lectures = 13**	**Title of the unit:Quantum Mechanics-II**

Schrödinger wave equation for a particle in a three dimensional box. The concept of degeneracy among energy levels for a particle in three dimensional box. Schrödinger wave equation for a linear harmonic oscillator & its solution by polynomial method. Zero point energy of a particle possessing harmonic motion and its consequence. Schrödinger wave equation for three dimensional Rigid rotator, energy of rigid rotator, space quantization; Schrödinger wave equation for hydrogen atom, separation of variables in spherical polar coordinates.

Unit – 3	**Number of lectures = 11**	**Title of the unit: Thermodynamics-I**

Brief resumé of first and second Law of thermodynamics.Entropy changes in reversible and irreversible processes; variation of entropy with temperature , pressure and volume, entropy concept as a measure of unavailable energy and criteria for the spontaneity of reaction; free energy functions and their significance, criteria for spontaneity of a process; partial molar quantities (free energy, volume, heat concept), Gibbs-Duhem equation, variation of chemical potential with temperature and pressure.		
Unit – 4	**Number of lectures = 15**	**Title of the unit:Thermodynamics –II & Phase Rule**
Thermodynamics II: Third law of thermodynamics (Nernst heat theorem, determination of absolute entropy, unattainability of absolute zero) and its limitation. **Phase Rule, Fugacity & Activity:** Phase Rule, Phase diagram for two completely miscible components systems. Concepts of fugacity, fugacity of gases and its determination. Activity and activity coefficient, choice of standard states, determination of activity coefficient for solute and solvent.		

12. Brief Description of self-learning / E-learning component

1. http://epgp.inflibnet.ac.in.
2. https://youtu.be/lH9SNnQCs54
3. https://youtu.be/1OFlW8OXN64
4. http://nptel.ac.in/courses/103101004/5
5. https://chemistry.mit.edu/classes/
6. https://www.edx.org/course/quantum-world-harvardx-chem160x#!

13. Books Recommended

1. Glasstone, S. Theoretical Chemistry
2. Glasstone, S. Thermodynamics for Chemists.
3. A. Chandra - Introductory Quantum Chemistry Paperback – 2017
4. Donald A. McQuarrie - Quantum Chemistry Paperback – 2016
5. Barrow, G.M. Physical Chemistry.
6. Srivastava, R.C., S.K. Saha and A.K.Jain. Thermodynamics
7. Pauling, L. Introduction to Quantum Mechanics with Applications to Chemistry.

1. Name of the Department : Chemistry							
2. Course Name	Stereo Chemistry and Organic Reaction Mechanisms-I		**L**	**T**		**P**	
3. Course Code	17060103		4	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**		
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practicals							
Lectures = 52		**Tutorials = Nil**	**Practical = Nil**				

8. Course Description:

Stereochemistry of molecules dictates isomerism, chemical and biochemical reactivity.These days, chiral drugs have become an integral part of pharmaceutical industry. A basic concept on 3D structures and conformations of molecules and asymmetric synthesis and other stereo chemical principles and attributes are essential. This course will lay the foundation on to which further advanced topics can be built up.

9. Course Objectives:

The objectives of this course are to:

a. Provide the students with knowledge and the basic understanding of stereochemistry.
b. Understand different conformations and configurations of organic molecules
c. Study different types of reactions, their mechanisms and their stability.
d. Study the asymmetric synthesis and its importance in organic synthesis.

10. Course Outcomes (COs):

1. Differentiate between chiral and achiral molecules.
2. Recognize and draw structural isomers (constitutional isomers), stereoisomers including enantiomers and diastereomers, racemic mixture, and meso compounds.
3. Identify the stereocenters in a molecule and assign the configuration as R or S.
4. Know the relationship between enantiomers and their specific rotations.
5. Differentiate simple synthesis and asymmetric synthesis of organic molecules.
6. Deliver the importance of reaction mechanism.
7. Identify and differentiate the aromatic and aliphatic nucleophillic & electrophillic substitution reactions.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 14**	**Title of the unit: Stereochemistry**

Stereoisomers, symmetry elements, Molecular representations: Wedge, Fischer, Newmann and Saw-horse formulae. Optical isomerism due to asymmetric carbon atoms: molecules with one, two or more chiral centers, Configuration nomenclature: D,L and R,S configurations. Optical isomerism in absence of chiral carbon (biphenyls, allenes and spirans), Optical isomerism of nitrogenous compounds, racemisation and resolution, methods of resolution, geometrical isomerism and E,Z configurations, properties of geometrical isomers.

Unit – 2	**Number of lectures = 12**	**Title of the unit: Asymmetric Synthesis and Conformational Analysis**

Stereoselectivity, Enantioselectivity, Diastereoselectivity, Asymmetric Induction: Cram, Cram-Chelate, Felkin-Ahn models, stereoselectivity in cyclic compounds, Sharpless asymmetric epoxidation, chiral auxiliaries, chiral Catalysts and chiral reagents.

Conformational analysis: Introduction to conformational analysis, steric, electronic and stereo electronic effects in governing the conformation of acyclic and cyclic (5 and 6 membered rings) systems, Conformations and stability of cyclohexanes (Mono and Disubstituted), cyclohexanones, halo cyclohexanones, decalins,decalols and decalones.

Unit – 3	**Number of lectures = 13**	**Title of the unit: Aliphatic and Aromatic Nucleophilic**

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		Substtitution (Reaction Mechanisms)
Aliphatic Nucleophilic Substitution: The S_N2, S_N1 and S_Ni mechanisms, mixed S_N1 & S_N2 mechanism SET mechanism. The neighbouring group mechanism (anchimeric assistance). Neighbouring group participation by pi and sigma bonds, Classical non classical & phenonium cations, Nucleophilic substitution at allylic, aliphatic trigonal and vinylic carbon. Effect on the reactivity due to – substrate structure, attacking nucleophile, leaving group and reaction medium. Ambident nucleophiles and substrates regioselectivity. **Aromatic Nucleophilic Substitution:** S_NAr, S_N1, benzyne and $S_{RN}1$ mechanisms. Reactivity effect of substrate structure, leaving group and nucleophile. The von Richter, Sommelet-Hauser, and Smiles rearrangements.		
Unit – 4	**Number of lectures = 13**	**Title of the unit: Aliphatic and Aromatic Electrophillic Substtitution**
Aliphatic Electrophilic Substitution: Bimolecular mechanisms - S_E2 and S_Ei. The S_E1 mechanism, Electrophilic substitution accompained by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity. **Aromatic Electrophilic Substitution:** The arenium ion, mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmeir reaction, Gattermann-Koch reaction. Pechmann reaction, Houben – Hoesch reaction, Fries rearangement.		
12. Brief Description of self learning / E-learning component		
1. http://www.colby.edu/chemistry/CH241F/Chapter%204.pdf 2. https://onlinecourses.nptel.ac.in/noc17_cy11/announcements 3. http://nptel.ac.in/courses/104105086/ 4. http://ocw.uci.edu/courses/chem_201_organic_reactions_mechanisms_i.html 5. https://swayam.gov.in/courses/189-organic-chemistry-iii-reaction-mechanisms-2 6. https://faculty.chemistry.harvard.edu/myers/pages/chem-115-handouts 7. http://www.cureffi.org/tag/chem-20/ 8. https://archive.org/details/EvansD.A.HarvardsAdvancedOrganicChemistry2003/page/n51		
13. Books Recommended		
1. Stereochemistry of carbon compounds by Ernest L.Eliel and Samuel H. Wilen 2. Stereochemistry of organic compounds- Principles and Applications by D. Nasipuri 3. Stereochemistry by Eliel 4. Advanced Organic Chemistry by Jerry March. 5. Advanced Organic Chemistry, F. A. Carey, R. J. Sundberg, Volume I and II 6. Highlights of Organic Chemistry, W.J. L. Nobel; An Advanced Text Book. 7. Stereochemistry conformation and Mechanism – P. S. Kalsi 8. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman. 9. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press. 10. Reaction Mechanism in Organic Chemistry, Om Prakash and S. P. Singh, Trinity. 11. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice Hall of India. 12. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Trinity.		

1. Name of the Department: Chemistry						
2. Course Name	Inorganic Chemistry Practical I		**L**	**T**	**P**	
3. Course Code	17060104		0	0	6	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = Nil		**Tutorials = Nil**		**Practical = 78**		

8. Course Description:

The lab work for this semester focuses on **Quantitative Inorganic Analyses** and **Cerimetry**. In the former analyses, binary mixtures of metal complexes will be taken and strengths of individual metal ions in these mixtures will be determined by **gravimetric** and **volumetric** analyses.

Cerimetry (also called **cerimetric titration** or **cerate oximetry**) is a redox titration in which a Fe^{2+}-1,10-phenanthroline complex (ferroin) changes colour at the end point. Ferroin is reversibly discolored in its oxidized form upon titration with a Ce^{4+} solution.

9. Course Objectives:

1. Separation and determination of selected binary mixtures of metal ions employing volumetric and gravimetric methods
2. Determination of strengths of Ferrous, Oxalate and Nitrite ions using cerimetry.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Separate and determine binary mixtures of metal ions using gravimetric and volumetric methods
2. Determine strengths of Ferrous, Oxalate and Nitrite ions using Cerimetry.

11. List of Experiments (At least seven experiments to be performed by the student)

I. Estimate the following metal ions gravimetrically.

Copper as copper thiocyanate

Nickel as nickel-dmg complex

II. Separation and determination of the following two metal ions involving volumetric and gravimetric methods

a. Silver-Copper
b. Copper-Nickel
c. Copper-Zinc
d. Copper-Magnesium
e. Copper-Barium
f. Copper-Nickel-Zinc
g. Copper-Nickel-Magnesium

III. Determination by Cerimetry

a. Ferrous
b. Oxalate
c. Nitrite

12. Brief Description of self learning / E-learning component

1. https://www.youtube.com/watch?v=tGHJ6LUUBIY
2. https://www.youtube.com/watch?v=0HZ7_muDE_8
3. https://www.youtube.com/watch?v=GI_o_34dVcM
4. https://www.youtube.com/watch?v=cptn5HCEK54

13. Books Recommended

1. Venkatesan, V, Veeraswamy, R and Kulandaivelu, A.R (1997): Basic Principles of Practical Chemistry", 2nd edition, Sultan Chand and Sons Publication, New Delhi.
2. Gurtur, J. N. and Kapoor, R (1987): Advanced Experimental Chemistry", Vol. I, S. Chand & Co., Ltd, New Delhi
3. Siddiqui, I.R., Singh, J., Shrivastava, J., Yadav,L.D.S., Singh, R.K.P., Singh, J. (2018): Advanced Practical Chemistry, 8th Edition, Pragati Prakashan.
4. Agarwal, S.K., Lal, K. Advanced Inorganic Analysis, Pragati Prakashan
5. Mendham, J. (2009): Vogel's Textbook of Quantitative Inorganic Analysis, Pearson Education.
6. Svehla, G., Sivasankar, B. (2012); Vogel's Qualitative Inorganic Analysis, Pearson Education.

1. Name of the Department: Chemistry							
2. Course Name	Physical Chemistry Practical –I	**L**	**T**	**P**			
3. Course Code	17060105	0	0	6			
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**		
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical							
Lectures = Nil		**Tutorials = Nil**	**Practical = 78**				

8. Course Description:

This Course will enable the students to learn various conductometric titrating techniques and concept of heat of neutralization. Students will also learn various properties of liquids such as refractometry, surface tension and adsorption. This course will also give a platform to develop methods of analysis of various properties of liquids.

9. Course Objectives:

1. To impart knowledge of concepts like partition coefficient and equilibrium constant.
2. To impart knowledge with respect to surface tension and adsorption of different systems.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Describe various conductometric titrations of Strong acid/Strong base, Weak acid /Weak base , Strong acid/Weak base and Weak acid/Strong base.
2. Describe the concept of pH through working of instrument like pH meter.
3. Determine partition coefficient and equilibrium constant of various systems

11. List of Experiments (At least seven experiments to be performed by the student)

1. Conductometry

i. HCl vs NaOH titration.
ii. Oxalic acid vs NaOH titration.
iii. CH_3 COOH vs NaOH titration.
iv. Mixture of CH_3COOH+HCl vs NaOH

2. Surface tension

To determine interfacial tension of two immiscible liquids.

3. Adsorption

To study the adsorption of Oxalic acid and Acetic acid on charcoal.

4. pH metric

a. HCl vs NaOH titration.
b. Oxalic acid vs NaOH titration.
c. CH_3COOH vs NaOH titration.

5. Distribution Law

a. To determine partition coefficient of benzoic acid between benzene and water.
b. To determine partition coefficient of Iodine between Carbon tetrachloride and water.
c. Determination of Equilibrium constant for $I_2 + I^- = I_3$

12. Brief Description of self-learning / E-learning component

1. https://youtu.be/E0oYzyJrKGg
2. https://www.britannica.com/science/surface-tension

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3. https://youtu.be/vMOa7wrP3w0 4. https://nptel.ac.in/courses/108105063/pdf/L-08(SS)(IA&C)%20((EE)NPTEL).pdf 5. https://www.thefreedictionary.com/distribution+law
13. Books Recommended
1. Khosla,B.D., V.C. Garg and A. Gulati.Senior Practical Physical Chemistry. 2. Thawale,A. and P. Mathur. Experimental Physical Chemistry. 3. Vishwanatha,B. and P. S Raghav. Practical Physical Chemistry. 4. Sindhu, P.S. Practical in Physical Chemistry.

1. Name of the Department: Chemistry						
2. Course Name	Organic Chemistry Practical-I		**L**	**T**		**P**
3. Course Code	17060106		0	0		6
4. Type of Course (use tick mark)		**Core (✓)**		**DSE ()**		**SEC ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals.						
Lectures = Nil		**Tutorials = Nil**		**Practical = 78**		

8. Course Description:

This Course will introduce the students to the basic principles of Separation, purification and identification of organic compounds in binary mixtures and will enable to develop and practice independent learning skills. This course will also give a platform to develop different methods to separate binary mixtures.

9. Course Objectives:

The objectives of this course are to:

1. Understand the separation of organic compounds in a binary mixture
2. Learn the identification and purification of separated compounds from the binary mixture..
3. Have knowledge of key methods of separation
4. Learn the mechanism of chemical reactions of the derivatives of organic compounds.
5. To make students able to perform the organic reactions safely and to understand the practical approach in chemistry.
6. To make students able to carry out organic reactions by following the reported procedure.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Demonstrate knowledge of separation of organic compounds from binary mixture
2. Recognize different types of procedures for separation , identification and purification of organic compounds
3. Apply basic chemical concepts to write the mechanisms of the derivatives.
4. Describe different methods for separation of mixtures.
5. Handle organic chemicals in a safe and competent manner.
6. Perform the standard techniques used in practical organic chemistry.

11. List of Experiments (At least seven experiments to be performed by the student)

I. Organic Synthesis

i. p-nitroacetanilide from aniline
ii. anthranilic acid from phthalic anhydride
iii. 2,4-dinitrophenylhydrazine from chlorobenzene
iv. m - Nitro aniline from nitrobenzene

II. Qualitative Analysis

Separation, purification and identification of organic compounds in binary mixtures by chemical tests and preparation of their derivatives.

12. Brief Description of self-learning / E-learning component

1. http://wwwchem.uwimona.edu.jm/lab_manuals/c10expt25.html
2. https://www.youtube.com/watch?v=Fw9KYlNVxm4
3. https://pubs.acs.org/doi/abs/10.1021/ed042p267

13. Books Recommended

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1. Pasto, D.C. Johnson and M. Miller. Experiments and Techniques in Organic Chemistry. Prentice Hall.
2. Williamson, K. L. and D.D. Heath. Macroscale and Microscale Organic Experiments.
3. Middleton, H.and Adward Arnold. Systematic Qualitative Organic Analysis.
4. Clark, H. and Edward Arnold. Handbook of Organic Analysis-Qualitative and Quantitative.
5. Tatchell, A. R. Vogel's Textbook of Practical Organic Chemistry. John Wiley.
6. Handbook of Organic Analysis -Qualitative and Quantitative by H.T. Clarke, and revised by Haynee, Edward Arnold, London 1975.

1. Name of the Department :Chemistry						
2. Course Name	Professional ethics and human values	**L**		**T**	**P**	
3. Course Code	17060107	2		0	0	
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**AEC ()**	**SEC (✓)**	**OE ()**
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 26		**Tutorials = 0**		**Practical = 0**		

8. Course Description:

This course provides students with the knowledge of ethics in professional life. Some of the examples from history and day to day life will make the students more responsible towards their profession, society and family.

9. Course Objectives:

1. To develop ethical and human values in students
2. To developthe responsibility in students at professional and societal levels.

10. Course Outcomes (COs):

1. The students will understand the values of professional ethics and moral values deeply.
2. The students will be able to take strong decisions and perform their duties responsibly as on professional.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Ethics and Human Values**

Definition, History and Development of Ethics, Universal declaration on Bioethics, Theories related to Bioethics: Utilitarian theory, Deontological theory and Communication theory.
Human Rights and Values : Autonomy, Consent, Equality, Confidentiality, Vulnerability and Personal Integrity, Environmental Ethics, Animal ethics

Unit –2	**Number of lectures = 14**	**Title of the unit: Professional Ethics & Responsibility**

Need and Importance of professional ethics, Goals, Dignity of Labour,IRB &its functions, Authorship

Religious and Cultural Values, Importance of a Family, Guidance to youngsters, Gender Equality

Responsibilities towards Safety and Risk, Voluntary vs involuntary Risk, Designing/Research for Safety – Risk, Benefit Analysis, Accidents.Disaster ethics,

Ethics in Media and Technology, Research Ethics, Intellectual Property Rights.

12. Brief Description of self learning / E-learning component

1. https://www.youtube.com/watch?v=cFOZplkRqsk&authuser=2
2. https://www.youtube.com/watch?v=HJk1Eodmf9A&authuser=2
3. https://www.youtube.com/watch?v=Fqt7m8LH5GY&authuser=2
4. https://youtu.be/2VYF_t51FyE

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5. https://youtu.be/hjzA_rZG-bU

13. Books Recommended

1. Professional Ethics and Morals by Prof.A.R.Aryasri, DharanikotaSuyodhana – Maruthi Publications.
2. Professional Ethics and Human Values by A. Alavudeen, R.KalilRahman and M. Jayakumaran – University Science Press.
3. Professional Ethics and Human Values by Prof.D.R.Kiran-Tata McGraw-Hill – 2013

1. Name of the Department : Chemistry							
2. Course Name	Environmental Chemistry	**L**	**T**	**P**			
3. Course Code	17060108	2	0	0			
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**	**SEC (✓)**			
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practicals							
Lectures =26		**Tutorials = 0**	**Practical = 0**				

8. Course Description:

This Course will introduce students to the principles and factual basis of chemistry in an environmental context and will enable them to develop and practice independent learning skills. This course will also give them an appreciation of scientific methodology and enable them to develop those problem-solving and critical-thinking skills necessary to analyze and discuss chemical and physical phenomena in the environment.

9. Course Objectives:

The objectives of this course are to:

1. Understand and apply fundamental concepts of chemistry in the environment.
2. Have knowledge of key themes, theories and problems
3. Learn the important chemical reactions in the environment.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Demonstrate knowledge of chemical and biochemical principles of fundamental environmental processes in air, water, and soil.
2. Recognize different types of toxic substances & responses and analyze toxicological information.
3. Apply basic chemical concepts to analyze chemical processes involved in different environmental matrices (air, water & soil).
4. To know about different case studies and pollution disasters.
5. To understand the pollution dynamics in separate environmental matrices.
6. Discuss local and global environmental issues based on the knowledge gained throughout the course.

