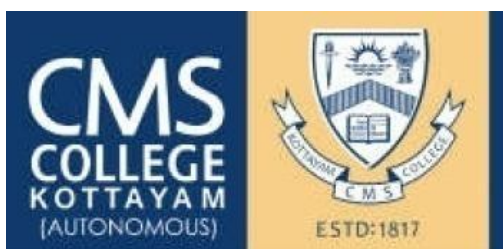


CMS COLLEGE KOTTAYAM
(AUTONOMOUS)

Affiliated to the Mahatma Gandhi University
Kottayam, Kerala



CURRICULUM FOR POST GRADUATE PROGRAMME

MASTER OF SCIENCE IN APPLIED
CHEMISTRY

UNDER CREDIT AND SEMESTER SYSTEM (CSS)
(With effect from 2019 Admissions)

Approved by the Board of Studies on 30th April 2019

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ACKNOWLEDGEMENTS

The Board of Studies in Chemistry, CMS College Kottayam (Autonomous), has made serious and sincere attempt to make the curriculum of postgraduate programme in Applied Chemistry. There are many personalities whose relentless support and guidance made this syllabus a success. We take this opportunity to express our sincere appreciation to all those who were part of this endeavor for structuring the syllabus of PG programme in Applied Chemistry. Our heartfelt gratitude to Dr. N. J. Rao, former Professor, Indian Institute of Science for the 2-day workshop on curriculum designing and to Dr. T. P. Sasikumar, former Professor ISRO for the 2-day curriculum workshop, and to Dr. C. James, Scott Christian College for the workshop on question-bank design.

We express profound gratitude to the Principal, Vice Principal, Members of the Governing council and Academic Council of CMS College for their sincere cooperation and guidance for completion of this work. We place on record our whole hearted gratitude and appreciation to the members of the Faculty of Chemistry and Board of Studies for their untiring efforts to prepare the syllabus. We also place on record our gratitude to all professionals, academicians and other stakeholders who gave valuable suggestions in this regard.

Smt. Ajitha Chandy
Chairman
Board of Studies

Kottayam
30.04.2019

PREFACE

The objective of the M.Sc. Applied Chemistry programme is to provide the graduates an in-depth knowledge of the scientific basis and the methodology of chemical research. On completing the programme, the students will be able to analyse and solve problems within the broad/specialized field of analytical chemistry. A master's degree in Applied Chemistry equips the graduates with the necessary skills for embarking a research career or for taking up independent leadership and management of complex work and development situations within the field. The M.Sc. Programme in Applied Chemistry combines core and elective theory courses as well as practical courses and an independent research guided by an experienced researcher from the department or a national institute. Adhering onto these objectives, M.Sc. Curriculum revision was carried out with utmost vigilance and care. The curriculum revision committee believes that we have taken care of every academic aspect to arrive at comprehensive syllabus for all the courses. While revising the M.Sc. syllabus, the committee has taken into account the emerging trends in various fields of theoretical and experimental chemistry. The thrust was given to inculcate the spirit of hard work and research aptitude in students to pursue higher education in the nationally/internationally reputed institutions and laboratories. Brain-storming discussions in this matter were carried out among the faculty members of Chemistry department of CMS College and experts from various other Colleges, Universities and Institutions. The board of studies believes that we have taken care of every aspect to arrive at comprehensive syllabus for all the courses that cater to the advance of the students' knowledge, career and future.

REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CREDIT SEMESTER SYSTEM 2019

Preamble

CMS College Kottayam (Autonomous) was conferred with the Autonomous status as per UGC No.F.22-1/2016(AC) Dtd. 9th March 2016 and Mahatma Gandhi U.O.No.2732/VII/2016/Acad. Dtd.12th May 2016.

REGULATIONS

CMS College Kottayam (Autonomous) follows Credit Semester System (CSS) for the Post Graduate programmes from the Academic year 2019-20. The Post Graduate programmes of the college are being redesigned and revised in tune with the modifications effected at the UGC Curriculum Framework. This will be reflected in the scheme, course content and mode of examination and Evaluation system. The scheme and syllabus of all the programmes are being revised accordingly. The revisions were effected based on the recommendations made at the Curriculum Revision workshops conducted for the purpose besides several sittings of the Curriculum Revision Committee.

1. TITLE

1.1.These regulations shall be called “**CMS COLLEGE KOTTAYAM (AUTONOMOUS) REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CREDIT AND SEMESTER SYSTEM 2019**”

2. SCOPE

2.1 Applicable to all regular Postgraduate Programmes conducted by the CMS College Kottayam (Autonomous) with effect from 2019 admissions.