11. Unit wise detailed content

Unit – 1	**Number of lectures = 14**	**Air & Water Chemistry**

Types and major sources of air pollutants, air borne diseases and effects of air pollutants on health. London Smog, Los Angeles Smog, Tropospheric Ozone, PAN, Benzo-α-pyrenes, Bisphenols. Air quality standards. Major sources of noise pollution, effects of noise pollution on health, noise level standard and control in industrial, commercial, residential and silence zones.

Types and major sources of water pollutants, effects of water pollutants on physico-chemical and biological properties of water bodies, carbonate – bicarbonate system in natural water bodies, water borne diseases with special reference to water pollution. Drinking water and waste water quality standards. Effects of mercury, lead, chromium, cadmium, arsenic and nitrate on human health. Wastewater treatment: Effluent and Sewage, Kepone Case, Arsenic in groundwater case studies.

Unit-2	**Number of lectures = 12**	**Solid waste management**

Types and major sources of soil pollutants, difference between soil pollution and soil contamination, relation of soil pollution with bioaccumulation and biomagnification. Waste categorization and segregation, Solid waste disposal and its effects on surrounding environment, Bio-medical waste, types, effects and its disposal guidelines, sanitary land filling, incineration, Plastics, their types and hazards. Love Canal Disaster.

12. Brief Description of self learning / E-learning component

1. https://www.youtube.com/watch?v=IIqFQkcHkCE
2. https://www.youtube.com/watch?v=51ixXCJ-Igo
3. https://en.wikipedia.org/wiki/Environmental_chemistry
4. https://www.nature.com/subjects/environmental-chemistry.

13. Books Recommended
1. De, A.K. Environmental Chemistry. 2. Manahan, S.E., Environmental Chemistry-. 3. Rao and Rao, Air Pollution 4. Bell and Bell, Industrial Noise Control

1. Name of the Department: Chemistry						
2. Course Name	Organometallics and Bioinorganic Chemistry	**L**	**T**	**P**		
3. Course Code	17060201	4	0	0		
4. Type of Course (use tick mark)	**Core (✓)**	**DSE ()**	**SEC ()**			
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical		
Lectures = 52	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

This special paper in Inorganic chemistry will introduce students to vital essential and trace elements found in nature. Students will become familiar with the various functions of these elements. The role of metal ions in various biological systems, nucleotides, proteins and enzymes will be described.

General introduction of organo-transition elements and types of bonding will be explained and futuristic aspects of organometallic chemistry will be discussed.

9. Course Objectives:

The objectives of this course are to:

1. Introduce students to essential and trace elements
2. Explain role of metal ions in biological systems and nucleotides
3. Understand role of metals in proteins (structure and function)
4. Understand role of metal ions in enzymes (structure and function)
5. Explain the structure and bonding in organometallic compounds

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Identify essential and trace elements found in nature and describe their function
2. Explain how metal ions contribute to functioning of vital biological systems
3. Explain the structure and function of vial metalloproteins
4. Explain the structure and function of vital metalloenzymes
5. Explain the structure and bonding in organometallic compounds

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Metal Ions in Biological System**

Metal Ions in Biological Systems: General survey of essential and trace metals, Disturbing factors in metabolic process and causes of diseases, different classes of drugs.

Alkali and alkaline earth metals in biological systems: Ionophores, active transport of cations across membranes, sodium-potassium pump, Calcium pump, Calcium carriers, role of carriers in muscle contraction, blood clotting and hormones.

Interaction of metal ions with Nucleotides: Metal ions in nucleotide systems, effect of metal ions on nuclei acids.

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Unit – 2	**Number of lectures = 13**	**Title of the unit: Metalloproteins**
Oxygen carriers: Porphyrins, metalloporphyrins, Hemoproteins, structure and functions of hemoglobin and myoglobin, synthetic oxygen carrier model systems **Nitrogen fixation**: Biological nitrogen fixation, Nitrogenase, model for nitrogenase, metal-N_2 complexes, photosynthesis and chlorophyll. **Metal transport and storage**: Transferrin, Ferritin, Siderophores		
Unit – 3	**Number of lectures = 13**	**Title of the unit: Metalloenzymes**
Zinc Enzymes – Carboxypeptidase & Carbonic anhydrase Iron Enzymes – Catalase, peroxidase & cytochrome P- 450 Copper Enzymes – Superoxide dismutase, blue copper- proteins Coenzymes – Vitamins B_{12}		
Unit – 4	**Number of lectures = 13**	**Title of the unit:Organo-transition metal chemistry**
General introduction, Structure and bonding, π bonded organometallic compounds including carbonyls, nitrosyls, tertiary phosphines, hydrides, alkene, alkyne, cyclobutadiene, cyclopentadiene, arene compounds. Metal-carbon multiple bonds. Fluxional organometallic compounds including π-allyl complexes and their characterization. Metallocycles, unsaturated nitrogen ligands including dinitrogen complexes. Futuristic aspects of organotransition metal chemistry.		
12. Brief Description of self -learning / E-learning component		
1. https://www.youtube.com/watch?v=C_Kg0EMPEJ8 2. https://www.youtube.com/watch?v=n8IU53mS7M0 3. https://www.youtube.com/watch?v=dZE0TUTZtpQ 4. https://www.youtube.com/watch?v=s8jO6_8arCE 5. https://www.youtube.com/watch?v=7726rvJ6mNY.		
13. Books Recommended		
1. Inorganic Chemistry: Principles of Structure and Reactivity by J.E. Huheey 2. Metal Ions in Biochemistry by P.K. Bhattacharya 3. Bioorganic, Bioinorganic and Supramolecular Chemistry by P.S. Kalsi and J.P.Kalsi		

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1. Name of the Department : Chemistry						
2. Course Name	Chemical Kinetics & Electrochemistry		**L**		**T**	**P**
3. Course Code	17060202		4		0	0
4. Type of Course (use tick mark)		**Core (✓)**		**DSE ()**		**SEC ()**
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52		**Tutorials = Nil**			**Practical = Nil**	

8. Course Description:

Effect of temperature on reaction rates, Collision theory of reaction rates and its limitations, Debye -Hückel theory of ion- ion interactions, Debye - Hückel limiting law of activity coefficients and its limitations, Hückel - Onsager treatment for aqueous solutions and its limitations Debye- Hückel -Onsager theory for non-aqueous solutions, Debye- Hückel - Bjerrum equation, Nernest heat theorem, Phase Rule, Chain reactions, Michaelis - Menton treatment, Stokes- Einstein relation, Walden's rule, Nernst - Planck Flux equation, Onsager phenomenological equations.

9. Course Objectives:

1. Students will be able to learn various areas of chemistry like chemical kinetics & electrochemistry.
2. Students will be able to learn various concepts of Physical Chemistry like Chain Reactions & Ion Transport in solutions.

10. Course Outcomes (COs):

The students will acquire knowledge of :

1. Scientific theories of ion-ion interactions
2. Various relationships such as equivalent conductivity vs. concentration, effect of ion association upon conductivity
3. Mechanism and further studies in chain reactions
4. Ion transport in solutions

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	**Title of the unit: Chemical Kinetics-I**

Rate of reaction , rate law and rate constant , units of rate constant , integrated rate laws for Zero , First and Second order reaction , effect of temperature on reaction rates, Rate law for opposing reactions of I^{st} order and II^{nd} order, Rate law for consecutive & parallel reactions of I^{st} order reactions, Collision theory of reaction rates and its limitations, steric factor, Activated complex theory, Ionic reactions: single and double sphere models, the comparison of collision and activated complex theory.

Unit – 2	**Number of lectures = 13**	**Title of the unit:Chemical Kinetics : Chain Reactions**

Chain reactions: hydrogen - bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane. Photochemical reactions (hydrogen - bromine & hydrogen -chlorine reactions). General treatment of chain reactions, apparent activation energy of chain reactions, chain length, Rice- Herzfeld mechanism of organic molecules decomposition(acetaldehyde) Branching chain reactions. Kinetics of (one intermediate) enzymatic

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reaction : Michaelis - Menton treatment, evaluation of Michaelis 's constant for enzyme - substrate binding by Lineweaver - Burk plot and Eadie- Hofstae methods. Competitive and non-competitive inhibition.		
Unit – 3	**Number of lectures = 15**	**Title of the unit: Electrochemistry: Ion - Ion Interactions**
The Debye - Hückel theory of ion- ion interactions: potential and excess charge density as a function of distance from the central ion, Debye - Hückel reciprocal length, ionic cloud and its contribution to the total potential, Debye - Hückel limiting law of activity coefficients and its limitations, ion - size effect on potential, ion -size parameter and the theoretical mean - activity coefficient in the case of ionic clouds with finite - sized ions.		
Unit – 4	**Number of lectures = 15**	**Title of the unit: Ion Transport in Solutions**
Ionic movement under the influence of an electric field , mobility of ions, ionic drift velocity and its relation with current density, Einstein relation between the absolute mobility and diffusion coefficient, the Stokes- Einstein relation , the Nernst -Einstein equation, Walden's rule, the Rate- Process approach to ionic migration , the Nernst - Planck Flux equation, ionic drift and diffusion potential ,Planck- Henderson equation for the diffusion potential.		
12. Brief Description of self-learning / E-learning component		
1. http://epgp.inflibnet.ac.in. 2. http://www.engr.uconn.edu/~jmfent/CHEG320_electrochemistry%20lectures.pdf 3. https://youtu.be/uTFtaslJ0LM 4. http://staff.uny.ac.id/sites/default/files/jas_ion_transport_in_solution.pdf 5. https://chemistry.mit.edu/classes/		
13. Books Recommended		
1. Bockris, J.O.M. and A.K.N. Reddy. Modern Electrochemistry Vol.1 2. Laidler, K.J. Chemical Kinetics. 3. Frost, A. & G.Pearson. Kinetics & Mechanism of Reaction Rates. 4. Eyring, H. Modern Chemical Kinetics. 5. Laidler, K.J., H.Eyring & S. Glasstone Theories of Reaction Rates.		

1. Name of the Department: Chemistry						
2. Course Name	Organic Reaction Mechanisms-II and Natural Products		**L**	**T**		**P**
3. Course Code	17060203		4	0		0
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem()	EverySem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52		**Tutorials = Nil**	**Practical = Nil**			

8. Course Description:

This course covers the mechanisms of free radical, elimination and addition reactions. It also cover metal hydride reduction of carbonyl compounds, mechanistic approach of all name reactions. It covers the reactions for the addition to carbon-carbon and carbon-hetero bond. It also covers main areas of natural product chemistry.

9. Course Objectives:

1. To make students able to understand free radical and elimination mechanisms of reactions.
2. This course makes the students able to understand all these mechanisms and their application in organic synthesis.
3. To give students knowledge of Natural Product chemistry

10. Course Outcomes (COs):

On completion of this course, the students will

1. Be able to understand all different kinds of mechanisms of different compounds.
2. Know about the regio and chemoselectivity, and different types of elemination and addition reactions.
3. Develop capacity to solve the organic reaction mechanisms related problems.
4. Develop a clear understanding about the reactions for addition to the carbon-carbon and carbon-hetero bonds.
5. Gain understanding of Natural Product Chemistry.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Free Radical and Elimination Reactions**

Free Radical Reactions: Types of free radial reactions, free radical substitution mechanisms. Mechanisms at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals. Effect of solvents on reactivity. Allylic halogenation (NBS), oxidation of aldehydes to acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction, Free radical rearrangement, Hunsdiecker reaction, Kolbe reaction, Hydroxylation of aromatics by Fenton's reagent.

Elimination Reactions: The E_2, E_1, E_{1cB} mechanisms. Orientation of the double bond. Effects of substrate structure, attacking base, leaving group and medium on reactivity. Mechanism and orientation in pyrolytic eliminations.

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Unit – 2	Number of lectures = 13	Title of the unit: **Addition to Carbon – Carbon Multiple Bonds**
Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring. Hydroboration, Michael reaction. Sharpless asymmetric epoxidation, Hydrogenation of double and triple bonds. Hydrogenation of aromatic rings.		
Unit – 3	**Number of lectures = 12**	**Title of the unit: Formation of Carbon-Carbon Bond**
Mechanism of some name reactions: Aldol, Perkin, Benzoin, Cannizarro, Wittig, Reformatsky, - Hoffmann, Claisen and Favorsky rearrangements, Openauer oxidation, Clemmensen Reduction, Meerwein - Pondorf Verley and Birch reductions. Stork enamine reactions, Michael addition, Mannich Reaction, Diels - Alder reaction, Ene - reaction, Baeyer - Villiger oxidation.		
Unit – 4	**Number of lectures = 15**	**Title of the unit: Natural Products**
Chemistry of natural products: Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids. Biogenesis of terpenoids and alkaloids.		

12. Brief Description of self learning / E-learning component

1. https://www.masterorganicchemistry.com/2013/07/30/free-radical-reactions
2. https://chem.ucr.edu/documents/curricularmaterials/neumantextbook/Chapter11.pdf
3. https://chem.libretexts.org/LibreTexts/Athabasca_University/Chemistry_360%3A_Organic_Chemistry_II/Chapter_23%3A_Carbonyl_Condensation_Reactions.
4. http://www.srmuniv.ac.in/sites/default/files/files/unit-1.pdf

13. Books Recommended

1. Advanced Organic Chemistry – Jerry March.
2. Advanced Organic Chemistry, F.A. Carey, R.J. Sunberg
3. Highlights of Organic Chemistry, W, J.L. Nobel.
4. March's Advanced Organic Chemistry (Reactions, Mechanism and Structure), Jerry march - Sixth Edition.
5. Advanced Organic Chemistry, Carey, F.A. and R.J. Sundberg.
6. A Guide Book to Mechanism in Organic Chemistry. Sykes, Peter.
7. Structure and Mechanism in Organic Chemistry, Ingold, C.K.
8. Mann, J., R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne. Natural Products: Chemistry and Biological Significance.
9. Finar, I.L. Organic Chemistry.

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1. Name of the Department: Chemistry						
2. Course Name	Inorganic Chemistry Practical II			**L**	**T**	**P**
3. Course Code	17060204			0	0	6
4. Type of Course (use tick mark)	**Core (✓)**		**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = Nil	**Tutorials = Nil**		**Practical = 78**			

8. Course Description:

This course provides practical training in qualitative analysis of inorganic salt mixture and in determination of qualitative properties of inorganic cations and anions.

9. Course Objectives:

The objectives of this course are to:

1. Identify different cations and anions in an inorganic mixtures.
2. Identify cations and anions specific properties (colour, flame, odour, colour of fumes, byproducts)

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Separate the components in an inorganic mixture
2. Identify quality of any chemical and any formulation.

11. List of Experiments

Semi-micro qualitative analysis (using H_2S or other methods) of mixtures - not more than eight ionic species (four anions and four cations, excluding insoluble salts) out of the following:

Cations : NH_4^+, Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, K^+

Anions : CO_3^{2-} , S^{2-}, SO_2^-, $S_2O_3^{2-}$, NO_3^-, CH_3COO^-, Cl^-, Br^-, I^-, NO_3^-, SO_4^{2-}, PO_4^{3-}, BO_3^{3-}, $C_2O_4^{2-}$, F^-

(Spot tests and flame tests should be carried out wherever feasible)

12. Brief Description of self- learning / E-learning component

1. https://www.academia.edu/10186454/SEMI_MICRO_QUALITATIVE_ANALYSIS_OF_SIMPLE_INORGANIC_SALT

2. https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&cad=rja&uact=8&ved=2ahUKEwiGz-nxrKziAhWhheYKHVkEC_4QFjADegQIAxAC&url=http%3A%2F%2Fwww.kchn.pg.gda.pl%2Fdidactics%2Fskrypt_lab%2Flab_gtm_salts.pdf&usg=AOvVaw2UQZFzj2vPJk2kgTohZ9kh
3. https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=6&cad=rja&uact=8&ved=2ahUKEwiGz-nxrKziAhWhheYKHVkEC_4QFjAFegQIBBAC&url=https%3A%2F%2Fwww.kau.edu.sa%2FFiles%2F0017486%2FSubjects%2Fex._6_7_and_8__inorganic_qualitative_analysis_acidic_radical.pdf&usg=AOvVaw3qS6PTSyRaV7eZdao2PXX7

13. Books Recommended

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009

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1. Name of the Department : Chemistry						
2. Course Name	Physical Chemistry practical-II		**L**	**T**	**P**	
3. Course Code	17060205		0	0	6	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = Nil		**Tutorials = Nil**	**Practical = 78**			

8. Course Description:

This Course will enable the students to learn various potentiometric titrating techniques and hands on experience of using instruments such as potentiometers. Students will also learn various experimental aspects of chemical kinetics This course will also give a platform to develop methods of analysis of various properties of liquids.

9. Course Objectives:

1. To motivate the students to understand the principles of chemical kinetics, potentiometric titrations of various systems.
2. To motivate the students to understand the concepts of Thermochemistry and Refractometry.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Describe various potentiometric titrations of Strong acid/Strong base and Weak acid/Strong base etc.
2. Describe application of thermochemistry in determination of heat of neutralization.
3. Know the handling of instruments such as refractometer.
4. Describe the kinetics of various reactions.

11. List of Experiments

1. Potentiometry

a. HCl vs NaOH titration.
b. Oxalic acid NaOH titration.
c. CH_3COOH vs NaOH titration.

2. Refractometry

i. To determine molar refractivity of the given liquid.
ii. To determine percentage composition of liquids in the given binary mixture.
iii. To determine concentration of sugar in a solution.

3. Chemical Kinetics

a. To study kinetics of hydrolysis of ester in the presence of acid.
b. To compare the relative strength of acids (HCl and H_2SO_4).

4. Thermochemistry

Determination of heat of neutralization of the followings:-

i. HCl NaOH
ii. CH_3COOH vs NaOH
iii. Oxalic acid NaOH

12. Brief Description of self-learning / E-learning component

1. https://nptel.ac.in/courses/103108100/37 2. https://youtu.be/w-YIzLQwtUk 3. https://youtu.be/N_zXl9n9SKA 4. https://youtu.be/UNvAZVaFLLs
13. Books Recommended
1. Khosla,B.D., V.C. Garg and A.Gulati.Senior Practical Physical Chemistry. 2. Thawale,A. and P. Mathur. Experimental Physical Chemistry. 3. Vishwanatha,B. and P. S Raghav. Practical Physical Chemistry. 4. Sindhu, P.S. Practical in Physical Chemistry.

1. Name of the Department: Chemistry							
2. Course Name	Organic Chemistry Practical-II	**L**	**T**	**P**			
3. Course Code	17060206	0	0	6			
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**		
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practicals							
Lectures = Nil		**Tutorials = Nil**	**Practical = 78**				

8. Course Description:

The course provides a core for future studies in Organic Synthesis. It includes introduction to basic practical skills including safe working practices (risk, hazard and control measures), laboratory report writing. It covers the multistep synthesis of some important organic compounds, their separation and purification.

9. Course Objectives:

1. To make students able to perform the organic reactions safely and to understand the practical approach in chemistry.
2. To make students able to carry out organic reactions by following the reported procedure.
3. To learn the methods for their separation and purification.
4. Learn the isolation of organic compounds.
5. Have knowledge of key methods of isolation.

10. Course Outcomes (COs):

By the end of this course, students should be able to:

1. Handle organic chemicals in a safe and competent manner.
2. Perform the standard techniques used in practical organic chemistry.
3. Carry out multistep synthesis of organic compounds following a prescribed procedure.
4. To develop skills to determine the mechanism of the performed practicals.
5. Characterize and purify the synthesized compounds.
6. Demonstrate knowledge of isolation of organic compounds.
7. Recognize different types of isolation methods.
8. Apply basic chemical concepts to estimate different types of organic compounds.
9. Describe different methods for isolation.

11. List of Experiments

I. Organic Synthesis

1. Synthesis of *p*-Bromoaniline from acetanilide
2. Synthesis of sym-tribromobenzene from aniline
3. Synthesis of 2,5-dihydroxyacetophenone from hydroquinone.
4. p-aminophenol from nitrobenzene

II. Isolation of natural products

1. Casein from milk
2. Isolation of caffeine from tea leaves
3. Isolation of piperine from black pepper

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4. Isolation of β-carotene from carrots 5. Isolation of lycopene from tomatoes
12. Books Recommended
1. Chapman and Hall, 5th edition, Textbook of Practical Organic Chemistry, 1996. 2. Nicolas Bogliotti, Roba Moumné ,Multi - step Organic Synthesis, A Guide through Experiments,Dec 2017. 3. Brian S,Furniss ,Vogels Textbook of Practical Organic chemistry, 5th addition,. 4. Tatchell, A. R. Vogel's Textbook of Practical Organic Chemistry. John Wiley.

1. Name of the Department : Chemistry							
2. Course Name	Techniques in Chemistry		**L**		**T**		**P**
3. Course Code	17060207		**4**		**0**		**0**
4. Type of Course (use tick mark)		**Core ()**		**DSE ()**		**SEC (✓)**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**		Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical.							
Lectures = 52		**Tutorials = Nil**		**Practical = Nil**			

8. Course Description:

This course is designed for students to acquire quality knowledge in General Spectroscopic techniques and Nanotechnology. Its use is varied, ranging from traditional device physics, to molecular self assembly, to improving new substances with dimensions on the nanoscale. The course also gives a theoretical as well as a practical introduction to principles and techniques of chromatography: adsorption and partition chromatography (normal and reversed-phase systems), thin layer chromatography (TLC), column liquid chromatography including HPLC, gas chromatography, ion exchange and size exclusion chromatography.

9. Course Objectives:

The objectives of this course are to:

1. Study the basic principles, instrumentation of Atomic Absorption Spectroscopy, Atomic Emission Spectroscopy and Flame Photometry.
2. Provide the students with knowledge and the basic understanding of nanomaterials.
3. Study different chromatographic techniques.
4. Study the concept of electrophoresis.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Understand the importance of general spectroscopic techniques.
2. Understand the need to increase Nanotechnology awareness.
3. Understand the basic need of Nanotechnology.
4. Know the processing of some nanoparticles.
5. Explain most important principles of liquid and gas chromatography.
6. Acquire some technical knowledge of gas and liquid chromatography, and in capillary electrophoresis.
7. Evaluate strengths and limitations of the most important chromatographic separation and detection methods in relation to the properties of the sample and of the analysis task.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Absorption and Emission Spectroscopy**

Atomic Absorption Spectroscopy - Principles, Instrumentation, Sensitivity and detection limits, Interferences in AAS and their elimination.

Atomic Emission Spectroscopy- Principles, Sources for excitation, Instrumentation, Qualitative and quantitative Analysis.

Flame Photometry- Principles, Interferences, Evaluation methods in Flame Photometry, Principle and Applications of TGA and DTA.

Unit -2	**Number of lectures = 13**	**Title of the unit: Introduction to Nanomaterials**

Nanomaterials and their historical perspective. Applications of nanoscience and nanotechnology in various fields. Unique properties of nanomaterials due to their nanosize, Quantum dots, Properties of nanostructured materials: opticals, magnetic, chemical and photo catalytic properties.

Unit-3	**Number of lectures = 13**	**Title of the unit:Nanomaterials Technology**

Techniques for synthesis of nanometerials:- Hydrothermal, Solvothermal, Microwave irradiation, sol-gel, Precipitation, Reverse Micelle Synthesis, Physical Vapour deposition (PVD), Chemical Vapour Deposition

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(CVD), Electro deposition, Characterization of nanomaterials by X-ray diffraction (XRD), Scanning Electron Microscope (SEM), Energy dispersive X-ray Analysis. Transmission Electron Microscope (TEM), Atomic Force Microscopy (AFM) techniques.		
Unit –4	**Number of lectures = 13**	**Chromatographic Techniques**
Purification of organic compounds using chromatographic techniques: paper chromatography, Thin- Layer Chromatography, Column Chromatography, High Pressure Liquid Chromatography (HPLC), Gas Chromatography, Ion-Exchange Chromatography, Counter- Current distribution and Electrophoresis		

12. Brief Description of self learning / E-learning component

1. https://en.wikipedia.org/wiki/Atomic_absorption_spectroscopy
2. http://www.liskeard.cornwall.sch.uk/images/Liskeard-Sixth-Form/Atomic-Absorption-Spectrometry.pdf
3. https://en.wikipedia.org/wiki/Atomic_emission_spectroscopy
4. https://en.wikipedia.org/wiki/Chromatography
5. https://www.khanacademy.org/test-prep/mcat/chemical-processes/separations-purifications/v/basics-of-chromatography.

13. Books Recommended

1. Poole, Charles P., Jr. Frank and J. Owens. Introduction to Nanotechnology. Wiley India
2. Sachdeva, Mamta. V. Basics of Nanochemistry.
3. Sergeev, G. B. and K. L. Klabunde.Nanochemistry. 2013. Elsevier.
4. Fahrner, W.R. Nano Technology and Nanoelectronics. Springer International.
5. Vantra, M. D., S. Evoy and J.R. Heflin-Introducation to Nanoscience and Technology. Edited Springer.
6. Lindsey, S. M. Introduction to Nanosciences. Oxford Press.
7. Muralidharan, V. S. and A. Subramania. Nano Science and Technolony.
8. Budhiraja, R.P. Basic Concepts of Analytical Chemistry by S.M. Khopkar, New age International Publishers.
9. Sharma,B.K. Instrumental Methods of Chemical Analysis. Goel Publishing House.

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Semester-III

Specialization: Inorganic Chemistry

1. Name of the Department : Chemistry							
2. Course Name	Advanced Inorganic Spectroscopy		**L**	**T**		**P**	
3. Course Code	17060301		4	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**		
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc.(Non- Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 52		**Tutorials = Nil**		**Practical = Nil**			

8. Course Description:

Spectroscopic analysis is based on the interaction of an atom or a molecule with electromagnetic radiation of specific wavelength. This course will cover basic principles and detailed understanding of different spectroscopic methods, which will include microwave , vibrational, electronic, NMR Spectroscopy, Mass Spectrometry and Mössbauer Spectroscopy.

9. Course Objectives:

The objectives of this course are to:

1. Learn the basic principles of different kinds of spectroscopy.
2. Apply the techniques for pure samples as well as complex mixtures.
3. Determine spectra and identify the unknown compounds, their shape and molecular composition.
4. Calculate the bond lengths of diatomic molecules.
5. Outline the selection rules for rotational and vibrational spectra and rationalize the role of dipole moment in the selection rules.
6. Identify the IR frequencies where simple functional group absorbs light.
7. Determine Spectra of Paramagnetic materials using NMR

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to

1. Identify and characterize the molecule on the basis of spectroscopic study.
2. Apply vibrational spectroscopy to identify modes of bonding of ambidentate ligands.
3. Apply ESR in transitional metals with unpaired electrons.
4. Define Hyperfine coupling and splitting,
5. Discuss the active sites of metalloproteins with Raman spectra.
6. Find application of mass spectrometry in various fields like fingerprint application, molecular weight determination, and evaluation of heat of sublimation of high melting solids.
7. Sketch qualitatively rotational-vibrational spectrum of diatomic molecule.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit:Vibrational Spectroscopy**

Symmetry and shapes of AB_2, AB_3, AB_4, AB_5 and AB_6 modes of bonding of ambidentate ligands, ethylenediamine and diketonate complexes, application of resonance Raman Spectroscopy particularly for the study of active sites of metalloproteins such as myoglobin and haemoglobin.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Electron Spin Resonance Spectroscopy**

Principles of ESR, Presentation of the spectrum, hyperfine coupling, hyperfine splitting in various structures, Factors affecting magnitude of g, zero field splitting and Kramer's degeneracy, Applications to transition metal

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complexes having one and more than one unpaired electron, applications to inorganic free radicals, study of electron exchange reactions.

Unit – 3	Number of lectures = 13	Title of the unit:Mössbauer Spectroscopy and Mass Spectrometry

Mössbauer Spectroscopy: Basic Principles, spectral display, isomer shift, factors affecting the magnitude of isomer shift, quadrupole and magnetic hyperfine interaction, applications of the technique to the study of bonding and structure of Fe^{2+}, Fe^{3+} ; Sn^{2+} and Sn^{4+} compounds; detection of oxidation states, nature of M-L bond,.

Mass Spectrometry: Principles, representation, interaction of molecule with high energy electrons, interpretation of mass spectrum, effect of isotopes on appearance of mass spectrum; applications ; fingerprint applications, molelcular weight determination, evaluation of heat of sublimation of high melting solids.

Unit – 4	Number of lectures = 13	Title of the unit:Nuclear Magnetic Resonance Spectroscopy

Nuclear Magnetic Resonance Spectroscopy: ^{19}F and ^{31}P NMR spectra – Chemical shifts, coupling constants, ^{19}F Spectra of fluoroacetone, 1-bromo-1-Fluoroethane, dimethyl phosphorus trifluoride and bromine pentafluoride ; ^{31}P spectra of HPF_2 $HPO(OH)_2$ H_2 $PO(OH)$, cis- $Pt(Pet_3)_2$ Cl_2, Application of ^{31}P NMR for structural determination of Complexes with phosphorus ligands.

Spectra of Paramagnetic materials: Contact shift, its origin and applications, Pseudo contact shift Diamagnetic complexes, Spectra of free radicals, Lanthanide shift Reagents, Magnetic susceptibility Measurement. Solid state NMR- Wide line NMR, Magnetic Angle spinning and Applications, Magnetic Resonance Imaging.

12. Brief Description of self- learning / E-learning component

1. https://www.slideshare.net/christophsontag/spectroscopic-methods-in-inorganic-chemistry-part1-uv-vis
2. https://www.slideshare.net/christophsontag/nmr-for-inorganic-chemistry

13. Books Recommended

1. Inorganic Spectroscopic Methods by Alan K. Brisdon
2. Spectroscopy in Inorganic Chemistry by C.N.R. Rao
3. NMR, NQR, EPR and Mössbauer spectroscopy in Inorganic Chemistry by R.V. Parish
4. NMR Spectroscopy in Inorganic chemistry by Jonathan A. Iggo
5. Structural Methods in Inorganic Chemistry by E.A.O. Ebsworth
6. Physical Methods in Chemistry by R.S. Drago
7. Introduction to Magnetic Resonance by A. Carrington & A.D. McLachlan.
8. Magnetism and Transition Metal Complexes by F.E. Mabbs & D.J. Machin

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1. Name of the Department: Chemistry						
2. Course Name	Coordination Chemistry	**L**	**T**		**P**	
3. Course Code	17060302	4	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52		**Tutorials = Nil**		**Practical = Nil**		

8. Course Description:

This core paper in Chemistry will enable postgraduate students to understand and rationalize bonding in transition metal complexes. The course will trace all theories of bonding in coordination complexes since its inception and will highlight to students how understanding of bonding in complexes evolved with time.

Derivation of Orgel and Tanabe-Sugano diagrams starting from spectroscopic terms will be explained. Important features of the electronic absorption spectra- calculation of Dq, B and β parameters, Jahn-Teller effect, Spectrochemical and nephelauxetic series, charge transfer spectra *etc* will be discussed. Basic principles of magnetochemistry will be explained and will be applied in structure determination.

In addition, structure and bonding of selected transition metal-Pi complexes (metal carbonyls, phosphines, nitrosyls, dinitrogen, and dioxygen complexes) will also be discussed.

9. Course Objectives:

The objectives of this course are to:

1. Introduce students to important theories postulated to understand bonding in transition metal complexes (Werner's theory, Sidgwick's EAN Rule, Valence Bond Theory, Crystal Field Theory and Molecular Orbital Theory)
2. Demonstrate how spectroscopic states are derived from spectroscopic terms
3. Explain Orgel and Tanabe-Sugano diagrams for transition metal complexes
4. Explain important features of the electronic spectra of complexes- Jahn-Tellar effect, Spectrochemical and nephelauxetic series, charge transfer spectra
5. Explain basic principles of magnetochemistry and apply them in structure determination
6. Explain structure and bonding in metal clusters (boranes, carboranes and metal carbonyl clusters) and transition metal-pi complexes (metal carbonyls, phosphines, nitrosyls, dinitrogen, and dioxygen complexes)

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Explain bonding in transition metal complexes
2. Derive spectroscopic states from spectroscopic terms
3. Interpret Orgel and Tanabe-Sugano diagrams
4. Explain electronic spectra of complexes
5. Apply fundamentals of magnetochemistry in structure determination.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Metal-Ligand Bonding**

Crystal field theory - applications and its limitations, molecular orbital theory, octahedral, tetrahedral or square planar complexes, π-bonding and molecular orbital theory, Ligand field theory and application.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Electronic Spectra of Transition Metal Complexes**

Spectroscopic ground states, correlation and spin-orbit coupling in free ions for I series of transition metals, Orgel and Tanabe-Sugano diagrams for transition metal complexes ($d^1 - d^9$ states) calculation of Dq, B and β parameters, effect of distortion on the d-orbital energy levels. Structural evidence from electronic spectrum, Jahn-Tellar effect, Spectrochemical and nephelauxetic series, charge transfer spectra, electronic spectra of molecular addition compounds.

Unit – 3	**Number of lectures = 13**	**Title of the unit: Magnetic Properties of Transition Metal Complexes**

Elementary theory of magnetochemistry, Gouy's method for determination of magnetic susceptibility, calculation of magnetic moments, magnetic properties of free ions, orbital contribution, effect of ligand-field, application of magnetochemistry in structure determination, magnetic exchange coupling and spin state crossover.

Unit – 4	**Number of lectures = 13**	**Title of the unit: Metal- Pi Complexes**

Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structure elucidation, important reactions of metal carbonyls; preparation, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes; tertiary phosphine as ligand.

12. Brief Description of self -learning / E-learning component

1. http://nptel.ac.in/courses/104105033/
2. https://www.youtube.com/watch?v=g01r2YRH9ok
3. http://nptel.ac.in/courses/104106064/lectures.pdf.

13. Books Recommended

1. Selected Topics in Inorganic Chemistry by Malik, Tuli and Madan
2. Concepts in Inorganic Chemistry, Vol. 3-7, Asim Das and Mahua Das
3. Advanced Inorganic Chemistry by Cotton and Wilkinson
4. Advances in inorganic Chemistry by SK Agarwal and Keemti Lal
5. Inorganic Chemistry- Principles of Structure and Reactivity by James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi

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1. Name of the Department: Chemistry							
2. Course Name	Inorganic Special Practical-I	**L**		**T**		**P**	
3. Course Code	17060303	0		0		6	
4. Type of Course (use tick mark)		**Core (✓)**		**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical							
Lectures = Nil		**Tutorials = Nil**		**Practical = 78**			

8. Course Description:

Practical work has had a central and distinct role in chemistry education (from school to university) for more than a century. Coordination complexes show diversity in structures depending on the metal ion, its coordination number and the dentcity of the ligands used. The module designed here for students is to understand the basic principles and learn the experimental part of complex preparation with transition elements.

9. Course Objectives:

The objectives of this course are to:

1. Make students understand the difference between double salts and coordination compounds.
2. Identify the chemicals and apparatus required for the synthesis of coordination complexes.
3. Discuss and compare the stability of different complexes.
4. Learn the formula and draw the structures of the complexes.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Synthesize different coordination complexes.
2. Observe the various colours associated with the particular complexes.
3. Compare the properties of these complexes by preparing similar complexes changing the metal
4. Analyze the samples and estimate their yield.

11. List of Experiments

Preparation of selected Inorganic Compounds complexes. Handling of air and moisture sensitive compounds:

1. Chromous Acetate
2. Hg $[Co(SCN)_4]$
3. $[Cu(NH_3)_4(H_2O)_2]\ SO_4$
4. $[Mn(NH_3)_6]\ Cl_2$
5. $K_3\ [Fe(C_2O_4)_3]$
6. $VO\ (acac)_2$
7. Microcosmic salt
8. $[Ni(en)_3]S_2O_3$
9. Prussian blue

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10. $[Co(NH_3)_5Cl]Cl_2$, $[Co(NH_3)_5NO_2]Cl_2$,$[Co(NH_3)_5ONO]Cl_2$
11. $K_3[Al(C_2O_4)_3]$
12. Green syntheses of
    i. Bis (acetylacetonato) Copper(II)
    ii. Tris (acetylacetonato) Iron (III)
    iii. Tris (acetylacetonato) Manganese (III)

12. Books Recommended

1. Siddiqui, I.R., Singh, J., Shrivastava, J., Yadav, L.D.S., Singh, R.K.P., Singh, J. (2018): Advanced Practical Chemistry, 8th Edition, Pragati Prakashan.
2. Agarwal, S.K., Lal, K. Advanced Inorganic Analysis, Pragati Prakashan.
3. Mendham, J. (2009): Vogel's Textbook of Quantitative Inorganic Analysis, Pearson Education.
4. Svehla, G., Sivasankar, B. (2012); Vogel's Qualitative Inorganic Analysis, Pearson Education.

1. Name of the Department: Chemistry						
2. Course Name	Inorganic Special Practical - II		**L**	**T**	**P**	
3. Course Code	17060304		0	0	6	
4. Type of Course (use tick mark)	**Core (✓)**		**DSE ()**		**SEC ()**	
5. Pre requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = Nil	**Tutorials = Nil**		**Practical = 78**			

8. Course Description:

The emphasis of the lab work for this semester is on **spectrophotometry**. In the first two units, concentrations of selected cations (Fe, Ni, Mn, Cr, V, and Ti) and selected anions (Fluoride, Nitrate and Phosphate) will be determined. In the third unit, pK value of an indicator will be determined.

Finally, stoichiometry and stability constants of complexes will be determined by Job's method and slope ratio method. In Job's method, UV-absorbance vs mole fraction. In the slope ratio method, absorbance is plotted against molar concentration of ions.

9. Course Objectives:

1. Spectrophotometric determination of selected cations and anions
2. Spectrophotometric determination of pK value of an indicator
3. Study of complexation (stoichiometry and stability constant) by Job's method/Slope ratio method

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Determine concentrations of selected cations and anions spectrophotometrically
2. Determine pK value of an indicator spectrophotometrically
3. Determine stoichiometry and stability constants of complexes by Job's method/Slope ratio method.

11. List of Experiments

Spectrophotometric determination:

1. Estimation of Fe, Ni, Mn, Cr, V, Ti and fluoride, Nitrate and phosphate spectrophotometrically.
2. Determination of pK value of an indicator spectrophotometrically.
3. Study of complexation (Stoichiometry and stability constant) by Job's method/ Slope ratio method.

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A. Fe-thiocynate,
B. Fe-phenanthroline
C. Cu-ethylenediamine

Complexometric Titration:

4. Determination of Calcium, Copper, Barium with Ethylene Diamine Tetraacetic Acid (EDTA) and Back titration
5. Titration of mixtures using masking agents

12. Brief Description of self learning / E-learning component

1. https://www.youtube.com/watch?v=98KYUaLe16U.
2. http://www.powershow.com/view1/f4f25-ZDc1Z/Spectrophotometric_determination_of_a_single_pKa_value_powerpoint_ppt_presentation
3. https://www.youtube.com/watch?v=Wn6PS-oTSyM.