2.2 Medium of instruction is English unless otherwise stated therein.

3. DEFINITIONS

3.1. Academic Week is a unit of five working days in which the distribution of work is organized from day one to day five, with five contact hours of one hour duration on each day.

3.2. Semester means a term consisting of **90** working days, within **18** five-day academic weeks for teaching, learning and evaluation.

3.3. Programme means a two year programme of study and examinations, spread over four semesters, with a set of courses, the successful completion of which would lead to the award of a degree.

3.4. Course comprises a set of classes or a plan of study on a particular subject which will be taught and evaluated within a semester of a study programme.

3.5. Core course means a course which should compulsorily be studied by a student as requirement in the subject of specialization within a degree programme.

3.6. Elective Course means an elective course chosen from the discipline/ subject, in an advanced area.

3.7. Credit is the numerical value assigned to a course according to the duration of the classes or volume of the syllabus of the course.

3.8. Department means any teaching department in the college.

3.9. Dean of Academic Affairs is a teacher nominated by the Academic Council to coordinate the academic affairs of the college relating to academic planning, curriculum implementation and review.

3.10. Dean of Student Affairs is a teacher nominated by the Academic Council to coordinate the admissions, grievances and other student related services.

3.11. Department Council means the body of all teachers of a department in the college.

3.12. Department Coordinator is a teacher nominated by a Department Council to coordinate the ⁱⁿ-Semester examination of the PG programme in that department.

3.13. Faculty Advisor means a teacher from the parent department nominated by the Department Council, who will advise the students of a class on academic matters.

3.14. Course Teacher means a teacher who is in charge of a course. If a course is taught by more than one teacher, one teacher should be assigned as course teacher, nominated by the HOD. The course teacher shall be responsible for the valuation of answer scripts of examinations and other continuous assessments.

3.15. In-Semester Assessment (ISA) means assessment consisting of Attendance, Assignment/Seminar/Viva voce and Examination (theory and practical).

3.16. End Semester Assessment (ESA) means Examination conducted at the end of each semester for all courses (theory and practical).

3.17. Internal Examiner means a teacher working in the college.

3.18. External Examiner means a teacher from outside the college.

3.19. Grace Marks shall be awarded to candidates as per the orders issued by Mahatma Gandhi University.

3.20. Grade means a letter symbol (A, B, C, etc.), which indicates the broad level of performance of a student in a Course/ Semester/Programme.

3.21. Grade Point (GP) is the numerical indicator of the percentage of marks awarded to a student in a course.

3.22. College Average (CA) means average mark secured (ISA+ESA) for a course at the college level.

3.23. Words and expressions used and not defined in this regulation shall have the same meaning assigned to them in the Act and Statutes of the University, UGC Regulations and the Constitution of the CMS College Kottayam (Autonomous).

4. ELIGIBILITY FOR ADMISSION AND RESERVATION OF SEATS

Eligibility for admission, norms for admission and reservation of seats for various Postgraduate Programmes shall be according to the regulations framed/orders issued by Govt. of Kerala, Mahatma Gandhi University and CMS College Kottayam in this regard.

5. PROGRAMME STRUCTURE

5.1 The nomenclature of all PG programmes shall be as per the specifications of University Grants Commission and the Mahatma Gandhi University.

5.2 Credit Semester System (CSS) will be followed for all PG Programmes from the academic year 2019– 2020.

5.3 All the PG Programmes will be of two-year duration with four Semesters. A student may be permitted to complete the Programme, on valid reasons, within a period of 8 continuous semesters from the date of commencement of the first semester of the programme.

5.4 There will be three/four/five courses in each semester and one viva voce and dissertation at the end of the fourth semester.

5.5 There will be three components for the programme viz. core course, elective course and project spread over four semesters.

5.6 The total credits required for completing a PG Programme is **80**.

5.7 The Syllabus for all courses in each semester has been divided into five modules based on certain thematic commonalities.

6. EVALUATION SYSTEM

i. The evaluation scheme for each course shall contain two parts:

- (a) In-Semester Assessment (ISA)
- (b) End-Semester Assessment (ESA)

ii. The proportion of ISA to ESA will be 1:3.

iii. The marks secured for each course shall be converted as grades. The grades for different semesters and overall programme are assigned based on the corresponding semester grade point average and cumulative grade point average respectively.

iv. A separate minimum of 40% is mandatory for both ISA and ESA to pass for every course.

6.1 EVALUATION OF THEORY COURSES

The marks allotted for theory courses in End-Semester Assessment shall be 120 and that for the In-Semester Assessment will be 40.