13. Books Recommended

1. Chatwal,G.R and Anand, S.K (2000): Instrumental Methods of Chemical Analysis, Himalaya Publishing House, Delhi
2. Kamalesh Bansal, (2009): Analytical Spectroscopy, Campus Book International.
3. Spectrometry and Spectrofluorimetry: A Practical Approach by Michael G. Gore

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1. Name of the Department: Chemistry						
2. Course Name		Inorganic Special Practical – III		**L**	**T**	**P**
3. Course Code		17060305		0	0	6
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = Nil		**Tutorials = Nil**		**Practical = 78**		

8. Course Description:

The emphasis of the lab work for this semester is on **instrumental analysis**. Students will be trained in **polarography** and **amperometry**. Students will be given hands-on training on **Atomic Absorption Spectrophotometer and Flame Photometer.**

Finally, students will be trained to interpret graphs generated by **Differential Thermal Analysis / Thermogravimetric Analysis (DTA/TGA)** instrument

9. Course Objectives:

1. Polarographic determination of selected metal ions and mixtures
2. Amperometric titration
3. Estimation of metal ions by Atomic Absorption Spectrophotometry and Flame Photometry.
4. Interpretation of DTA/TGA graphs of a given sample

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Determine selected metal ions and mixtures polarographically
2. Conduct amperometric titrations
3. Estimate metal ions by Atomic Absorption Spectrophotometry and Flame Photometry.
4. Interpret graphs of DTA/TGA for a given sample

11. List of Experiments

Interpretation of IR spectrum and determination of structure/bonding in some simple inorganic compounds and coordination compounds, such as:

a. Ammonium salts [NH_4Cl, $(NH_4)_2 SO_4$, $NH_4 SCN$, $NH_4 NO_3$]
b. Sulphate ions in different bonding mode: ionic – K_2SO_4 , $CaSO_4$ etc., unidentate, bidentate, bridged etc.
c. Thiocynate and Isothiocynate complexes.
d. Oxalato complexes

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e. Cyano complexes – $K_4 Fe(CN)_6$, Na_2 [$Fe(CN)_5 NO$]
f. Ammine complexes
g. Spectra of isomers – Nitro – and Nitrito.

12. Brief Description of self learning / E-learning component

1. https://www.youtube.com/watch?v=3olOk_xNq8g
2. https://www.youtube.com/watch?v=3olOk_xNq8g
3. https://www.slideshare.net/nareshbabu7792/thermal-analysis-tga-dta
4. https://www.chemie-biologie.uni-siegen.de/ac/be/lehre/.../summary_of_tg_and_dta.pd
5. https://www.perkinelmer.com/CMSResources/.../44-74556GDE_TGABeginnersGuide

13. Books Recommended

1. Chhatwal, G.R and Anand, S.K (2000): Instrumental Methods of Chemical Analysis, Himalaya Publishing House, Delhi

Semester-III

Specialization: Physical Chemistry

1. Name of the Department: Chemistry						
2. Course Name	Chemical Dynamics & Surface Chemistry		**L**	**T**	**P**	
3. Course Code	17060306		4	0	0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52		**Tutorials = Nil**		**Practical = Nil**		

8. Course Description:

Thermodynamics of electrified interfaces, Helmholtz-Perrin model, Gouy- Chapman model and Stern model of electrified interfaces, fundamental problems in the study of pure liquid electrolytes, Butler-Volmer equation, Polarizable and non-polarizable interfaces, Gibb's adsorption equation and its applications, thermodynamics of micellization, Theories of unimolecular reactions, London-Eyring-Polanyi method for the calculation of energy of activation.

9. Course Objectives:

1. Students will be able to learn various areas of chemistry like thermodynamics of electrified interfaces & rate of reactions.
2. To study the physical and chemical (experimental) methods for determining the concentrations of the species participating in chemical reactions.
3. To introduce advanced topics related to surface chemistry.

10. Course Outcomes (COs):

The students will acquire knowledge of :

1. Thermodynamics of electrified interfaces
2. Models of simple ionic liquids & lattice oriented models
3. Gibb's adsorption equation and its applications
4. Method for the calculation of energy of activation

11. Unit wise detailed content

Unit-1	**Number of lectures = 11**	**Title of the unit: Electrified Interfaces**

Thermodynamics of electrified interfaces: electrocapillary thermodynamics, fundamental thermodynamic equation of polarizable interfaces, determination of excess charge density on the electrode, electrical capacitance and surface excess of the interface, potential of zero charge, Helmholtz-Perrin model, Gouy - Chapman model and Stern model of electrified interfaces.

Unit – 2	**Number of lectures = 11**	**Title of the unit: Chemical Dynamics**

Study of fast reactions, Flow methods, Relaxation method, Flash photolysis and shock tube method. Theories of unimolecular reactions: Lindemann's theory, Hinshelwood's treatment, R.R.K. and R.R.K.M. theories, The theory of absolute reaction rates, potential energy surfaces, activation energies, London-

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Eyring-Polanyi method for the calculation of energy of activation.		
Unit – 3	**Number of lectures = 13**	**Title of the unit:Adsorption**
Surface active agents and their classification, concept of micelles, critical micelle concentration (cmc), determination of cmc by conductivity and surface tension methods; factors affecting cmc, counter - ion binding to micelles, thermodynamics of micellization.Surface tension, capillary action, pressure difference across curved surface (Laplace equation), Gibb's adsorption equation and its applications, BET equation and its application for the determination of surface area;		
Unit – 4	**Number of lectures = 17**	**Title of the unit:Ionic Liquids & Electrodics**
Ionic Liquids: The thermal dismantling of an ionic lattice,the fundamental problems in the study of pure liquid electrolytes, models of simple ionic liquids: lattice oriented models (the vacancy model, the hole model), quantification of the hole model, the Furth approach to the work of hole formation, distribution function for the sizes of the holes and the average size of a hole. **Electrodics:** Rate of charge- transfer reactions under zero fields, under the influence of an electric field, the equilibrium exchange current density, the non-equilibrium drift-current density (Butler-Volmer) equation. Some general and special cases of Butler-Volmer equation, the high-field and low-field approximations, physical meaning of the symmetry factor , a simple picture of the symmetry factor and its dependence on overpotential. Polarizable and non-polarizable interfaces		
12. Brief Description of self-learning / E-learning component		
1. http://epgp.inflibnet.ac.in/ 2. http://nptel.ac.in/courses/122101001/27 3. http://www.engr.uconn.edu/~jmfent/CHEG320_electrode%20kinetics%20lectures.pdf 4. *https://chem.libretexts.org. 29: Chemical Kinetics II: Reaction Mechanism*		
13. Books Recommended		
1. Bockris, J.O.M. and A.K.N. Reddy. Modern Electrochemistry Vol.1& 2. 2. Laidler, K.J. Chemical Kinetics. 3. Frost, A. and G.Pearson. Kinetics and Mechanism of Reaction Rates. 4. Laidler, K.J., H.Eyring and S. Glasstone. Theories of Reaction Rates. 5. Glasstone, S. Electrochemistry.		

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1. Name of the Department: Chemistry						
2. Course Name		Statistical Thermodynamics & Advanced Quantum Mechanics	**L**	**T**	**P**	
3. Course Code		17060307	4	0	0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**	**SEC ()**		
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non-Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52		**Tutorials = Nil**		**Practical = Nil**		

8. Course Description:

Maxwell - Boltzmann statistics, Partition function and its factorization, Derivation of equation of state for a mono atomic ideal gas, Derivation of expressions for transitional, vibrational, rotational, electronic energy; expressions for entropy, Gibbs free energy, work function due to transitional, vibrational and rotational motion of a molecule, Chemical equilibrium and equilibrium constant in terms of partition functions, Free energy function, Applicability of perturbation theory to an electron in a one dimensional box under the influence of electric field, LCAO-MO approximation. Chemical bonding.

9. Course Objectives:

1. To introduce the student to today's understanding of statistical physics and statistical mechanics.
2. Students will be able to learn various areas of chemistry like Statistical Thermodynamics & Quantum Mechanics.
3. To introduce advanced topics related to Quantum Statistical Mechanics.

10. Course Outcomes (COs):

The students will acquire knowledge of :

1. computing entropy by counting the number of allowed states for simple systems such as the ideal gas.
2. identifying the relationship and correct usage of infinitesimal work, work, energy, heat capacity, specific heat, latent heat, and enthalpy.
3. using some empirical equations of state to compute the final state of thermodynamically systems such as the ideal gas.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Statistical Thermodynamics I**

Statistical Thermodynamics: Concept of distribution, thermodynamic probability and most probable distribution, Types of st atistics: Maxwell Boltzmann, Bose-Einstein & Fermi-Dirac statistics and its statistical thermodynamic formulation, Idea of microstates and macrostates . Canonical, grand canonical and microcanonical ensembles. Statistical thermodynamic formulation of Maxwell - Boltzmann distribution law, Maxwell - Boltzmann law of distribution of energy and evaluation of average velocity, root mean square velocity; law of equipartition of energy; Partition function and its factorization, relationship of atomic and

molar partition function to thermodynamic properties(I) internal energy (ii) entropy (iii) Gibb's free energy (iv) heat content (v) work function (vi) pressure (vii) heat capacity at constant volume. Derivation of equation of state for a monoatomic ideal gas.		
Unit – 2	**Number of lectures = 14**	**Title of the unit: Statistical Thermodynamics II**
Evaluation of Translational partition function, calculation of absolute entropy of an ideal monoatomic gas, Vibrational, Rotational, & electronic partition function of diatomic molecules, Derivation of expressions for transitional ,vibrational, rotational, electronic energy; expressions for entropy, Gibbs free energy, work function due to transitional, vibrational and rotational motion of a molecule. Chemical equilibrium and equilibrium constant in terms of partition functions, Free energy function.		
Unit – 3	**Number of lectures = 13**	**Title of the unit:Quantum Mechanics- I**
Approximate methods : First order time-independent perturbation theory for non-degenerate states, variation principle. Application of first order perturbation and variation principle to evaluate ground state of helium atom. Applicability of perturbation theory to an electron in a one dimensional box under the influence of electric field.		
Unit – 4	**Number of lectures = 13**	**Title of the unit: Quantum Mechanics- II**
Born-Oppenheimer approximation,Valence bond method to hydrogen molecule ion and hydrogen molecule their symmetric and anti-symmetric solution without actual evaluation of various integrals, energy of molecular hydrogen system, LCAO-MO approximation of hydrogen molecule , Configuration Interaction. Extension of MO theory to other systems- Homonuclear and heteronuclear diatomic molecules.		

12. Brief Description of self-learning / E-learning component

1. http://epgp.inflibnet.ac.in/
2. https://youtu.be/bE7Z6Zkst1I
3. https://youtu.be/CBrsWPCp_rs
4. https://youtu.be/7ItAyG_m7jA
5. http://chemistry.umeche.maine.edu/Modeling/lcao.html.

13. Books Recommended

1. Glasstone, S. Theoretical Chemistry.
2. Levine.Quantum Chemistry.
3. Pauling, Eyring and Wilson. Quantum Chemistry
4. Nash, L.K. Introduction to Statistical Mechanics.
5. Donald. A. McQuarrie - Statistical Mechanics-2011.
6. Frank L. Pilar, Elementary Quantum Chemistry – 2001

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1. Name of the Department: Chemistry							
2. Course Name	Physical Special Practical -1		**L**	**T**		**P**	
3. Course Code	17060308		0	0		6	
4. Type of Course (use tick mark)		**Core (✓)**		**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**		Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical							
Lectures = Nil		**Tutorials = Nil**		**Practical = 78**			

8. Course Description:

This Course will enable the students to learn various potentiometric titrating techniques and concept of characterizing an acid without indicators. Students will also learn various concepts of electrochemistry, polarimeter and dipole metry. It will also give a platform to develop various skills of laboratory experimentation to quality control methods of analysis.

9. Course Objectives:

1. To motivate the students to understand the principles of Potentiometry, Polarimetery and Dipole metry.
2. To impart knowledge with respect to surface tension and adsorption of different systems.
3. Identify dextro and laevo rotatory substances and measure their specific rotation using polarimeter.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Determine dielectric constant of non-aqueous liquid at different concentration and hence determination of *Dipole* Moment.
2. Describe various potentiometric titrations.
3. Describe application and functioning of pH meter & Dipole meter.

11. List of Experiments

I. Potentiometric titrations

a. Mohr's salt or $FeSO_4$ vs $KMnO_4$ titration
b. Mohr's salt or $FeSO_4$ vs $K_2Cr_2O_7$ titration.
c. KCl or KI vs $AgNO_3$ titration
d. (KCl + KI) vs $AgNO_3$ mixture titration
e. (KCl + KBr +KI) vs $AgNO_3$ mixture titration
f. Ce^{4+} vs Fe^{2+} titration.

II. Polarimetry

a. To determine specific rotation for various optically active substances.
b. To determine concentration of glucose or fructose or sucrose or tartaric acid in solution.To determine the percentage composition of optical substances in the binary mixture (components comprise of Glucose or Fructose or sucrose or Tartaric acid)

III .Dipole metry

a. To determine the dielectric constant of various organic liquids.

12. Brief Description of self-learning / E-learning component

1. https://youtu.be/g5z6EaT46iA
2. https://youtu.be/JwCeCS2YRVo
3. https://youtu.be/mFE1EBsPEas
4. www.iiserpune.ac.in/~bhasbapat/phy221_files/SITechPolar.pdf
5. https://www.jhuapl.edu/techdigest/views/pdfs/V07_N1_1967/V7_N1_1967_Tossman.pdf

13. Books Recommended

1. Khosla,B.D., V.C. Garg and A. Gulati.Senior Practical Physical Chemistry.
2. Thawale,A. and P. Mathur. Experimental Physical Chemistry.

3. Vishwanatha,B. and P. S Raghav. Practical Physical Chemistry.
4. Sindhu, P.S. Practical in Physical Chemistry.

1. Name of the Department: Chemistry							
2. Course Name	Physical Special practical-II		**L**	**T**		**P**	
3. Course Code	17060309		0	0		6	
4. Type of Course (use tick mark)		**Core (✓)**		**DSE ()**		**SEC ()**	
5. Pre-requisite .	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical							
Lectures = Nil		**Tutorials = Nil**		**Practical = 78**			

8. Course Description:

This lab course teaches the use of very important instruments like conductometer, polarimeter and flame photometer. Students can apply the principle behind acid base titrations and can find the strength of unknown solutions by measuring the mobility of ions using conductometer. Polarimeter will help the students to find out specific rotation of various optically active substances. Flame photometry is a process where in emission of radiation by neutral atom is measured.

9. Course Objectives:

The objectives of this course are to:.

1. Understand the theory behind conductivity of ions .
2. Use conductometric titrations for detecting sharp equivalence point.
3. Perform experiments on alkali and alkali earth metals by thermally dissociating in flame.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to

1. Perform titrations of strong acid-strong base, weak acid- strong base and strong acid-weak base, conductometrically.
2. Perform titration of combination of acids with alkali and find their respective strength conductometrically.
3. Determine the concentration of ions of alkali and alkali earth metals using flame photometry.

11. List of Experiments

I. Conductometric titrations

a. Citric acid vs NaOH
b. Succinic Acid vs NaOH
c. CH_3COOH vs NH_4OH
d. HCl vs CH_3COONa
e. (HCl + CH_3COOH) vs NaOH mixture
f. (HCl + CH_3COOH + $CuSO_4$) vs NaOH mixture.
g. To study the conductometry titration of hydrochloric acid with sodium carbonate. Also determine the concentration of sodium carbonate in a commercial sample of soda ash.
h. KCl or KI vs $AgNO_3$
i. To determine solubility and solubility product of sparingly soluble salts (AgCl, $PbSO_4$, $BaSO_4$)
j. Verify of Debye Hükel Onsager equation for strong electrolytes.

II. pH metric titrations

a. Succinic Acid titration vs NaOH
b. Citric Acid titration vs NaOH
c. To predict composition of Copper amine complex from $CuSO_4$ vs.NH_4OH titration.
d. To determine dissociation constant of weak acid

III. Flame Photometry

1. To determine the concentration of Na+ or Li+ or Ca++ ions in solution.

12. Brief Description of self-learning / E-learning component

1. https://nptel.ac.in/courses/122101001/37 2. https://nptel.ac.in/courses/122101001/Slide/lect38/38_6.htm 3. https://nptel.ac.in/courses/122101001/Slide/lect38/38_4.htm 4. https://youtu.be/JhBs_8DrPYo 5. https://youtu.be/2tJqZStFwjU
13. Books Recommended
1. Khosla,B.D., V.C. Garg and A. Gulati.Senior Practical Physical Chemistry. 2. Thawale,A. and P. Mathur. Experimental Physical Chemistry. 3. Vishwanatha,B. and P. S Raghav. Practical Physical Chemistry. 4. Sindhu, P.S. Practical in Physical Chemistry.

1. Name of the Department: Chemistry							
2. Course Name	Physical Special Practical-III		**L**		**T**		**P**
3. Course Code	17060310		0		0		6
4. Type of Course (use tick mark)		**Core (✓)**		**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practicals							
Lectures = Nil		**Tutorials = Nil**		**Practical = 78**			

8. Course Description:

This course provides practical training on the use of special instruments like Ultrasonic Interferometer and spectrocolorimeter. This lab course also enables the students to have practical knowledge about the kinetics of different reactions and the factors it depends upon.

9. Course Objectives:

The objectives of this course are to:

1. Have clear concepts about kinetics of a reaction.
2. Understand terms like rate law, order of reaction, molecularity and chemistry behind iodine clock reaction.
3. Enable students to apply the basic principles of UV-visible spectrophotometer and determine concentration of unknown solution from their λ_{max} values.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to

1. Measure the sound for various liquids.
2. Verify Lambert-Beer's law by different coloured solutions and find the unknown concentration of any coloured solution.
3. Determine the activation energy for hydrolysis of an ester.
4. Study reaction kinetics of the iodine clock reaction.

11. List of Experiments

I. Ultrasonic Interferometry

a. To measure speed of sound for various liquids.
b. To determine the isentropic compressibility of liquids.

II. Colorimetry

a. To test the validity of Lambert- Beer's Law for $KMnO_4$ and $K_2Cr_2O_7$
b. To determine the concentration of copper sulphate, potassium permanganate and potassium dichromate in the given solution.
c. To study complex formation between ferric and thiocyanate ions.

III. Chemical Kinetics

a. To determination the activation energy for the hydrolysis of ethyl or methyl acetate.
b. To determine the temperature coefficient for the hydrolysis of ethyl or methyl acetate.
c. To study the kinetics of reaction between potassium iodide and potassium persulphate solution using the clock reaction.
d. To study the kinetics of acid catalyzed inversion of cane sugar.

12. Brief Description of self-learning / E-learning component

1. https://youtu.be/UG-pzCUsEq0
2. https://nptel.ac.in/courses/103108100/module2/module2.pdf
3. https://www.slideshare.net/TapeshwarYadav1/colorimeter-52697150
4. chemistry.bd.psu.edu/jircitano/kinetics.html

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13. Books Recommended

1. Khosla,B.D., V.C. Garg and A. Gulati.Senior Practical Physical Chemistry.
2. Thawale,A. and P. Mathur. Experimental Physical Chemistry.
3. Vishwanatha,B. and P. S Raghav. Practical Physical Chemistry.
4. Sindhu, P.S. Practical in Physical Chemistry.

Semester-III

Specialization: Organic Chemistry

1. Name of the Department : Chemistry							
2. Course Name	Organic Spectroscopy		**L**	**T**		**P**	
3. Course Code	17060311		4	0		0	
4. Type of Course (use tick mark)		**Core (✓)**		**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**		Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals							
Lectures = 52		**Tutorials = Nil**		**Practical = Nil**			

8. Course Description:

The structures in chemistry are symbols representing real existence of the compounds that form the substance of study in organic chemistry. The student had in the course of the study of organic chemistry written many structures without asking how the structures had come to be. The course introduces the key spectroscopic methods used by chemists and biochemists to analyze the molecular structure of organic compounds and provides opportunity to learn and appraise the use of spectroscopic instruments in the determination of the structures of organic compounds.

9. Course Objectives:

The objectives of this course are to:

1. Discuss similarities and differences between spectroscopy and spectrometry.
2. Identify the basic components of spectroscopic instrumentation.
3. Introduce the theory of the various instruments and the signals produced when analyzing compounds.
4. Demonstrate a working knowledge of ultraviolet-visible (UV-Vis) spectroscopy, infrared (IR) spectroscopy, nuclear magnetic resonance (NMR) spectroscopy and mass spectrometry (MS).

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Determine functional groups and write structures.
2. Study the spectra of compounds and propose structures for compounds.
3. Elucidate the structures of organic molecules from spectral data.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Ultraviolet and Visible Spectroscopy**

Introduction – Electronic energy levels, electronic transitions and selection rules. The origin, general appearance and designation of UV bands, absorption laws and measurement of absorption intensity, chromophores, auxochromes, bathochromic shift, hypsocromic shift, hypochromic effect, hyperchromic effect. The ultraviolet spectrometer,Woodward and Fieser's rules for calculating ultraviolet absorption maxima for conjugated dienes, unsaturated carbonyl compounds and aromatic carbonyl compounds. Application of UV spectroscopy to problems in organic chemistry.

Unit – 2	**Number of lectures = 12**	**Title of the unit: Infrared Spectroscopy**

Introduction – Basic theory and instrumentation including FT IR infrared spectrum. Units of frequency wavelength and wave number, Molecular vibrations. Functional group and fingerprint regions.Fundamental vibrations, overtones, Fermi resonance. Frequency of vibrations of a diatomic molecule, factors influencing vibrational frequencies, sampling techniques, characteristic frequencies of organic molecules and interpretation of spectra.

Unit – 3	**Number of lectures = 15**	**Title of the unit: Nuclear Magnetic Resonance Spectroscopy (^{1}H and ^{13}C NMR)**

Introduction – The Nuclear spin, Larmor frequency, population of nuclear spin level, spin - spin relaxation and spin - lattice relaxation. Principles of NMR, Measurement techniques (CW & FT NMR).equivalent and non

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equivalent protons, enantiotopic and diastereotopic protons, Chemical shift, reference compounds, factors affecting the chemical shift, spin - spin coupling, multiplicity of splitting and relative intensity of lines in a multiplet, integration, vicinal, germinal and long range couplings, Coupling constants and factors affecting coupling constants. Techniques for simplification of complex spectra: solvent effects, Lanthanide shift reagents, spin decoupling (double resonance), Nuclear Overhauser effect (NOE). Effect of sensitivity of ^{13}C NMR compared to ^{1}H NMR, comparison of ^{13}C NMR and ^{1}H NMR, chemical shifts of ^{13}C NMR. Simplification of ^{13}C NMR spectra by process of Broadband decoupling, Selective decoupling and off resonance decoupling.

Unit – 4	**Number of lectures = 15**	**Title of the unit: Mass Spectrometry & (ORD and CD)**

Mass Spectrometry : Introduction – Elementary theory , instrumentation, Measurement techniques (EI, CI, FD, FAB), Mass spectrum, base peak, molecular ions, isotope ions, rearrangement ions, fragment ions, even electron rule, nitrogen rule, matastable ions. Salient features of fragmentation pattern of organic compounds including β-cleavage, McLafferty rearrangement, retro Diels – Alder fragmentation and ortho effect.

Optical Rotatory Dispersion (ORD) and Circular Dichroism (CD): Definition, haloketo rule, octant rule for ketones. Cotton effect and Cotton curves, deduction of absolute configuration.

12. Brief Description of self learning / E-learning component

1. https://swayam.gov.in/courses/252-organic-spectroscopy.
2. http://nptel.ac.in/courses/102103044/4
3. http://ocw.uci.edu/courses/chem_203_organic_spectroscopy.html

13. Books Recommended

1. R.M. Silverstein & G.C. Bassler, Spectrometric Identification of Organic Compounds.
2. W. Kemp. Organic Spectroscopy.
3. D.H. Williams and I. Fleming. Spectroscopic Methods in Organic Chemistry.
4. Jag Mohan. Organic Spectroscopy.
5. Dyer, J.R. Application of Spectroscopy of Organic Compounds.
6. Pavia. Organic Spectroscopy.
7. Williams, D.H. and I. Fleming Spectroscopic Methods in Organic Chemistry.

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1. Name of the Department : Chemistry						
2. Course Name	Heterocyclic Chemistry and Organic Synthesis		**L**	**T**	**P**	
3. Course Code	17060312		4	0	0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52		**Tutorials = Nil**	**Practical = Nil**			

8. Course Description:

Classification of heterocycles. Synthesis and reactions of aziridines,oxetanes and thietanes, imidazole, thiazole and oxazole, pyrimidines and purines. Structural elucidation of uric acid and caffeine. General methods of formation and general study of nitrogen, phosphorous and sulphur ylides. Disconnecion approach.

9. Course Objectives:

1. To introduce synthesis and reaction mechanisms of heterocyclic compounds and ylides.
2. To describe the structure elucidation of Nucleosides and Nucleotides
3. To discuss the physiological action and the chemical constitution of drugs.

10. Course Outcomes (COs):

The students will acquire knowledge of

1. Nomenclature, synthesis and reactivity of different heterocyclic compounds.
2. Nucleosides and Nucleotides
3. General methods of formation and reaction mechanisms of Ylides
4. Relationship between physiological action and the chemical constitution of different type of drugs

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Three, Four and Five-membered Heterocycles**

Three membered and four membered heterocycles - synthesis and reactions of aziridines,oxetanes and thietanes
Five-membered Heterocycles: Synthesis and reactions of 1, 3-Azoles: imidazole, thiazole and oxazole.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Six membered Heterocycles**

Six membered Heterocyclics with one heteroatom: Synthesis and reactions of coumarines,chromones and pyridine.
Six membered Heterocyclics with two heteroatoms: Synthesis and reactions of pyrimidines and purines.

Unit – 3	**Number of lectures = 11**	**Title of the unit: Ylides**

General methods of formation, General study of reactions with their mechanisms of Nitrogen (ammonium, immonium, diazonium and nitrile), phosphorous and sulphur ylides.

Unit – 4	**Number of lectures = 15**	**Title of the unit: Disconnectin Approach**

Introduction to disconnection approach, Synthons and synthetic equivalents, Guidelines for choosing disconnections, Functional group interconversions.
One group C-C Disconnections: Synthesis of alcohols and carbonyl compounds by 1,1 C-C disconnections, synthesis of alcohols and carbonyl compounds by 1,2 C-C disconnections.
Regioselectivity in Michael reactions, Alkene synthesis by Wittig reaction, use of acetylenes (alkynes) and aliphatic nitro compounds in organic synthesis.
Two group C-C Disconnections: Diels Alder reaction: stereospecificity and stereoselectivity, endo selectivity, regioselectivity. 1,3-dicarbonyl compounds, Michael addition and Robinson annelation.

12. Brief Description of self learning / E-learning component

1. http://nptel.ac.in/syllabus/104105034/
2. http://bhavanscollegedakor.org/images/pdf/sci/disconnetcion.pdf.

3. https://onlinecourses.nptel.ac.in/noc18_cy03/preview.
13. Books Recommended
1. Singh, J., Yadav, L.D.S. and Singh J. Organic synthesis (2018) 2. Gupta, R.R., M. Kumar and V. Gupta. Heterocyclic Chemistry. 3. Ahluwalia, V.K. Heterocyclic Chemistry 4. Finar, I.L. Organic Chemistry, Volume 2 5. Sturant Warren, John Wiley and sons,Organic synthesis : The Disconnection Approach. 6. Warren.S, Willey. Designing Organic Synthesis.

1. Name of the Department: Chemistry							
2. Course Name	Organic Special Practical-I		**L**		**T**		**P**
3. Course Code	17060313		0		0		6
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**		
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practicals							
Lectures = Nil		**Tutorials = Nil**	**Practical = 78**				

8. Course Description:

This Course will introduce the students to determine the structures of organic compounds through spectroscopic methods and chemical methods and will enable them to develop and practice independent learning skills. This course will also give a platform to develop different methods to determine the structure of organic compounds..

9. Course Objectives:

The objectives of this course are to:

1. Perform the standard techniques used in practical organic chemistry.
2. Plan and carry out identification using a prescribed procedure.
3. Identify and report relevant structures of compounds.
4. Handle organic chemicals safely and describe their potential dangers.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Describe various techniques used for the structural determination of organic compounds.
2. Describe disposal techniques and laboratory emergency procedures.
3. Understand the handling of instruments.
4. Apply identification techniques for the structural determinationof organic compounds

11. List of Experiments

Structural determination of organic compound using spectroscopic methods (IR, UV, NMR & Mass) followed by chemical methods (Monofunctional and Bifunctional compounds).

Note: Students need to analyze at least eight compounds.

12. Books Recommended

1. R.M. Silverstein & G.C. Bassler, Spectrometric Identification of Organic Compounds.
2. W. Kemp. Organic Spectroscopy.
3. D.H. Williams and I. Fleming. Spectroscopic Methods in Organic Chemistry.
4. Jag Mohan. Organic Spectroscopy.
5. Dyer, J.R. Application of Spectroscopy of Organic Compounds.
6. Williams, D.H. and I. Fleming Spectroscopic Methods in Organic Chemistry.
7. Nicolas Bogliotti, Roba Moumné ,Multi step organic synthesis,A guide through experiments, 2017.
8. Brian S,Furniss ,Vogels text book of practical organic chemistry, 5th addition,.
9. Tatchell, A. R. Vogel's Textbook of Practical Organic Chemistry. John Wiley.

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1. Name of the Department: Chemistry							
2. Course Name	Organic Special Practical –II		**L**		**T**		**P**
3. Course Code	17060314		0		0		6
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**		
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical							
Lectures = 0		**Tutorials = 0**	**Practical = 78**				

8. Course Description:

This Course will introduce the students to synthesize the organic compounds through multi step processes and will enable them to develop and practice independent learning skills. This course will also give a platform to develop different methods to synthesize organic compounds..

9. Course Objectives:

The objectives of this course are to:

1. Perform the standard techniques used in practical organic chemistry.
2. Plan and carry out a multi-step synthesis using a prescribed procedure.
3. Measure and report relevant physical properties of prepared compounds.
4. Handle organic chemicals safely and describe their potential dangers.
5. Use the reference material found in the laboratory.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Describe various techniques used for synthesis of organic compounds.
2. Describe disposal techniques and laboratory emergency procedures.
3. Know the handling of instruments.
4. Apply purification techniques for the purification of organic compounds

11. List of Experiments

Multistep synthesis

1. Benzanilide from benzene
2. Benzilic acid from benzoin.
3. Benzopinacolone from benzophenone.
4. Acridone from anthranilic acid
5. m-Nitroaniline from benzene.
6. p-nitrobenzanilide from benzophenone.

Or

any other suitable multistep synthesis

12. Books Recommended

1. Chapman and Hall, 5th edition, Textbook of Practical Organic Chemistry, 1996.
2. Nicolas Bogliotti, Roba Moumné ,Multi step organic synthesis, A guide through experiments,.Dec 2017.
3. Brian S,Furniss ,Vogels text book of practical organic chemistry, 5th addition,.
4. Tatchell, A. R. Vogel's Textbook of Practical Organic Chemistry. John Wiley.

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1. Name of the Department : Chemistry						
2. Course Name	Organic Special Practical-III		**L**	**T**	**P**	
3. Course Code	17060315		0	0	6	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = Nil		**Tutorials = Nil**	**Practical = 78**			

8. Course Description:

This course provides students with practical experience of the techniques of analysis of quantitative data. Using examples of research in chemical science and other fields. It is addressed to students who have little or no experience of using quantitative data and it aims to enable students to develop an understanding of basic and intermediate quantitative methods and the ability to use these methods.

9. Course Objectives:

1. To develop quantitative technique skills in students.
2. To isolate the organic compounds from the natural resources.

10. Course Outcomes (COs):

Students will gain an understanding of:

1. the application of analytical methods based on titrations, isolation, separations, etc
2. the design and application of an analysis related to a question of relevance based on experience in the laboratory and research of the scientific literature
3. Solving most important problems of quantitative analysis.

11. List of Experiments

Quantitative Analysis

a. Determination of percentage or number of hydroxyl groups in an organic compound by the acetylation method.
b. Estimation of Amines using bromate-bromide solution or acetylation method.
c. Estimation of phenols using bromate-bromide solution or acetylation method.
d. Estimation of Iodine by Vij's Solution
e. Estimation of glucose and sucrose by chemical methods.
f. Estimation of amino acids by chemical methods

Spectrophotometric (UV/VIS) Estimations:

a. Amino acids
b. Carbohydrates
c. Ascorbic acid
d. Aspirin
e. Cholesterol

12. Books Recommended

1. Pasto, D., C. Johnson and M. Miller. Experiments and Techniques in Organic Chemistry. Prentice-Hall.
2. Williamson, K. L. and D.D. Heath. Macroscale and Microscale Organic Experiments.
3. Middleton, H. and Adward Arnold. Systematic Qualitative Organic Analysis.
4. Clark, H .and Adward Arnold. Handbook of Organic Analysis: Qualitative and Quantitative.
5. Tatchell, A. R. Vogel \'s Textbook of Practical Organic chemistry. John Wiley.

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1. Name of the Department : Chemistry						
2. Course Name	Research Methodology and Technical Writing	**L**	**T**	**P**		
3. Course Code	17060316	4	0	0		
4. Type of Course (use tick mark)		**Core ()**	**DSE ()**		**SEC (✓)**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52	**Tutorials = Nil**	**Practical = Nil**				

8. Course Description:

This course offers an overview of research methodology including basic concepts employed in quantitative and qualitative research methods. The need for research and literature review, steps in conducting research, research methods associated with conducting scholarly research, lab safety measures, ethical, legal social & scientific issues in research are included.

9. Course Objectives:

The objectives of this course are to:

1. understand some basic concepts of research and its methodologies
2. identify appropriate research topics
3. select and define appropriate research problem and parameters
4. organize and conduct research in a more appropriate manner
5. write a research report and thesis

10. Course Outcomes (COs):

On completion of the course, each student will be able to:

1. have basic knowledge on qualitative research techniques.
2. have adequate knowledge on measurement & scaling techniques as well as the quantitative data analysis.
3. demonstrate knowledge of research processes (reading, evaluating, and developing).
4. perform literature reviews using print and online databases.
5. identify, explain, compare, and prepare the key elements of a research proposal/report.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit: Introduction of Research Methodology**

Introduction and basic concepts in Research Methodology: Meaning of research, objectives and significance of research, Criteria for good research & problems encountered by research scholars.

Research Problem: Necessity and techniques of defining research problem, Formulation of research problem, Objectives of research problem

Literature search- source of information

Unit – 2	**Number of lectures = 11**	**Title of the unit: Research Design**

Research Design: Meaning, need and features of good research design, Basic Principles of Experimental Designs, Design of experiments and performing experiment.

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Data Collection and Validation: Primary & secondary data collection, case study method etc. Data preparations, processing, analysis & interpretation		
Unit – 3	**Number of lectures = 13**	**Title of the unit: Ethical, legal social, & scientific issues**
Ethical, legal social & scientific issues in research, informed concept, Role of ethical committee. Lab Safety Measures: Introduction, Code of conduct - while entering in the lab, while working with the chemicals, while disposal of chemicals, Storage and disposal of chemical wastes - aqueous wastes, organic wastes and radioactive wastes, Human contribution to reduce hazardous wastes.		
Unit – 4	**Number of lectures = 13**	**Title of the unit: Report Writing**
Writing of report: Basic concepts of paper, their writing, review of literature, Concepts of Bibliography and References, significance of report writing, steps of report writing Presentation of report/ paper: Oral, Poster presentation, research paper, review aritcles, peer reviewed journals		
12. Brief Description of self learning / E-learning component		
1. http://www2.ift.ulaval.ca/~chaib/IFT-6001/articles/RMethodology_Marzuki_1.pdf 2. https://shodhganga.inflibnet.ac.in/bitstream/10603/71970/14/14_chapter%204.pdf 3. http://www.tamuc.edu/academics/cvSyllabi/syllabi/201440/40503.pdf		
13. Books Recommended		
1. Blum, Deborah and Mary Knudson, eds. A field guide for science writers: the official guide of the National Association of Science Writers, New York: Oxford University Press, 1997. 2. Davis, Martha. Scientific Papers and Presentations. San Diego: Academic Press, 1997. 3. Fuscaldo, AA, Erlick, BI, Hindman, B. Laboratory Safety: Theory and Practice. New York: Academic Press, 1980. 4. Bajpai, PK. Biological Instrumentation and Methodology. New Delhi: S. Chand & Co. Ltd. 2006. 5. CR Kothari, Research Methodology: Methods & techniques, Gaurav Garg. New Age Publishers.		

1. Name of the Department: Chemistry						
2. Course Name	Nanoscience & Technology		**L**	**T**		**P**
3. Course Code	17060317		4	0		0
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 52		**Tutorials = Nil**	**Practical = Nil**			

8. Course Description:

This discipline specific elective course will enable postgraduate students to develop an understanding of nanoscience and its applications. Various aspects of nanochemistry such as classifications of nanostructured materials and preparation methods will be explained along with introduction, definition, structure and types of organic nanoparticles. Applied nanochemistry involving application of organic nanopartcles will also be discussed in detail.Various concepts such as Nanoceramics, Nanoploymers & Nanocomposites with their applications will be explained. Finally, sustainability in nanotechnology will be discussed covering topics like fate of nanomaterials in environment and environmental life cycle of nano materials etc.

9. Course Objectives:

1. To acquaint foundational knowledge of the Nanoscience and related fields.
2. To make the students acquire an understanding of Nanochemistry and its applications.
3. To help them understand outline of Nanoscience and technology.
4. To make students learn about Nanoceramics, Nanoploymers & Nanocomposites.
5. To develop an understanding of Nanoscience with environment.

10. Course Outcomes (COs):

Students will be able to:

1. Learn about the background on Nanoscience
2. Understand the synthesis of nanomaterials and their application and the impact of nanomaterials on environment.
3. Apply their learned knowledge to develop Nanomaterials.
4. Gain understanding of Nanoceramics, Nanoploymers & Nanocomposites.

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit: Nanochemistry**

Introduction: Nanoscale Science and Technology-Implications for Chemistry, Classifications of nanostructured materials, nanoparticles; quantum dots, nanowires, ultra-thinfilms-multilayered materials. Preparation methods: Bottom-up Synthesis-Top-down Approach: Precipitation, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, Sputtering, Evaporation, Organic Nanoparticles : Introduction, definition, structure, types of NP, analytical methods (Extraction and isolation, Separation, Characterization and Imaging), general method of preparation, properties, detection, and characterization of organic nanoparticles: hydrophobic drugs, protein, peptide, lipid, cyclodextrine, polysaccharides. Nanocochleates, Prospects and

Future Challenges.		
Unit – 2	**Number of lectures = 12**	**Title of the unit: Applied Nanochemistry**
Applications of Organic Nanoparticles: Application of Lipids, CNTs, Proteins, peptides, Dendrimer, cyclodextrin, Polysaccharide based organic nanoparticles in nanomedicine and drug delivery through nanoscopic structure and nanoformulation; Nanoparticles as catalysts; Applications of one dimensional nanotubes and nanowires: Nanotube/nanowire-based field effect transistors for biosensing, gas sensing, Piezoelectric nanowires as nanogenerator, Thermoelectric Nanowires, Quantum dots for bio-sensing; Application of Nanoporous materials: A Single Nanopore for DNA sequencing, Nanoporous anodized aluminum oxide, Nanoporous metal-organic framework for gas absorption, Nanoporous materials for Li/Cd-ion battery applications.		
Unit – 3	**Number of lectures = 15**	**Title of the unit: Nanoceramics, Nanoploymers & Nanocomposites**
Applications of Nano ceramics: Dielectrics, ferroelectrics, magnetoceramics, and multiferroics Magnetism; Dia-, Para-, Ferro-, Antiferro-, Ferri-magnetism. Application of Nanopolymers: Preparation and characterization of diblock Copolymer based nanocomposites, Nanoparticles polymer ensembles; Applications of Nanopolymers in Catalysis, Nanofibers, nanophotonics; Application of Nanocomposites: Metal-Metal nanocomposites, Polymer-Metal nanocomposites, Ceramic nanocomposites: Dielectric and CMR based nanocomposites.		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Sustainable Nanotechnology**
Application of industrial ecology to nanotechnology, Fate of nanomaterials in environment, environmental life cycle of nanomaterials, environmental and health impacts of nanomaterials, toxicological threats, eco-toxicology, exposure to nanoparticles – biological damage, threat posed by nanomaterials to humans, environmental reconnaissance and surveillance. Corporate social responsibility for nanotechnology, Nano materials in future - implications.		
12. Brief Description of self learning / E-learning component		
1. https://nptel.ac.in/courses/103103033/module9/lecture1.pdf 2. https://nptel.ac.in/courses/118102003/ 3. http://ice.chem.wisc.edu/Small%20Science/From_Small_Science_Comes_Big_Decisions/Choices_files/Environment.pdf		
13. Books Recommended		
1. Nanochemistry: A Chemical Approach to Nanomaterials by G. A. Ozin, A.C. Arsenault, and L. Cademartiri, The Royal Society of Chemistry, Cambridge, 2nd Ed., 2009. 2. Polymer nanocomposites, edited by Yiu-Wing Mai and Zhong-Zhen Yu, First published 2006, Woodhead Publishing Limited and CRC Press LLC, USA. 3. Nanoscale Science and Technology, edited by R. W. Kelsall, I. W. Hamley, and M. Geoghegan, Wiley, West Sussex, 2005. 4. Nanocomposite science and technology by P.M. Ajayan, L.S. Schadler, P.V. Braun, Wiley, New York. 5. Environmental Chemistry for a Sustainable World, Volume 1: Nanotechnology and Health Risk Editors: Lichtfouse, Schwarzbauer, Robert.		