A. IN-SEMESTER ASSESSMENT

The In-semester assessment for theory is based on the marks obtained for Attendance, Assignment, Major Seminar and two Test Papers for a particular course.

(i) **Attendance**

Percentage of attendance	Mark
90 and above	6
85 - 89	5
80 - 84	4
76 - 79	3
75	2
Below 75	0

Maximum marks = 6

(ii) **Assignment (One assignment per course)**

Evaluation Component	Mark
Review of related literature	2
Content	3
Reference	2
Punctuality	1

Maximum marks = 8

(iii) **Major Seminar**

A student should present one Major Seminar in a Semester. The faculty advisor should allot students to the respective course teacher in a semester. The seminar topics shall be incorporated in the syllabus for each course/ declared in the beginning of each semester. The student shall prepare the seminar paper with the guidance of the course teacher. The student is expected to make a detailed presentation in a common session in the department, with students and all course teachers. The student shall also make a brief conclusion including the future scope of studying the topic. The teacher in charge of the particular course has to act as the moderator for the seminar.

The course teachers of that semester shall evaluate the seminar and give marks for their course or the average mark of all the evaluators shall be taken as the seminar mark for each course of a semester.

Evaluation Component	Mark
Involvement/punctuality	1
Review of related literature	1
Content	3
Presentation	3
Interactions/ justification	1
Conclusion	1

Maximum marks = 10

(iv) **Test paper**

For each course, two In-Semester examinations of total 16 marks shall be conducted. One of the test paper will be centralized examination of 8 marks and the remaining 8 marks will be awarded with one or more class tests conducted by the course teacher.

B. END -SEMESTER ASSESSMENT

End-Semester examinations for each course are conducted at the end of every semester with a maximum marks of 120. The examination for each course will have two components viz., descriptive test and an objective type test. Questions shall be set to evaluate the attainment of course outcomes. The question paper for each course will be generated from the Question Bank which is prepared by due mapping of Course outcomes and Program Specific Outcomes.

(i) Descriptive Test

A written examination with a maximum marks of 100 and of three hours duration will be conducted.

PATTERN OF QUESTIONS

A question paper shall be a judicious mix of short answer type, short essay/problem solving type and long essay type questions.

No.	Section	Type of questions	Total Questions	Number of questions to be answered	Mark for each question	Total Marks
1	Section A	Short answer type	8	5	4	20
2	Section B (One pair should be from each module)	Short essay/problem solving type	10 (Either/or)	5	8	40
3	Section C	Long essay type	4	2	20	40
	Total		22	12	-	100

(ii) Objective Test

A Multiple Choice Objective type Test shall be a component of the End-semester examination which will be conducted in the online mode for each course. The marks obtained shall be converted into 20. The objective type examination for all courses in a semester shall be conducted in a session of one hour. The number of questions in Arts stream will be 50 and that of Science and Mathematics stream will be 40. Questions should be equally distributed among the courses in a semester. There will be four choices for each question. Each question carries 4 marks for correct answer, zero marks for no answer and -1 marks for wrong answer.

6.2 EVALUATION OF PRACTICAL COURSES

Practical examination will be conducted at the end of each semester/ end of an academic year. The time of conduct of the practical examination will be decided by the respective BOS.

A. IN-SEMESTER ASSESSMENT

Evaluation Component	Mark
Attendance	6
Lab Involvement	8
Test	12
Record	8
Viva	6

Maximum Marks = 40

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

B. END- SEMESTER ASSESSMENT

Evaluation Component	Mark
Attendance	18
Lab Involvement	24
Test	36
Record	24
Viva	18

Maximum Marks = 120

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

6.3 EVALUATION OF PROJECT

An academic project work shall be done and a dissertation shall be submitted in the final semester of the programme. There will be both In semester and End semester assessment for the project work.

A. IN- SEMESTER ASSESSMENT

Evaluation Component	Mark
Relevance of the topic	5
Project content and report	15
Presentation	15
Project viva	10
Paper presentation* in Seminar/Conference or publications with ISBN/ISSN (*valid certificate to be submitted)	5

Maximum marks = 50

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

B. END -SEMESTER ASSESSMENT

The dissertation at the end of final Semester will be evaluated by a panel of one internal evaluator assigned by HOD and one external evaluator / a panel of two external evaluators, as may be decided by the respective BOS.

Evaluation Component	Mark
Relevance of the topic	15
Project content and report	45
Presentation	45
Project viva	30
Paper presentation* in Seminar/Conference or publications with ISBN/ISSN (*valid certificate to be submitted)	15

Maximum marks = 150

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

6.4 EVALUATION OF COMPREHENSIVE VIVA VOCE

A comprehensive viva voce shall be done at the end of the final semester. There will be both In-semester and End-semester assessment for the viva voce examination.

A. IN - SEMESTER ASSESSMENT

Evaluation Component	Mark
+2/ UG level questions	4
PG syllabus level questions	10
Subject of interest based questions	8
Advanced level questions	3

Maximum marks = 25

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

B. END- SEMESTER ASSESSMENT

The comprehensive Viva Voce Examination at the end of final Semester will be evaluated by a panel of one internal evaluator assigned by HOD and one external evaluator / a panel of two external evaluators, as may be decided by the respective BOS.

Evaluation Component	Mark
+2/ UG level questions	12
PG syllabus level questions	30
Subject of interest based questions	24
Advanced level questions	9

Maximum marks = 75

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

7. Grievance Redressal Mechanism

In order to address the grievance of students regarding In-Semester assessment, a two-level Grievance Redressal mechanism is established.

Level 1: Department Level: The Department cell is chaired by the HOD, Department Coordinator as member secretary and Course teacher in-charge as member. If the grievance is not redressed at the Department level, the student shall report the grievance to the College Level Grievance Redressal Cell.

Level 2: College level: College Level Grievance Redressal Cell has the Vice-Principal as the Chairman, Dean of Student Affairs as the Member Secretary and HOD of concerned Department as member.

8. Eligibility for End Semester Examination

A minimum of 75% average attendance for all the courses is mandatory to register for the examination. Condonation of shortage of attendance to a maximum of 10 days in a semester subject to a maximum of 2 times during the whole period of the programme may be granted by the College on valid grounds. Attendance may be granted to students attending University/College union/Co-curricular activities for the days of absence, on production of participation/attendance certificates, within one week, from the teacher in charge of the activity and endorsed by the Dean of Student Affairs. This is limited to a maximum of 10 days per semester. Monthly Attendance report will be published in the college website on or before the 10th of every month. Those students who are not eligible even with condonation of shortage of attendance shall repeat the semester along with the next batch after obtaining readmission.

9. Promotion to the next Semester

Those students who possess the required minimum attendance and have registered for the End Semester Examination during an academic semester are promoted to the next semester.

Those students who possess the required minimum attendance and progress during an academic semester and could not register for the semester examination are permitted to apply for Notional Registration to the examinations concerned enabling them to get promoted to the next semester.

10. Eligibility for Readmissions

An additional chance of readmission will be given to those students who could not register for the examination due to shortage of attendance. Readmitted students shall continue their studies with the subsequent batch of students. If an applicant for readmission is found to have indulged in ragging or any other misconduct in the past, readmissions shall be denied.

11. MARK CUM GRADE CARD

The College under its seal shall issue to the student a MARK CUM GRADE CARD on completion of each semester/programme, which shall contain the following information:

- (a) Name of the College
- (b) Title of the Postgraduate Programme
- (c) Name of the Semester
- (d) Name and Register Number of the student
- (e) Date of publication of result
- (f) Code, Title, Credits and Maximum Marks (ISA, ESA & Total) of each course opted in the semester.
- (g) ISA, ESA and Total Marks awarded, Grade, Grade point and Credit point in each course opted in the semester
- (h) College average (CA) of the marks of all courses
- (i) The total credits, total marks (Maximum & Awarded) and total credit points in the semester
- (j) Semester Grade Point Average (SGPA) and corresponding Grade.
- (k) Cumulative Grade Point Average (CGPA) and corresponding Grade.

The final Mark cum Grade Card issued at the end of the final semester shall contain the details of all courses taken during the study programme and the overall mark/grade for the total programme.

There shall be a College Level Monitoring Committee comprising Principal, Vice Principal as member-secretary, Dean of Academic Affairs, Controller of Examinations, IQAC Director and Administrative Assistant as members for the successful conduct of the scheme.