1. Name of the Department : Department of Chemistry							
2. Course Name	Drug Design and Development		**L**		**T**		**P**
3. Course Code	17060318		4		0		0
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**		**SEC ()**		
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non-Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practicals							
Lectures = 52		**Tutorials = Nil**	**Practical = Nil**				

8. Course Description:

This discipline specific elective course will enable postgraduate students to develop an understanding of design of drug. Concepts involved in understanding drug targets through study of various drug receptors will be explained. Various concepts such as isosterism, bioiososterism and prodrugs with their applications in drug design will be explained. Role of stereoselectivity in drug design will also be discussed. Role of QSAR studies and molecular properties will also be part of study. Finally, Computer aided drug design and Pharmacophore modeling will be explained.

9. Course Objectives:

1. This course will explore the process of drug development from target identification
2. It will present drug development as a process involving target selection, lead discovery using computer-based methods and combinatorial chemistry/high-throughput screening.
3. Students will learn about molecular recognition, computer aided drug design, and toxicology as applied to the development of new medicines.
4. To acquaint students with deep knowledge about drug receptors

10. Course Outcomes (COs):

Students will be able to:

1. Develop an understanding of drug targets as a recognition site for pharmaceutical agents; how the chemical structure of a substance influences interaction with a drug target
2. Identify new drug targets for future drug discovery.
3. Understand the key concepts of drug design.
4. Apply knowledge to QSAR and molecular properties in designing of new drugs.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Drug Receptors**

Specific and non-specific drug action, Drug receptors, Basic concept and classification of receptors, Forces involved in drug receptors- interactions, Receptor agonism and antagonism, Concept of Spare receptors, Simple kinetics of drug- receptor interaction, Ion Channel receptors, Topographical study of the following receptors includes only preferred conformations, pharmacophores and modes of bindings/interactions : Adrenergic, Cholinergic, Opioid receptors, H-1 & H-2 receptors.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Drug Design**

Concept of isosterism and bioiososterism and their applications in drug design, Antimetabolite approach to drug design, Analog drug design, Prodrugs, Carrier-linked prodrugs, Bioprecursors, Role of functional groups in prodrug design, General pathways of drug metabolism and simple kinetics of drug metabolism, Pharmacokinetic oriented drug design, Stereochemical aspects of drug action : Setereoselectivity of optical isomers, Role of planarity in drug action, Stereoselectivity of conformational isomers

Unit – 3	**Number of lectures = 13**	**Title of the unit: QSAR and Molecular properties in drug design**

Types of QSAR models, Classification of parameters utilized in QSAR studies, Applications of QSAR in

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drug design
Molecular modeling: Molecular and Quantum Mechanics in drug design, Molecular dynamics
Molecular properties and drug design: Prediction and analysis of ADMET properties of new molecules and its importance in drug design.
De novo drug design: Receptor/enzyme-interaction and its analysis,
Basics of combinatorial chemistry, Rational approach to drug design, Basic strategies of drug discovery.

Unit – 4	**Number of lectures = 13**	**Title of the unit: Computer aided drug design and Pharmacophore modeling**

Introduction to computer aided drug design (CADD)
Physicochemical parameters and methods to calculate them: Hammett equation and electronic parameters (sigma), lipophilicity effects and parameters (log P, π-substituent constant), steric effects (Taft steric and molar refractivity). Biological parameters.
Pharmacophore modeling: Concept of pharmacophore, identification of pharmacophoric features and pharmacophore modeling.

11.Brief Description of self-learning / E-learning component

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4975341/
2. https://nptel.ac.in/noc/individual_course.php?id=noc18-bt28
3. https://nptel.ac.in/courses/102106065/58

12. Books Recommended

1. Manfred E. Wolff, Burger's medicinal Chemistry and Drug Discovery, Vol. I to V, 5thed., A Wiley-Interscience publication John Wiley & Sons, Inc. (New York), 1995.
2. William O. Foye, Principles of Medicinal Chemistry, 3rd ed., Varghese Publishing House, Mumbai, 1989.
3. Kadam & Mahadik, Bothara, Principles of Medicinal Chemistry vol. I & II, 4th ed. Nirali Prakash Pune, 1997.
4. Leach A., Molecular Modeling: Principles and Applications, Pearson, New York.
5. Langer T., Hoffmann R.D., Pharmacophores and Pharmacophore Searches, Volume-32, Wiley-VCH, Weinheim.
6. Perun T.J. and Propst C.L., Computer-aided Drug Design Methods and Applications, Saurabh Prakashan Pvt.Ltd., New Delhi.
5. Veerapandian P., Structure Based Drug Design, CRC Press, London.

1. Name of the Department: Chemistry						
2. Course Name	Metals in Medicine		**L**	**T**	**P**	
3. Course Code	17060319		4	0	0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 52	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

This course gives diverse knowledge about the role of metals in medicines .Students come to know about metal deficiency diseases ,toxicity of metals in biological systems and their therapies and remedies.The course also highlights the role of ligands and the pros and cons of ligand chelation in biological systems.

9. Course Objectives:

The objectives of this course are to:

1. Enable the students to know about the role of metals in biological systems.
2. Study various diseases due to metal deficiencies and their therapies.
3. Discuss metal toxicity and their detoxification methods.
4. Understand the vital role of vitamins in our body.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to

1. Identify the metal deficiency diseases and treat them with proper therapy.
2. Become familiar with carcinogens, tumor growth and role of various metals in anticancer activity.
3. Discuss role of ligands and their beneficial effects as chelating agents in anti-cancer drugs, antiviral activity etc.
4. Apply knowledge of nuclear medicine as they study about radioiodine -131, technetium – 99m, gallium and indium.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Metals in Medicine**

Biochemical bases of essential metal deficient diseases; Iron, copper and zinc deficiencies and their therapies, carcinogens and carcinostatic agents, zinc in tumour growth and inhibition, anticancer activity and mechanism of platinum complexes, anticancer activity of Rhodium, copper and Gold complexes, anti cancer activity of Selenium, antibacterial and antiviral properties of metal complexes, polyamino carboxylic acids and polyethylene amines as chelating drugs.

Unit – 2	**Number of lectures 13**	**Title of the unit: Heavy metals in Biological systems**

Drugs in hypo and hyper activity of thyroid, Inorganic drugs in dental carries, clinical disorders of alkali and alkaline earth metals and their remedies, lithium drugs in psychiatry.
Toxicity of heavy metals – and their detoxification, role of Selenium in Biological systems with reference to its essentiality and toxicity, mechanism of metal ion induced toxicity, interaction between orally administered drugs and metal ions in gut.

Unit – 3	**Number of lectures = 13**	**Title of the unit: Ligand Therapy**:

Ligand induced toxicity, interfererence with haemoglobin in oxygen transport system, intefererence with metallo-enzymes, beneficial effects of ligand chelation; carcinogenic ligands, carcinostatic ligands, alkylating agents as anticancer drugs, Thiosemicarbazones as anticancer drugs, macrocyclic antibiotic ligands and prodable mechanism of the drug, antiviral activity of chelating agents, aspirin chelation, drugs where chelation and therapeutic activity are unrelated.

Unit – 4	**Number of lectures = 13**	**Title of the unit: Vitamins and their functions**

Vitamins, recommended dietary allowances , deficiencies and supplementations, dietary miners, calcium and vitamin D, antioxidants and their health effects, biomineralisation. Radiopharmacology, nuclear medicines, radioiodine -131, technetium – 99m, gallium and indium scan.
12. Brief Description of self learning / E-learning component
1. https://www.slideshare.net/mohdsakharkar/metal-ion. 2. https://authors.library.caltech.edu/25052/10/BioinCh_chapter9.pdf
13. Books Recommended
1. Metals in Medicine by James C. Dabrowiak 2. Metallotherapeutic Drugs & Metal-Based Diagnostic Agents by Marcel Gielen

Semester-IV
Specialization: Inorganic Chemistry

1. Name of the Department: Department of Chemistry							
2. Course Name	Organometallic Chemistry		**L**	**T**		**P**	
3. Course Code	17060401		4	0		0	
4. Type of Course (use tick mark)		**Core (✓)**		**DSE ()**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**		Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals							
Lectures = 52		**Tutorials = Nil**		**Practical = Nil**			
8. Course Description:							
This course provides detailed knowledge about organometallic compounds, their classification, synthesis properties and applications in different fields.							
9. Course Objectives:							
The objectives of this course are to: 1. Enable the students to get an idea about organometallic compounds and their chemistry. 2. Help them classify these compounds on the basis of bonding. 3. Have an idea about their synthesis and reaction mechanisms 4. Know their diverse applications in industries.							
10. Course Outcomes (COs):							
Upon successful completion of this course, the student will be able to 1. Define and identify an organometallic compound 2. Write their structure, synthesis and reaction mechanism. 3. Apply their properties for different applications like polymerization, catalytic hydrogenation etc 4. Comment on their kinetics and stability.							
11. Unit wise detailed content							
Unit-1	**Number of lectures = 13**	**Title of the unit: Introduction of organometallic compounds**					
Introduction and Classification of organometallic compounds by bond types viz. covalent, ionic, electron deficient and cluster compounds. **Alkyls and Aryls of Transition Metals:** Types, routes of synthesis, stability and decomposition pathways, organocopper in organic synthesis.							
Unit – 2	**Number of lectures = 13**	**Title of the unit:Transition Metal π–Complexes**					
Transition metal π–complexes with unsaturated molecules- alkenes, alkynes, allyl, & dienyl(metallocene) complexes, preparation, properties and nature of bonding and structural features, important reactions related to nucleophilic and electrophilic attack on ligands and to organic synthesis							
Unit – 3	**Number of lectures = 12**	**Title of the unit:Compounds of Transition Metal-Carbon Multiple Bonds**					
Transition metal- carbene complexes: Fischer type and Schrock type carbene complexes, their synthesis, reactions and structures & bonding; Transition metal-carbyne complexes: their synthesis, reactions and structural features.							
Unit – 4	**Number of lectures = 14**	**Title of the unit:Fluxional Organometallic Compounds and role of organometallics as catalysts**					
Fluxionality & dynamic equilibria in compounds such as acyclic alkenes,σ-bonded and π–bonded cyclic alkenes, rotation of ligands on metals, ligand scrambling on metals. **Applications of Transition metal Organometallics as Catalysts:** Zeigler-Natta polymerization;							

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homogeneous catalytic hydrogenation; alkene hydrogenation-Wilkinson Catalyst; Oxidation of olefins-Wacker's process; hydroformylation of olefins – the oxo process.
12. Brief Description of self learning / E-learning component
1. https://onlinecourses.nptel.ac.in/noc18_cy09/preview. 2. https://ocw.mit.edu/courses/chemistry/5-44-organometallic-chemistry-fall-2004/
13. Books Recommended
1. Organometallic Compounds by M.L.H. Green 2. Principles of Organometallic Chemistry by G.E. Coates, M.L.H. Green and P. Power. 3. Organometallic Chemistry by R.C. Mehrotra 4. Basic Organometallic Chemistry: Concepts, Syntheses and Applications by Anil J. Elias and B.D. Gupta

1. Name of the Department : Chemistry							
2. Course Name	Inorganic Materials and Advanced Analytical Techniques				**L**	**T**	**P**
3. Course Code	17060402				4	0	0
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**		
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()	

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 52	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

Many aspects of modern life are dependent upon the availability of functional solids .Hence Chemists are in a strong position to contribute to their syntheses. This course provides an overview of the synthesis of inorganic materials their properties, characterization and applications. The course also introduces the fundamental principles needed to understand the behavior of materials at the nanometer length scale and the different classes of nanomaterials with applications ranging from information technology to biotechnology. The last two sections deal with advanced analytical techniques and their applications in various fields.

9. Course Objectives:

The objectives of this course are to:

1. Provide an introduction to the concepts underlying solid state chemistry.
2. Understand an overview of the synthesis and applications of inorganic materials
3. To recognize the structure and compound identification in the solid state.
4. Develop and characterize nanomaterials, including X-ray techniques, scanning probe microscopy and electron microscopy; and to identify the electronic, magnetic, optical and mechanical properties of nanomaterials.
5. Apply a variety of spectroscopic and advanced analytical techniques to identify and characterize the inorganic materials.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to

1. Display an appreciation of the techniques available for the study of structures and mechanisms in solid state inorganic chemistry.
2. Demonstrate knowledge of crystal structures and their defects, nonstoichiometry and physical properties.
3. Compare the advantages and/or disadvantages of electrogravimetry and coulometry.
4. Describe how a coulometric titration is performed and discuss the advantages of a coulometric titration over a conventional redox titration,
5. Describe the process of performing an amperometric titration.
6. Determine the size of nanoparticles using TEM and SEM
7. Use the techniques of solvent extraction, ion exchangers including liquid ion exchangers and chromatographic methods for identification and estimation of multicomponent systems (such as TLC, GC, HPLC, etc)

11. Unit wise detailed content

Unit-1	**Number of lectures = 15**	**Title of the unit: Inorganic Materials**

Introduction to solid state, metallic bond, band theory(Zone model, Brillouin Zones, Limitations of the zone Model); Defects in solids, p-type, n- type, inorganic semiconductors(used in transistors, IC, Etc) electrical, optical , magnetic and thermal properties of inorganic materials, superconductors with special emphasis on the synthesis and structure of high temperature superconductors.

Solid state Lasers (Ruby, YAG and Tunable Lasers): Inorganic Phosphor materials, Synthesis and advantages of optical fibres over conducting fibres, diffusion in solids, catalysis and zone refining of metals.

Unit – 2	**Number of lectures 13**	**Title of the unit: Nano Materials**

Preparation of nanomaterials and their characteristic differences over bulk materials. Principles of Electron

microscopy, Dynamic Light Scattering, Atomic Force Microscopy and characterization of nanomaterials.		
Unit – 3	**Number of lectures = 15**	**Title of the unit: Analytical techniques**
Electroanalytical methods-polarography (DC, AC and pulse), cyclic voltammetry, coulometry and anode stripping voltammetry. Optical methods: UV/Visible, X-ray photoelectron spectroscopy(XPS), Auger Electron Spectroscopy (AES), ESCA, Atomic absorption and emission spectroscopy. Imaging Techniques: Electron Microscopy (SEM, TEM) Infrared spectroscopy, Dispersive and Fourier Transform Raman, Resonance Raman and Surface Enhanced Raman spectroscopy- Dispersive and Fourier Transformed. Hifanated Techniques: GC –IR, TG-IR Spectroscopy, GC Mass Spectroscopy and any other.		
Unit – 4	**Number of lectures = 15**	**Title of the unit: Advanced Analytical Techniques**
Diffraction Methods: single crystal and powder X-Ray Diffraction and their applications to inorganic Compounds, Neutron Diffraction and Electron Diffraction. Separation Methods: Theory and applications of separation methods in analytical chemistry:solvent extraction, ion exchangers including liquid ion exchangers and chromatographic methods for identification and estimation of multicomponent systems (such as TLC, GC, HPLC, etc)		

12. Brief Description of self learning / E-learning component

1. http://www.tricliniclabs.com/directory/solid-state-development-services/physical-and-analytical-chemistry/inorganic-materials-analysis-phase-identification-quantification.html.
2. http://www.extra.research.philips.com/hera/people/aarts/_Philips%20Bound%20Archive/PJR/PJR-47-1992_93-147.pdf.
3. https://www.youtube.com/watch?v=X6caYRvVOyg&list=PLKyB9RYzaFRj5Mvxv3cqLAOK9Ee5sqJ5k

13. Books Recommended

1. Keer,H.V Principles of the solid state ,Wiley Eastern Ltd: New Delhi(1993).
2. West, A.R. Solid state chemistry and its Applications, John Wiley&Sons (1987).
3. Hannay, N.Treatise on Solid State Chemistry Plenum (1976).
4. Timp. G; Ed.Nanotechnology Springer-Verlag:N.Y(1999).
5. Cheetham, AK.&Day, P; Eds. Solid state Chemistry Techniques Clarindon Press, Ixford (1987).
6. Christian,G.D; Analytical Chemistry : 6th Ed, John Wiley&Sons, Inc (2004).
7. Skoog D A; West, D.M; Holler, R.J.& Nieman, T.A Principles of Instrumental Analysis, Saunders Golden Sunburst Series(1997).
8. Willard, H.H; Merritt L.L; Dean, J.A.& Settle, F.A.(Eds).
9. Instrumental Methods Of Analysis.7th Ed; Wadsworth Publishing (1988) ISBN 0534081428
10. Khopkar, S.M. Concepts in Analytical Chemistry Halsted(1984).

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1. Name of the Department: Chemistry							
2. Course Name	Inorganic Special Practical-IV		**L**	**T**		**P**	
3. Course Code	17060403		0	0		6	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**		
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practicals.							
Lectures = Nil		**Tutorials = Nil**	**Practical = 78**				

8. Course Description:

This Course will introduce the students to the basic principles of drawing chemical compound structures, plotting graphs and will enable to develop and practice independent learning skills. This course will also give a platform to learn software based chemistry.

9. Course Objectives:

The objectives of this course are to:

1. Understand basic principle of softwares used by chemists.
2. Learn the drawing of chemical structures of compounds.
3. Have knowledge about the softwares which are used by chemists.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Demonstrate knowledge of structure of chemical compounds.
2. Recognize different types of softwares used by chemists.
3. Apply basic concepts to draw the structure of chemical compounds.

11. List of software's

1. ChemDraw
2. Origin
3. Hyperchem
4. Chem Sketch
5. MS Office

Or

Any other related softwares.