12. CREDIT POINT AND CREDIT POINT AVERAGE

Credit Point (CP) of a course is calculated using the formula:-

$CP = C \times GP$, where C is the Credit and GP is the Grade point

Semester Grade Point Average (SGPA) of a Semester is calculated using the formula:-

$SGPA = TCP/TC$, where TCP is the Total Credit Point of that semester, ie, $\sum_1^n CP_i$; TC is the Total Credit of that semester, ie, $\sum_1^n C_i$, where n is the number of courses in that semester

Cumulative Grade Point Average (CGPA) is calculated using the formula:-

$CGPA = TCP/TC$, where TCP is the Total Credit Point of that programme, ie, $\sum_1^n CP_i$; TC is the Total Credit of that programme, ie, $\sum_1^n C_i$, where n is the number of courses in that programme

Grades for the different courses, semesters and overall programme are given based on the corresponding CPA as shown below:

CPA	Grade with Indicator
4.5 to 5.0	A+ Outstanding
4.0 to 4.49	A Excellent
3.5 to 3.99	B+ Very Good
3.0 to 3.49	B Good (Average)
2.5 to 2.99	C+ Fair
2.0 to 2.49	C Marginal
Up to 1.99	D Deficient (Fail)

13. TRANSITORY PROVISION

Notwithstanding anything contained in these regulations, the Principal shall, for a period of six months from the date of coming into force of these regulations, have the power to provide by order that these regulations shall be applied to any programme with such modifications as may be necessary.

The Principal is also authorized to issue orders for the perfect realization of the regulations.

Annexure I
(Model Mark Cum Grade Card)



CMS COLLEGE KOTTAYAM (AUTONOMOUS)
Affiliated to Mahatma Gandhi University Kottayam
(Autonomous College as per UGC order no.F.22-1/216(AC)dated 9th March 2016)
MARK CUM GRADE CARD

Section :
Name of the Candidate :
Unique Permanent Registration Number :
Degree :
Programme :
Stream :
Name of the Examination :
Date of Publication of Result :

Course Code	Course Title	Credits (c)	Marks						Grade Awarded (G)	Grade Point (GP)	Credit Point (C x)	College Average	Result
			ISA		ESA		TOTAL						
			Awarded	Maximum	Awarded	Maximum	Awarded	Maximum					

ISA - In - Semester Assessment, ESA – End - Semester Assessment

SGPA:
Checked by

SG:
Section Officer

Controller of Examinations

Date:

Annexure II



CMS COLLEGE KOTTAYAM (AUTONOMOUS)

Kerala, India – 686 001 Website: www.cmscollege.ac.in

e-mail: kottayamcmscollege@gmail.com Tel: 91-481-2566002, Fax: 91-481-2565002

Affiliated to Mahatma Gandhi University Kottayam, Kerala

(Autonomous College as per UGC Order No.F.22-1/216 (AC) dated 9th March 2016)

CONSOLIDATED MARK CUM GRADE CARD

Name of the Candidate:

Unique Permanent Register Number (UPRN):

Degree:

Programme:

Stream:

Date of Birth:

Date of Eligibility for the Degree:

PHOTO

CMS COLLEGE KOTTAYAM (AUTONOMOUS)

Name:

UPRN:

Course Code	Course Title	Credits (C)	Marks						Grade Awarded (G)	Grade Point	Credit Point (CxGP)	College Average (CA)	Result
			ESA		ISA		Total						
			Awarded	Maximum	Awarded	Maximum	Awarded	Maximum					

Final Result

Cumulative Grade Point Average CGPA :
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Semester Summary

Sl.No	Semester	Credit	SGPA	Grade	Month/year	Result
	Semester 1					
	Semester 2					
	Semester 3					
	Semester 4					

Date:

Controller of Examinations

Annexure III



(Reverse side of the Mark cum Grade Card (COMMON TO ALL SEMESTERS))

Description of the Evaluation Process

Table 1

Grade and Grade Point

The Evaluation of each Course comprises of Internal and External Components in the ratio 1:3 for all Courses.

Grades and Grade Points are given based on the percentage of Total Marks (Internal + External) as given in Table 1

(Decimals are to be rounded mathematically to the nearest whole number)

% Marks	Grade	GP
Equal to 88 and above	A+ Outstanding	5
Equal to 76 and < 88	A Excellent	4
Equal to 64 and < 76	B+ Very Good	3
Equal to 52 and < 64	B Good(Average)	2
Equal to 40 and below 52	C Marginal	1
Below 40	D Deficient (Fail)	0
	Ab Absent	

Credit point and Credit point average

Grades for the different Semesters and overall Programme are given on a 7-point Scale based on the corresponding CPA, as shown in Table 2.

Table 2

Credit point (CP) of a paper is calculated using the formula $CP = C \times GP$, where **C is the Credit; GP is the Grade Point**

Semester or Programme (cumulative) Grade Point Average of a Course/Programme is calculated using the formula

$SGPA/CGPA = \frac{TCP}{TC}$, where **TCP is the Total Credit Point; TC is the Total Credit**

CPA	Grade with Indicator
4.5 to 5.0	A+ Outstanding
4.0 to 4.49	A Excellent
3.5 to 3.99	B+ Very Good
3.0 to 3.49	B Good (Average)
2.5 to 2.99	C+ Fair
2.0 to 2.49	C Marginal
Up to 1.99	D Deficient (Fail)

NOTE

A separate minimum of 40% marks each for internal and external (for both theory and practical) are required for a pass for a course. For a pass in a programme, a separate minimum of **Grade C** is required for all the individual courses. If a candidate secures **D Grade** for any one of the course offered in a Semester/Programme **only D grade** will be awarded for that Semester/Programme until he/she improves this to **C GRADE** or above within the permitted period.

CURRICULUM

GRADUATE PROGRAMME OUTCOMES (GPO) – POST GRADUATE PROGRAMMES

At the completion of the Post Graduate Programme, the student will be able to accomplish the following programme outcomes.

GPO No.	Graduate Programme Outcomes
GPO.1	Critical Thinking: Ability to engage in independent and reflective thinking in order to understand logic connections between ideas.
GPO.2	Effective Communication: Development of communication skills for effectively transmitting and receiving information that focuses on acquiring knowledge, problem solving, improving on arguments and theories thereby paving the way for better employability and entrepreneurship.
GPO.3	Social Consciousness: Acquire awareness towards gender, environment, sustainability, human values and professional ethics and understand the difference between acting, responding and reacting to various social issues.
GPO.4	Multidisciplinary Approach: Combining various academic disciplines and professional specializations to cross borders and redefine problems in order to explore solutions based on the new understanding of complex situations.
GPO.5	Subject Knowledge: Acquiring knowledge at a higher level that would help develop the necessary skills, fuel the desire to learn and contribute to the field of expertise thereby providing valuable insights into learning and professional networking with the aim of catering to the local, national and global developmental needs.
GPO.6	Lifelong Learning: Understanding the necessity of being a lifelong learner for personal enrichment, professional advancement and effective participation in social and political life in a rapidly changing world.

PROGRAMME SPECIFIC OUTCOMES

	Program Specific Outcomes <i>Upon completion of this programme, the students will be able to;</i>	GPO
PSO1	Demonstrate advanced knowledge of fundamental principles of Chemistry in the core areas of Organic, Inorganic, Physical and Theoretical Chemistry.	1,2,4,5
PSO2	Apply fundamental and advanced concepts in chemistry to the formulation and solution of complex problems in the oil, fats, perfumery and related industries	1,2,4,5,6
PSO3	Develop the knowledge of experimental techniques, theoretical concepts and acquire a broader understanding of research strategies, scientific thinking and data analysis	1,2,4,5
PSO4	Interpret research literature in his/her field of study and Conduct independent research under limited supervision within a research group and Communicate chemistry effectively, by using both oral and written skills.	1,2,3,4,5, 6

PROGRAMME DESIGN

The Post graduate programme in Applied Chemistry is a two year programme of four semesters. There are five components for the programme namely, the core course, elective course, practical course, viva-voce and a major project. In the first three semesters there are four core courses and three practical courses in each semester. In the fourth semester, there are three elective courses, three practical courses, a major project and a comprehensive viva-voce. The total credits for completing M.Sc. programme in Chemistry are 80.

The Course Design is given below:

Sl No	Course Type	No of courses	Total credits
1.	Core courses	12	45
2.	Elective courses	3	12
3	Practical	6	18
4.	Viva -voce	2	2
5	Project	2	3
	TOTAL	25	80