12. Brief Description of self learning / E-learning component

1. https://www.youtube.com/watch?v=00xtRYpTHaI
2. https://www.youtube.com/watch?v=00xtRYpTHaI
3. https://www.youtube.com/watch?v=EfH4_eYwGds

Semester-IV
Specialization: Physical Chemistry

1. **Name of the Department : Department of Chemistry**							
2. **Course Name**	Solid State Chemistry and Polymers		**L**	**T**	**P**		
3. **Course Code**	17060404		4	0	0		
2. **Type of Course (use tick mark)**		**Core (✓)**	**DSE ()**		**SEC ()**		
3. **Pre-requisite (if any)**	B.Sc. (Hons) Chemistry or B.Sc. (Non-Medical)	4. **Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()	
5. Total Number of Lectures, Tutorials, Practicals							
Lectures = 52		**Tutorials = Nil**	**Practical = Nil**				

6. Course Description:

This course highlights the use of electrochemistry in different applications like fuel cells, lead batteries, dry cells etc and in amperometric titrations .Another unit deals with solid state chemistry. The students will obtain required knowledge for understanding materials science problems .They will study the structure of solids and get introduced with the importance of chemical and physical bonds, crystal disorders and defects for material properties. The third unit includes detailed study of polymers. Here the students will learn about polymers, their types , their preparations ,mechanisms involved in polymerization and molecular mass determination. The course also outlines a brief idea about biopolymer solutions and their thermodynamics.

7. Course Objectives:

The objectives of this course are to

1. Provide an introduction to the concepts underlying solid state chemistry.
2. Illustrate the wide range of materials and physical properties currently available.
3. Enable students identify different types of polymers in our surroundings.
4. Introduce students to the practical application of polymers
5. Explain polymerization methods and understand polymerization kinetics.
6. Understand thermodynamics of biopolymers.

8. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Apply the principles of electrochemistry in various electrochemical energy converters.
2. Perform Amperometry titrations determination of activation energy for an irreversible electrode process.
3. Classify types of solids and calculate lattice energy.
4. Identify the structure and packing in solids and different defects in crystals.
5. Identify polymerization reactions and their kinetics.
6. Calculate the molecular weight of polymers by osmometry, viscometer, light scattering and sedimentation method.
7. Evaluate the size, shape, molecular weight and extent of hydration of biopolymers by various experimental techniques.

9. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Solid state – I**

Interaction of radiation with condensed matter and how this can be used in generalized crystallography. Bragg condition, Miller indices, Laue method, Bragg method, Debye-Scherrer method of X-ray structural analysis of crystals , Different type of symmetry elements in crystal system, types of crystal lattice , X-ray diffraction techniques ,X- ray diffraction pattern of different solid structures , Derivation of Bragg's equation, Different types of solids (i.e. Metallic solid, ionic solid, covalent solid and molecular solid), Close packing and calculation of packing fraction , Electrical and magnetic properties of solids, optical properties

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of solids.		
Unit – 2	**Number of lectures = 13**	**Title of the unit: Solid State – II**
Solid State Chemistry: Thermal decomposition reactions, Nucleation, Free energy of nucleation: Laws, Classification, Functions and growth of nuclei. Kinetic expressions for diffusion controlled, phase boundary controlled and nucleation and growth controlled reactions. Perfect and imperfect crystals, Intrinsic and extrinsic defects, Point defects, Line and plane defects, Vacancies: Schottky and Frenkel defects, Thermodynamics of Schottky and Frenkel defect formation, Color centers, non-stoichiometry defects. Classification of solids, Lattice energy, Evaluation of Madelung constant (NaCl), Calculation of repulsive potential exponent: Lattice heat capacity. Einstein and Debye model of lattice heat capacity, Debye T^3 law.		
Unit – 3	**Number of lectures = 13**	**Title of the unit: Polymers.**
Polymers: Classification of polymers and polymerization, condensation and addition polymers, kinetics of condensation (step-wise) polymerisation, size distribution in linear condensation polymers, molecular size control, degree of polymerization; mechanism of vinyl radical polymerisation, molecular weight and its determination, effect of temperature and pressure on chain polymerisation, stereochemistry of polymer chain & stereo regular polymerisation, Ionic polymerisation (similarities and contrast), kinetics of cationic, anionic polymerisation, kinetics of copolymerisation, criteria for polymer solubility; Mass number and Mass average molecular weight, determination of molecular weight of polymers by osmometry,light scattering and sedimentation method.		
Unit – 4	**Number of lectures = 13**	**Title of the unit: Biopolymers and their thermodynamics.**
Thermodynamics of biopolymer solutions: Thermodynamics of biopolymer solutions: Entropy of mixing & liquid state model along with limitation, Free volume theory, Heat and free energy of mixing. Osmotic pressure membrane equilibrium, Muscular contraction and energy generation in mechanochemical system. **Biopolymers and their molecular weights:** Evaluation of size, shape, molecular weight and extent of hydration of biopolymers by various experimental techniques. Sedimentation equilibrium, Hydrodynamic methods, Diffusion, Sedimentation velocity, Viscosity, Electrophoresis and rotational motions		

10. Brief Description of self-learning / E-learning component

1. http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-50532002000100004.
2. https://www.chem.uci.edu/~lawm/Basic%20West%20Ch%201.pdf
3. https://leseprobe.buch.de/images-adb/36/0c/360cdf9a-dc74-4828-b88e-3d807e0b79b8.pdf
4. http://iopscience.iop.org/article/10.1088/0953-8984/18/14/E01/meta

11. Books Recommended

1. Billmeyer, F.W. and Jr. Wiley. Textbook of Polymer Science.
2. Alcock, H.R. and F.W. Lambe. Contemporary Polymer Chemistry.
3. Cowie, J.M.C. Physics and Chemistry of Polymer.
4. Flory, P.J. Polymer Chemistry.
5. Bockris, J.O.M. and A.K.N. Reddy. Modern Electrochemistry. Vol.1 & 2.
6. Glasstone, S. Electrochemistry.
7. Reiger, P.H. Electrochemistry.
8. Heyrovsky. Polarography.
9. Kannala, Zutshi. Introduction to Polarography and Allied Techniques.

1. Name of the Department: Chemistry							
2. Course Name	Molecular Spectroscopy		**L**	**T**	**P**		
3. Course Code	17060405		**4**	**0**	**0**		
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**		
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc.(Non-Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practicals							
Lectures = 52	**Tutorials = Nil**	**Practical = Nil**					

8. Course Description:

Nuclear Magnetic Resonance Spectroscopy, simplification of complex spectra, Theory & application of Electron spin resonance spectroscopy, Theory & application of Mössbauer Spectroscopy and basic concepts of symmetry elements and symmetry operations, point groups of molecules and fundamental principles of Group Theory. Another unit deals with the electronic spectra of polyatomic molecules, Raman spectra and its applications.

9. Course Objectives:

1. To enable students to learn the principles & applications behind different spectroscopic techniques such as NMR, Mössbauer, ESR spectroscopy.
2. To illustrate the use of different spectroscopic methods in the structure elucidation of some simple compounds.
3. Illustrate symmetry concepts and demonstrate the scope of symmetry and Group Theory.
4. Classify the atomic and molecular orbitals according to symmetry.
5. Determine the point group of a molecule in a systematic method.
6. Apply Group Theory in electronic spectroscopy and Raman spectroscopy.

10. Course Outcomes (COs):

The students will acquire knowledge of :

1. Various techniques studying metal complexes or organic radicals and determining structure of molecules
2. Identify symmetry elements and recognize symmetry operations generated by each symmetry element for a given molecule.
3. Combine symmetry operations and set up multiplication tables for simple point groups.
4. Perform vector transformation and generate reducible representations of common molecules.
5. Classify the irreducible representations into translational, rotational and vibrational modes.
6. Find the number of infrared and Raman active vibrations in a molecule.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Spin Resonance Spectroscopy**

Spin and an applied field; the nature of spinning particles, interaction between spin and magnetic field,

Larmor precession, population of energy levels. Nuclear Magnetic Resonance Spectroscopy; Hydrogen Nuclei, the chemical shift, the coupling constant, coupling between several nuclei, analysis by NMR technique, exchange phenomena, simplification of complex spectra.

Unit – 2	**Number of lectures = 12**	**Title of the unit: Electron Spin Resonance spectroscopy & Mössbauer Spectroscopy**

Electron spin resonance spectroscopy; the theory of E.S.R. the position of E.S.R. absorption, the g factor, the fine and hyperfine structures of E.S.R. absorption. Applications of E.S.R. spectroscopy.
Mössbauer Spectroscopy: The theory of Mössbauer spectroscopy, the chemical shift quadrupole effects, the effect of magnetic field, application of Mössbauer spectroscopy.

Unit-3	**Number of lectures = 14**	**Title of the unit: Symmetry and Group Theory**

Symmetry and Group Theory in Chemistry: Symmetry elements and symmetry operation group and its properties, Multiplication table, point symmetry groups. Representations of groups by matrices (representations for the C_n, C_{nv}, C_{nh}, D_{nh} etc. groups to be worked out explicitly) Irreducible representation of groups, the Great Orthogonality Theorem (without proof) and its importance, character tables and their use in spectroscopy.

Unit – 4	**Number of lectures =14**	**Title of the unit: Electronic Spectroscopy**

Electronic Spectroscopy of Polyatomic Molecules :Free electron model, spectra of carbonyl group spectrum of ethene, n-π and π - π transitions, spectrum of benzene , spectra of transition metals, charge-transfer transition, fluorescence phosphorescence.
Raman Spectroscopy : Quantum theory of Raman effect, Classical theory of Raman effect, Pure rotational Raman spectra, Raman activity of vibrations, vibrational Raman spectra, polarization of light and Raman effect, applications.

12. Brief Description of self-learning / E-learning component

1. staff.mbi-berlin.de/schultz/biomed/script4.pdf
2. https://www.slideshare.net/solairajananant/nmr-spectroscopy-13887430
3. https://youtu.be/Q2Fo5BAReGo
4. www.npl.co.uk/upload/pdf/the_electrochemistry_of_corrosion.pdf
5. http://epgp.inflibnet.ac.in.

13. **Books Recommended**

1. Barrow, G.M. Introduction of Molecular Spectroscopy.
2. Banwell, C.N. Fundamentals of Molecular Spectroscopy.
3. Vincent, A. Molecular Symmetry and Group theory.
4. Bauim, A. Nass. Applied Group Theory.
5. Swarnlakshmi, S., T. Saroja and R.M. Ezhilarasi. Group Theory in Chemistry.
6. Kakkan,R.Atomic and Molecular Spectroscopy, Cambridge University Press, 2015.
7. F.A.Cotton, Chemical Applications of Group Theory.- 3rd Edition Chang, Basic Principles of Spectroscopy.

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1. Name of the Department: Chemistry							
2. Course Name	Physical Special Practical-IV		**L**	**T**	**P**		
3. Course Code	17060406		0	0	6		
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**		
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practicals.							
Lectures = Nil		**Tutorials = Nil**		**Practical = 78**			
8. Course Description:							
This Course will introduce the students to the basic principles of drawing chemical compound structures, plotting graphs and will enable to develop and practice independent learning skills. This course will also give a platform to learn software based chemistry.							
9. Course Objectives:							
The objectives of this course are to: **1.** Understand basic principle of softwares used by chemists. **2.** Learn the drawing of chemical structures of compounds. **3.** Have knowledge about the softwares which are used by chemists.							
10. Course Outcomes (COs):							
Upon successful completion of this course, the student will be able to: 1. Demonstrate knowledge of isolation of organic compounds. 2. Recognize different types of software's used by chemists.. 3. Apply basic concepts to draw the structure of chemical compounds.							
11. List of software's							
1. Chemdraw 2. Origin 3. Hyperchem 4. Chem Sketch 5. MS Office Or Any other related softwares.							
12. Brief Description of self learning / E-learning component							
4. https://www.youtube.com/watch?v=00xtRYpTHaI 5. https://www.youtube.com/watch?v=00xtRYpTHaI 6. https://www.youtube.com/watch?v=EfH4_eYwGds							

Semester-IV

Specialization: Organic Chemistry

1. Name of the Department: Chemistry							
2. Course Name	Photochemistry and Pericyclic Reactions		**L**	**T**		**P**	
3. Course Code	17060407		4	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**		
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem()	EverySem ()	
7. Total Number of Lectures, Tutorials, Practicals							
Lectures = 52		**Tutorials = Nil**	**Practical = Nil**				

8. Course Description:

To cover the types of EMR, electronic excitation, what is quantum yield and photochemistry of intramolecular reaction of carbonyl compounds. To cover the intermolecular photochemical reaction of carbonyl compounds, along with aromatic and alkenes. Free radical reactions. To cover the complete, PMO, FMO and HMO approach and its utilisation to understand electrocyclic, cycloaddition and sigmatropic rearrangements.

9. Course Objectives:

1. Students should understand the effect of EMR on matter and how chemical reaction procced by the action of EMR
2. Student should understand the photochemical raection of alkene, and photorearrangment
3. To understand pericyclic reactions, its types and MOs change during different types of photochemical reactions.

10. Course Outcomes (COs):

On completion of this course, the students will

2. Be able to understand and deal phenomenon of photochemistry.
3. Be able to understand the photochemical reactions of Alkenes, Carbonyl and Aromatic compounds.
4. Be able to understand and be able to apply the Woodward–Hoffmann rules governing pericyclic reactions.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Photochemistry**

Photochemical reactions: Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry.

Photochemistry of Alkenes: Intramolecular reactions of the olefinic bond- geometrical isomerism, cyclisation, rearrangement of 1,4 and 1,5 – dienes.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Photochemistry of Carbonyl and Aromatic compounds**

Photochemistry of Carbonyl Compounds: Intramolecular reactions of carbony! compounds–saturated, cyclic and acyclic,β,γ-unsaturated andα,β-unsaturated compounds, Cyclohexadienones.Intermolecular cycloaddition reactions–dimerisations and oxetane formation.

Photochemistry of Aromatic Compounds: Isomerisations, additions and substitutions.

Miscellaneous Photochemical Reactions: Photo-Fries reactions of anilides. Photo-Fries rearrangement. Barton reaction. Singlet molecular oxygen reactions. Photochemical formation of smog. Photodegradation of

polymers.		
Unit – 3	**Number of lectures = 13**	**Title of the unit: Pericyclic Reactions**
Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions, Woodward – Hoffmann correlation diagrams, FMO and PMO approach Electrocyclic reactions – conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems. Cycloadditions – antarafacial and suprafacial additions, 4n and 4n+2 systems with a greater emphasis on (2+2) and (4+2) cycloaddition-stereochemical effects and effects of substituents on the rates of cycloadditions, 1,3-dipolar cycloadditions and cheleotropic reactions.		
Unit – 4	**Number of lectures = 13**	**Title of the unit: Sigmatropic Rearrangements**
Sigmatropic Rearrangements-suprafacial and antrafacial shifts [1,2]- sigmatropic shifts involving carbon moieties retention and inversion of configuration, (3,3) and (5,5) sigmatropic rearrangements, detailed treatment of Claisen and Cope rearrangements, fluxional tautomerism, aza-cope rearrangements, introductions to Ene reactions, simple problems on pericyclic reactions. Elecrocyclic rearrangement of cyclobutenes and 1,3 cyclohexadienes.		
12. Brief Description of self learning / E-learning component		
1. http://nptel.ac.in/courses/104105038/ **2.** http://assets.vmou.ac.in/MSCCH06.pdf.		
13. Books Recommended		
1. Organic Photochemistry – Chapman and Depuy. 2. Organic Photochemistry – W.H. Horsepool. 3. Photochemistry of Excited States – J.D.Goyle. 4. Organic Photochemistry. Coxon,J. and B. Halton. 5. Organic Photochemistry. Kan, Robert O. 6. Pericyclic Reactions, Mukherji, S.M. 7. N.J.Turro, V.Ramamurthy, J.C.Scaiano,Principles of Molecular Photo Chemistry An Introduction.		

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1. Name of the Department : Chemistry							
2. Course Name	Reagents and Rearrangements		**L**	**T**	**P**		
3. Course Code	17060408		4	0	0		
4. Type of Course (use tick mark)		**Core (✓)**	**DSE ()**		**SEC ()**		
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical							
Lectures = 52		**Tutorials = Nil**	**Practical = Nil**				

8. Course Description:

This course is designed for students to acquire knowledge in organic transformations using different reagents. It provides sound knowledge of different molecular rearrangements in the synthesis of organic compounds. .

9. Course Objectives:

The objectives of this course are to:

1. Study the preparation,properties and applications of organometallic reagents
2. Study the preparation,properties and applications of oxidizing agents
3. Study the preparation,properties and applications of reducing agents
4. Discuss different molecular rearrangements.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Apply different reagents in the organic transformations.
2. Understand the need to study molecular rearrangements.
3. Construct efficient, simple mechanistic pathways for the synthesis of a given compound

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Organo Metallic Reagents**

Preparation, properties and applications of following reagents in organic synthesis with mechanistic details. Organo magnesium reagents, Organo copper reagents, Organo zinc reagents, Organo lithium reagents, Organo boron reagents, , Organo tin reagents and Organo silicon reagents.

Unit – 2	**Number of lectures = 13**	**Title of the unit: Oxidation**

Preparation, properties and applications of following reagents in organic synthesis with mechanistic details. DDQ, Selinium dioxide, Peracids, Prevost Oxidations, Osmium teraoxide, Potassium permanganate, Cr(VI) oxidants, DMSO oxidants, Manganese dioxide, Silver Carbonate, Periodic acid, Lead tetra acetate and thallium (III) nitrate.

Unit – 3	**Number of lectures = 13**	**Title of the unit: Reduction**

Preparation, properties and applications of following reagents in organic synthesis with mechanistic details Catalytic hydrogenations, Lithium aluminiumhydride, sodium borohydride, DIBAL-H, Sodium cyano borohydride, Alanes and Boranes, Metal basic medium reductions, Metal acidic medium reductions and Diimide reductions.

Unit – 4	**Number of lectures = 13**	**Title of the unit: Molecular rearrangements**

Definition and classification. Molecular rearrangements involving 1) electron deficient carbon: Wagner-Meerwein, Pinacol-Pinacolone, Allylic and Wolff Rearrangement. 2) electron deficient Nitrogen: Hofmann, Lossen, Curtius, Schmidt and Beckmann rearrangements 3) electron deficient Oxygen: Baeyer-Villiger oxidation. 4) Base catalysed rearrangements: Benzilic acid, Favourski, Transannular, Sommlett-Hauser and Smiles rearrangement

12. Brief Description of self learning / E-learning component

1. http://nptel.ac.in/course.php.
2. http://www.chem.iitb.ac.in/~kpk/ra.pdf
3. https://nptel.ac.in/courses/104101005/downloads/LectureNotes/chapter%2011.pdf

13. Books Recommended

1. Warren, S. Designing Organic Synthesis.
2. Fuhrhop, J. and G. Penzilin. Organic Synthesis Concepts, Methods and Starting Materials.
3. Carruthers, W. Some Modern Methods of Organic Synthesis.
4. House, H.O. and W.A. Benjamin. Modern Synthesis Reactions.
5. March, J. Advanced Organic Chemistry Reactions Mechanism and Structure.
6. Norman, R. and J.M. Coxon. Principles of Organic Synthesis.
7. Carey, F.A. and R.J. Sundburg. Advanced Organic Chemistry Part-B.
8. Mehrotra, R.C. and A. Singh. Organometallic Cchemistry: A Unified approach.
9. Sondhi, G.S., R. Gopalan. and V. Ramalingam. Organometallic Chemistry: Concise Coordination Chemistry.

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1. Name of the Department: Chemistry								
2. Course Name	Organic Special Practical-IV			**L**		**T**		**P**
3. Course Code	17060409			0		0		6
4. Type of Course (use tick mark)		**Core (✓)**		**DSE ()**		**SEC ()**		
5. Pre-requisite (if any)	NA	**6. Frequency (use tick marks)**		Even (✓)	Odd ()	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practicals.								
Lectures = Nil		**Tutorials = Nil**		**Practical = 78**				

8. Course Description:

This Course will introduce the students to the basic principles of drawing chemical compound structures, plotting graphs and will enable to develop and practice independent learning skills. This course will also give a platform to learn software based chemistry.