PROGRAMME STRUCTURE

	Code	Course	Hours /Week	Total Hours	Credit
Semester 1	AC1921101	Organometallics and Bioinorganic chemistry	4	72	4
	AC1921102	Introduction to Physical Organic Chemistry and stereochemistry	4	72	4
	AC1921103	Applied Quantum Mechanics and Group theory	4	72	4
	AC1921104	Equilibrium Thermodynamics	3	54	3
	AC1922601	Inorganic Chemistry Practical	3	54	Evaluation at the end of second
	AC1922602	Organic Chemistry Practical	3	54	
	AC1922603	Physical Chemistry Practical	4	72	
		Total		25	450
Semester 2	AC1922105	Structural aspects and stereochemistry of inorganic complexes	4	72	4
	AC1922106	Chemistry of reactive intermediates and reaction mechanisms	4	72	4
	AC1922107	Advanced quantum mechanics and molecular modeling	4	72	4
	AC1922108	Fundamentals of Spectroscopic techniques	3	54	3
	AC1922601	Inorganic Chemistry Practical	3	54	3
	AC1922602	Organic Chemistry Practical	3	54	3
	AC1922603	Physical Chemistry Practical	4	72	3
		Total		25	450
Semester 3	AC1923109	Essential oils and Aromatics	4	72	4
	AC1923110	Advanced Synthetic Organic Chemistry	4	72	4
	AC1923111	Physical Chemistry	4	72	4
	AC1923112	Applied Molecular Spectroscopy	3	54	4
	AC1924604	Industrial Oil and Fat Products Practical	3	54	Evaluation at the end of fourth semester
	AC1924605	Essential Oils and Aromatics Practical	3	54	
	AC1924606	Fixed Oils and Fats Practical	4	72	
		Total		25	450
Semester 4	AC1924301	Industrial oil and Fat Products	5	90	4
	AC1924302	Biochemistry of Fatty Acids	5	90	4
	AC1924303	Advanced Applied Chemistry	5	90	4
	AC1924604	Industrial Oils and Fat Products Practical	3	54	3
	AC1924605	Essential Oils and Aromatics Practical	3	54	3
	AC1924606	Fixed Oils and Fats Practical	4	72	3
	AC1924801	Project			3
	AC1924901	Viva			2
	Total		25	450	26
Grand Total					80

DETAILED SYLLABUS OF ALL COURSES

SEMESTER I

Course	Details				
Code	AC1921101				
Title	ORGANOMETALLICS AND BIOINORGANIC CHEMISTRY				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	1/I				
Type	Core Course				
Credits	4	Hrs/Week	4	Total Hours	72

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Demonstrate knowledge of advanced content in the areas of inorganic chemistry such as in organometallic compounds, bioinorganic compounds and nuclear chemistry.	U	1,3
2	Rationalize the synthesis, structure, bonding, properties and reactivity of organometallic compounds.	An	3
3	Recognize different types of catalytic processes and industrially important organometallic polymers.	An	4,
4	Analyze the chemical and physical properties of metal ions responsible for their biochemical action as well as the techniques frequently used in bioinorganic chemistry such as oxygen transport, e- transfer, communication, catalysis, transport, storage etc.	An	1, 3,
5	Evaluate the role of nuclear chemistry to find the most suitable measures, administrative methods and industrial solutions to ensure sustainable use of the world's nuclear resources.	An	3,
6	Integrate knowledge with critical thinking to solve problems.	Ap	2,

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	Organometallic Compounds-Synthesis, Structure and Bonding.	18	
1.1	Haptonomenclature of organometallic compounds. Organometallic compounds with linear pi donor ligands-olefins, acetylenes, dienes and allyl complexes-synthesis, structure and bonding.	4	1,2
1.2	Synthesis and structure of complexes with cyclic pi donors-metalloenes and cyclic arene complexes. Bonding in ferrocene and dibenzenechromium. Carbene and carbyne complexes.	4	1,2
1.3	Metal carbonyls: CO as a π -bonding ligand, synergism, preparation, properties, structure and bonding of simple mono and binuclear metal carbonyls, metal nitrosyls, metal cyanides and dinitrogen complexes. Polynuclear metal carbonyls with and without bridging. Carbonyl clusters-LNCCS and HNCCS, Isoelectronic and isolobal analogy, Wade-Mingos rules, cluster valence electrons. IR spectral studies of bridging and non-bridging CO-ligands.	10	1,2