9. Course Objectives:

The objectives of this course are to:

1. Understand basic principle of softwares used by chemists.
2. Learn the drawing of chemical structures of compounds.
3. Have knowledge about the softwares which are used by chemists.

10. Course Outcomes (COs):

Upon successful completion of this course, the student will be able to:

1. Demonstrate knowledge of isolation of organic compounds.
2. Recognize different types of software's used by chemists..
3. Apply basic concepts to draw the structure of chemical compounds.

11. List of software's

1. Chemdraw
2. Origin
3. Hyperchem
4. Chem Sketch
5. MS Office

Or

Any other related softwares.

12. Brief Description of self learning / E-learning component

1. https://www.youtube.com/watch?v=00xtRYpTHaI
2. https://www.youtube.com/watch?v=00xtRYpTHaI
3. https://www.youtube.com/watch?v=EfH4_eYwGds

1. Name of the Department : Chemistry							
2. Course Name	Medicinal Chemistry		**L**	**T**	**P**		
3. Course Code	17060411		4	0	0		
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**		**SEC ()**		
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical							
Lectures = 52		**Tutorials = Nil**		**Practical = Nil**			

8. Course Description:

This course gives an overview of medicinal chemistry, neurotransmitters, drug resistance, and general introduction to antibiotics, mechanism of action of drugs such as antimalarial, antipyretic, antianalgesic, antifertility, and anticancer drugs.Structure elucidation and synthesis of pencillin, chloramphenicol, and streptomycin

9. Course Objectives:

The objectives of this course are to

1. learn the physiological action and the chemical constitution of drugs.
2. learn the synthesis of drugs.
3. make the students aware of the many pharmaceutically active products.
4. give students the skills to make meaningful changes to these substances.

10. Course Outcomes (COs):

On completion of the course, The students will

1. understand the relationship between physiological action and the chemical constitution of different type of drugs
2. understanding of the mechanism of drug resistance
3. be able to design and synthesize drugs
4. acquire the acknowlege of neurotransmitters and classes of neurotransmitters

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit:Introduction to Medicinal chemistry**

Introduction to the history of medicinal chemistry. General introduction to antibiotics, Mechanism of action of lactam antibiotics, non-lactam antibiotics. Neurotransmitters, classes of neurotransmitters, Drugs affecting collingeric and adrenergic mechanisms. DrugResistance

Unit – 2	**Number of lectures = 17**	**Title of the unit: Synthetic drugs**

Relation between physiological action, chemical constitution and synthesis of antimalarial, antipyretic, antianalgesic, antifertility, and anticancer drugs.

Unit – 3	**Number of lectures = 12**	**Title of the unit:Antibiotics**

Structure elucidation and synthesis of pencillin, chloramphenicol, and streptomycin

Unit – 4	**Number of lectures = 10**	**Title of the unit: Prostaglandins**

Classification amd physiological effects of prostaglandins. Synthesis of prostaglandins such as PGE2 and PGE2α

12. Brief Description of self learning / E-learning component

1. http://faculty.smu.edu/jbuynak/medicinal_outline_11_4_04.pdf
2. http://semmelweis.hu/mikrobiologia/files/2014/09/FoD_03.pdf
3. https://nptel.ac.in/courses/104106106/

4. https://nptel.ac.in/noc/individual_course.php?id=noc19-cy05

13. Books Recommended

1. Gringauz, A. Introduction to Medicinal Chemistry: How Drugs Act and Why? John Wiley & Sons (1997).
2. Patrick, G. L. Introduction to Medicinal Chemistry Oxford University Press (2001).
3. Lemke, T. L. & William , D. A., Foye's Principles of Medicinal Chemistry, 5th Ed., USA, (2002)
4. Wilson, Charles O., Ole Gisvold and Robert F. Doerge. Textbook of Organic Medicinal and Pharmaceutical Chemistry.
5. Foye, William., O. Thomas, L. Lemice and David A. Williams, Principles of Medicinal Chemistry.
6. Wolff and M.E. Burgers, Medicinal Chemistry and Drug Discovery.

1. Name of the Department : Chemistry						
2. Course Name	Materials Chemistry		**L**	**T**		**P**
3. Course Code	17060412		4	0		0
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even ()	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)		
Lectures = 52	**Tutorials = Nil**	**Practical = Nil**

8. Course Description:

Introduction to materials and their classification. Advanced, future and modern materials. Why study properties of materials? Economic, Environmental and societal considerations of materials. Recycling issues, Life cycle analysis and its use in design. Examples, properties and applications of polymers, ionic conductors, Glasses, Ceramics, Composites and nanomaterials. Organic solids, fullerenes and their applications in molecular devices

9. Course Objectives:

The objectives of this course are to:

1. Learn the the most common and important materials such as Glasses, Ceramics, Composites, nanomaterials, and polymers
2. To understand theatomic-level build-up of solid materials.
3. To learn the properties of materials such as electrical, thermal, magnetic and electrical properties
4. Learn the economic, environmental and societal considerations of materials.
5. Learn the impotance of organic solids and their applications in molecular devices

10. Course Outcomes (COs):

On completion of the course, the student should be able to:

1. describe the most common and important materials.
2. describe the principles for the atomic-level build-up of solid materials.
3. explain the importance of various properties of different types of materials.
4. understand the recycling issues, life cycle analysis and its use in design of materials.
5. describe the organic solids and molecular devices

11. Unit wise detailed content

Unit-1	**Number of lectures = 16**	**Title of the unit:Introduction of Materials**

Classification of materials. Advanced Materials, Future materials and modern materials. Why study properties of materials? Properties of materials: electrical, thermal, magnetic and optical properties. Corrosion and Degradation of Materials: Corrosion of metals and ceremics, degrationa of polymers. Economic, Environmental and societal considerations of materials. Recycling issues, Life cycle analysis and its use in design.

Unit – 2	**Number of lectures = 13**	**Title of the unit:Polymers and Ionic conductors**

Polymer melts: The tube model, viscoelastic behavior, experimental observations of single chain dynamics-Rouse and Zinn models, polymer blends, copolymers, incompatibility and segregation.

Types of ionic conductors, mechanism of ionic conduction, interstitial types (Frenkel); vacancy mechanism, diffusion superionic conductors; phase transitions and mechanism of conduction in superionic conductors, examples and applications of ionic conductors.

Unit – 3	**Number of lectures = 13**	**Title of the unit:Glasses, Ceramics, Composites and Nanomaterials**

Glassy state, glass formers and glass modifiers, applications. Ceramic structures, mechanical properties, clay

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products. Refractories, characterization, properties and applications. Microscopic composites, dispersion strengthened and particle-reinforced, fibre-reinforced composites, macrosopic composities. Nanocrystalline phase, preparation procedures, special properties, applications.		
Unit – 4	**Number of lectures = 10**	**Title of the unit:Organic solids, fullerenes, molecular devices**
Conducting organics, organic superconductors, magetism in organic materials, Fullerenes: C_{60}, C_{70}, doped fullerenes as superconductors. Graphenes Molecular rectifiers and transistors, artificial photosynthetic devices, optical storage memory and switches-sensors.		
12. Brief Description of self learning / E-learning component		
1. https://nptel.ac.in/courses/Webcourse-contents/IISc-BANG/Material%20Science/pdf/MS_Syllabus.pdf 2. https://nptel.ac.in/courses/112104122/14 3. https://www.youtube.com/watch?v=fuMuabkSbYM 4. http://textofvideo.nptel.ac.in/118102003/lec15.pdf		
13. Books Recommended		
1. Callisterm, W.D., Jr. Materials Science & Engineering: An Introduction, John Wiley & Sons: New York **2.** Keer, H.V. Principles of the Solid State, Wiley Eastern Ltd.: New Delhi **3.** Cowie, J. M.G. Polymers: Chemistry and Physics of Modern Materials, 2nd Ed CRC Press **4.** Hamley, I. W. Introduction to Soft Matter: Polymers, Colloids, Amphiphiles and Liquid Crystals John Wiley & Sons. **5.** O. P. Khaanna, Material Science and Matallurgy, Dhanpat Rai publications.		

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1. Name of the Department : Department of Chemistry						
2. Course Name	Foodscience and Technology		**L**	**T**	**P**	
3. Course Code	17060413		4	0	0	
4. Type of Course (use tick mark)	**Core ()**		**DSE (✓)**		**SEC ()**	
5. Pre-requisite (if any)	B.Sc. (Hons) Chemistry or B.Sc. (Non-Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 52		**Tutorials = Nil**		**Practical = Nil**		

8. Course Description:

This discipline specific elective course will enable postgraduate students to develop an understanding of food science and technology involved in various aspects of food such as storage, packaging and preserving etc. Concepts of food chemistry covering various constituents of food and its stability will be discussed. Preservation of food will be explained and its processing will also be discussed by detailed study of preservation methods. Moreover, spectroscopic techniques such as UV/Vis, fluorescence, IR, FTIR, NIR, NMR and Atomic Absorption techniques involved in food analysis will also discussed with students. Finally, food quality management will be explained through various Food standards and Specifications.

9. Course Objectives:

1. To make students learn properties and role of various constituents in foods, interaction and changes during processing.
2. To enable students with importance of various foods and nutrients in human nutrition.
3. To acquaint students with principles of different techniques used in processing and preservation of foods.
4. To facilitate knowledge of food quality parameters and control systems, food standards, regulations, specifications

10. Course Outcomes (COs):

Students will be:

1. Able to apply the scientific method to food science problems.
2. Having sufficient knowledge of food chemistry to control reactions in foods.
3. Able to know the principles involving food preservation.
4. Able to explain the principles and current practices of processing techniques and the effects of processing parameters on product quality.
5. Apply and incorporate the principles of food science in practical, real- world situations and problems.

11. Unit wise detailed content

Unit-1	**Number of lectures = 13**	**Title of the unit: Food Chemistry**

Major and Minor constituents of foods, Water Activity and its relation with Food Stability, Sorption Isotherms and Hysterisis. Carbohydrates-classification and Structure. Browning Reactions, Functions of Carbohydrates,Lipids-Classification and Structure, Reactions of Lipids, Rancidity and Control. Modification of Lipids, Refining of Oils. Proteins-Classification and Structure, Functional Properties of Proteins, Denaturation of proteins and its implications. Vitamins, Minerals and Pigments & their properties.

Unit – 2	Number of lectures = 13	Title of the unit: Preservation & Processing of Foods
Basics of effective utilization of Food supply, Food Wastage, Causes of Quality deteriorations and quantitative losses of foods and their prevention by physical, chemical and biological means, Preservation by Lowering of Water Activity, Concentration: Evaporators and Freeze Concentration. Dehydration of foods, Types of Driers and principles involved. Freeze Drying. Preservation of foods using High Temperatures, D, Z and F values, Preservation of foods using Low Temperatures, Chilling, Freezing, Immersion Freezing, IQF Foods. Preservation of foods by Radiations, Spices and Additives. Optimal Processing of Foods.		
Unit – 3	**Number of lectures = 13**	**Title of the unit: Techniques in Food Analysis**
Spectroscopic techniques using UV/Vis, fluorescence, IR, FTIR, NIR, NMR and Atomic Absorption techniques. Chromatographic techniques: Adsorption, column, partition, affinity, ion exchange, GC & HPLC Techniques. Special techniques: Immunoassay techniques; Isotopic, non-isotopic and enzyme immunoassays, enzymatic methods of food analysis.		
Unit – 4	**Number of lectures = 13**	**Title of the unit: Food Quality Management**
Definition of Quality, Quality control and Quality Assurance, Total Quality Control (TQC) and TQM.. Sensory Attributes, Sensory evaluation in Quality Management of foods. Analysis and Interpretation of sensory scores. Instrumental measurements of sensory attribute of foods: Rheological and textural characteristics . Texture profile analysis. Types of Instruments used. Food standards and Specifications: Previous Food laws: PFA, FPO, SWMA, MPO, AgMark, and BIS Standards. FSSAI: Definitions, Provisions, Scope and standards.		

11.Brief Description of self-learning / E-learning component

1. https://nptel.ac.in/courses/103103029/pdf/mod6.pdf
2. https://nptel.ac.in/noc/individual_course.php?id=noc18-ar08
3. http://www.savitapall.com/food_chemistry/notes/food%20chemistry%20summary.pdf
4. https://edblog.hkedcity.net/te_tl_e/wpcontent/blogs/1685/uploads/FST/Food%20Booklet%2010%20eng.pdf

12. Books Recommended

1. Macleod AJ. 1973. Instrumental Methods of Food Analysis. Elek Sci. Marcel Dekker.
2. Linden G. 1996. Analytical Techniques for Foods and Agricultural Products. VCH.
3. DeMan JM. 1976. Principles of Food Chemistry. AVI.
4. Swaminathan M. 1974. Essentials of Foods and Nutrition. Vol. II. Ganesh & Co.
5. Early R.1995.Guide to Quality Management Systems for Food Industries. Blackie Academic.
6. Fellows PJ. 2000. Food Processing Technology: Principles and Practices. 2nd Ed. CRC-Woodhead Publ.
7. Ramaswamy H and Marcott M, Food Processing Principles and Applications CRC Press, 2006

1. Name of the Department: Chemistry						
2. Course Name	Nanotechnology for Medical Diagnostics and Therapy		**L**	**T**	**P**	
3. Course Code	17060414		4	0	0	
4. Type of Course (use tick mark)		**Core ()**	**DSE (✓)**	**SEC ()**		
5. Pre requisite (if any)	B.Sc.(Hons) Chemistry or B.Sc.(Hons) Physics or B.Sc. (Non Medical)	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals.						
Lectures = 52	**Tutorials = 0**	**Practical = 0**				

8. Course Description:

Nanomedicine is a rapidly emerging interdisciplinary area of science that involves the integration of nanotechnology and biomedical research. The course will introduce use of nanotechnology in diagnostics and drug delivery. In detail, the course will cover synthesis, characterization and properties of different types of nano biomaterials; surface modification of bionanomaterials; and nanocarriers. Nano barcodes and nano biosensors used in diagnosis of diseases will be described. In addition, an overview of bioMEMS as biosensors will be delivered. A detailed explanation of imaging techniques, *e.g.* MRI, CT, PET *etc* will be given. Finally, use of nanotechnology in targeted drug delivery to treat specific diseases, for instance cancer, cardiovascular disease, diabetes will be discussed.

9. Course Objectives:

The objectives of this course are to:

1. Introduce students to medical perspectives of nanotechnology
2. Describe synthesis, characterization and properties of different types of bionanomaterials and their biomedical applications
3. Introduce students to nanobarcode technology and nano biosensors used in disease diagnostics
4. Explain to students nanotech based imaging techniques
5. Discuss nanotechnology for targeted drug delivery and treatment in cancer, cardiovascular diseases and diabetes.

10. Course Outcomes (COs):

Upon completion of the course, students should be able to:

1. Understand how nanotechnological approaches can be used in biomedical therapies
2. Understand biomaterials and interaction of biomaterials with cells, body fluids and tissues
3. Understand nano barcode technology and use of nanobiosensors in disease diagnostics
4. Understand nanotech based imaging techniques
5. Understand use of nanotechnology in targeted drug delivery and treatment in specific ailments, for instance, cancer, heart disease and diabetes.

11. Unit wise detailed content

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Unit-1	Number of lectures = 13	Title of the unit: Introduction to Nanomedicine
Overview of nanotechnology from medical perspective, different types of nano biomaterials and their biomedical applications, and cell nanostructure interactions Synthesis, characterization, and properties of smart nanomaterials,Surface modification/biofunctionalization of nanomaterials, Nanocarriers (e.g. liposomes, polymer capsules, polymer nanoparticles, porous materials, nanogels, dendrimers, microemulsions, inorganic nanoparticles, carbon nanotubes, lipoproteins, solid lipid nanoparticles) for drug delivery applications.		
Unit – 2	**Number of lectures = 13**	**Title of the unit: Nanotechnology for Disease Diagnostics**
Nanomachines, nanobarcodes and nanosensors: Quantum dot conjugation strategies with DNA-aptamer; Quantum dot Nano barcode for Multiplexed Gene Expression,Protein and Antibody – Biobarcode Assay for Proteins, Single-Molecule Barcoding System for DNA Analysis- Nanoparticle-Based Colorimetric DNA Detection Method; and Cantilevers as Biosensors for Molecular Diagnostics –Carbon Nanotube Biosensors and FRET-Based DNA Nanosensors for Cancer, AIDS, tuberculosis and other disease diagnostics, Nanoparticle assisted multiplexed diagnostic assays (Bio-barcode amplification assay, Sandwich DNA assay, ELISA) and point-of care diagnostics (Lateral flow assay).Overview of bioMEMS as miniaturized biosensors and for diagnostics		
Unit – 3	**Number of lectures = 13**	**Title of the unit: Nanotech based Imaging Techniques**
Imaging Techniques: Nanotech based imaging techniques: Conventional imaging, MRI, Computed tomography (CT), Positron emission tomography (PET), Single photon emission computed tomography (SPECT), Florescence imaging, Ultrasound imaging, Photoacoustic imaging, Dual modality imaging.		
Unit – 4	**Number of lectures = 13**	**Title of the unit: Nanotechnology for drug delivery**
Nano structured materials in medicine,especially,Nanoparticles in cancer targeting and treatment, treating cardiovascular diseases and diabetes,Types of Nanoparticles in targeting and treatment - Lipid, polymeric, Hyaluronic acid and heparin functionalized core shell nanoparticle as drug delivery vehicles; Carbon nanotube-based vectors for delivering immune therapeutics and drugs, Hydrogels for drug delivery, nanoparticle induced Gene delivery for gene therapy; Inorganic nanoparticles, *e.g.* Gold, Magnetite, Silver etc.; liposomes; micelles and dendrimers; artificial DNA structures, Active and Passive cancer tissue targeting, Immunotherapy, Gene delivery, Photo dynamic therapy, hyperthermia, radiotherapy, combinational treatment, Multifunctional nanoparticles, Stem cell therapy, 3D printing.		

12. Brief Description of self learning / E-learning component

11. http://www.nanomedicinecenter.com
12. http://nptel.ac.in/syllabus/syllabus_pdf/118104007.pdf
13. https://www.youtube.com/watch?v=0wq_Iny6KFw
14. https://www.youtube.com/watch?v=M9OAKXlPsDw
15. http://www.understandingnano.com/nanotechnology-drug-delivery.html

13. Books Recommended

Text Books:

1. The handbook of Nanomedicine by Kewal K. Jain, Humana Press, ISBN: 978-1-60327-319-0.
2. Nanomaterials for Medical Diagnostics and Therapy by Challa Kumar (Editor), Wiley-VCH, ISBN-978-3-527-31390-7.
3. Nano Medicines Edited by Dr.Parag Diwan and Ashish Bharadwaj, Pentagon press(2006) ISBN 81-8274-139-4.
4. Christof M. Niemeyer, Chad A. Mirkin, Nanobiotechnology: Concepts, applications and perpectives, Wiley-Interscience 2004.
5. Geoffery A. Ozin, Andre C. Arsenault, Nanochemistry: A chemical approach to nanomaterials, RSC publishing (2005).
6. Challa Kumar, Biofunctionalization of nanomaterials, Wiley Interscience (2006).

Reference Books:

1. Medical Nanotechnology and Nanomedicine by Harry F. Tibbals, CRC Press (Taylor & Francis, ISBN: 13-978-1-4398-0876-4.
2. Vladimir P.Torchilin, Nanoparticulates as Drug Carriers, , Imperial College Press, North Eastern, University, USA (2006).
3. David E Reisner, Bionanotechnology, Global Preospects, CRC press (2008).
4. James A. Schwarz, Cristian I. Contescu, Karol Putyera, "Dekker Encyclopedia of nanoscience and nanotechnology" CRC Press, 2004.
5. Y. Lu, S.C. Chen, "Micro and nano -fabrication of biodegradable polymers for drug delivery" Advanced Drug Delivery Reviews, 56 (1621 -1633) 2004.