2.0	Reactions of Organometallic Compounds	9	
2.1	Substitution reactions-nucleophilic ligand substitution, nucleophilic and electrophilic attack on coordinated ligands.	2	1,2
2.2	Addition and elimination reactions-1,2 additions to double bonds, carbonylation and decarbonylation. Oxidative addition- concerted addition, SN2 reactions and radical and ionic mechanisms. Reductive elimination- binuclear reductive elimination and σ -bond metathesis. Oxidative coupling and reductive decoupling. Insertion (migration) and elimination reactions – insertions of CO and alkenes, insertion into M–H versus M–R and α , β , γ and δ eliminations.	7	1,2
3.0	Industrially important catalytic processes and organometallic polymers	18	
3.1	Homogeneous and heterogeneous organometallic catalysis-alkene hydrogenation using Wilkinson catalyst, Tolman catalytic loops.	2	1,3,6
3.2	Reactions of carbon monoxide and hydrogen-the water gas shift reaction, the Fischer-Tropsch reaction(synthesis of gasoline).	2	1,3,6
3.3	Hydroformylation of olefins using cobalt and rhodium catalysts.	1	1,3,6
3.4	Polymerization by organometallic initiators and templates for chain propagation- Ziegler Natta catalysts. Polymerisation by metallocene catalysts.	2	1,3,6
3.5	Carbonylation reactions: Monsanto acetic acid process. Olefin hydroformylation: oxo process. Carbonylation of alkenes and alkynes in the presence of a nucleophile: the Reppe reaction. Carbonylation of aryl halides in the presence of a nucleophile.	2	1,3,6
3.6	Olefin methathesis-synthesis gas based reactions, photodehydrogenation catalyst (“Platinum Pop”).	2	1,3,6
3.7	Oxidation of olefins: Palladium catalysed oxidation of ethylene-the Wacker process.	2	1,3,6
3.8	Polymers with organometallic moieties as pendant groups, polymers with organometallic moieties in the main chain, condensation polymers based on ferrocene and on rigid rod polyynes, poly(ferrocenylsilane)s, applications of Poly(ferrocenylsilane)s and related Polymers, applications of Rigid-Rod Polyynes, Polygermanes and Polystannanes polymers prepared by ring opening polymerization, organometallic dendrimers.	5	1,3,6
4.0	Bioinorganic Compounds	18	
4.1	Essential and trace elements in biological systems, Toxic effects of metals (Cd, Hg, Cr and Pb, As), structure and functions of biological membranes, mechanism of ion transport across membranes, sodium pump, ionophores, valinomycin. Phosphate esters in biology, Redox metalloenzymes, cytochromes-cytochrome P450.	5	1,4
4.2	Oxygen carriers and oxygen transport proteins-Structure and functions of haemoglobins and myoglobin. Oxygen transport mechanism, cooperativity, Bohr effect. Structure and functions of haemerythrins, haemocyanin.	3	1,4
4.3	Biochemistry of zinc and copper, structure and functions of carbonic anhydrase, carboxypeptidase A and superoxide dismutase.	3	1,4

4.4	Other important metal containing biomolecules, vitamin B12 and the vitamin B12 coenzymes, Photosynthesis-chlorophyll a, PS I and PS II.	3	1,4
4.5	Role of calcium in muscle contraction, blood clotting mechanism and biological calcification. Metals in medicine-therapeutic applications of cis-platin, radio-isotopes and MRI agents.	4	1,4
5.0	Nuclear Chemistry	9	
5.1	Radioactive decay- α , β and γ , nuclear isomerism & isomeric transition, internal conversion, Augerelectrons and Auger effect.	1	1,5,6
5.2	Nuclear Reactions- Q value and reaction threshold, reaction cross section, cross section and reaction rate, neutron capture cross section- variation of neutron capture cross section with energy (1/V law). Nuclear fission and fusion reactions- fission fragments and mass distribution, fission yields, fission energy, fission cross section and threshold fission neutrons, nuclear fusion reactions and their applications.	2	1,5,6
5.3	Principles of counting technique such as G.M. counter, proportional, ionization and scintillation counters. Cloud chamber.	1	1,5,6
5.4	Synthesis of transuranic elements such as Neptunium, Plutonium, Curium, Berkelium, Einsteinium, Mendelevium, Nobelium, Lawrencium and elements with atomic numbers 104 to 109.	1	1,5,6
5.5	Analytical applications of radioisotopes-radiometric titrations, kinetics of exchange reactions, measurement of physical constants including diffusion constants, Radioanalysis, Neutron Activation Analysis, Prompt Gama Neutron Activation Analysis and Neutron Absorptiometry.	2	1,5,6
5.6	Applications of radio isotopes in industry, medicine, autoradiography, radiopharmacology, radiation safety precaution, nuclear waste disposal. Isotope dilution analysis, determination of volume of blood in patients.	1	1,5,6
5.7	Radiation chemistry of water and aqueous solutions. Measurement of radiation doses. Relevance of radiation chemistry in biology, organic compounds and radiation polymerization.	1	1,5,6

References:

1. J.E. Huheey, E.A. Keiter, R.L. Keiter, Inorganic Chemistry Principles of Structure and Reactivity, 4thEdn., Harper Collins College Publishers,1993.
2. F.A. Cotton, G Wilkinson, C.A. Murillo, M. Bochmann, Advanced Inorganic Chemistry, 6th edition, Wiley-Interscience, 1999.
3. K.F. Purcell, J.C. Kotz, Inorganic Chemistry, Holt-Saunders, 1977.
4. P. Powell, Principles of Organometallic Chemistry, 2nd Edn., Chapman and Hall, 1988.
5. B.E. Douglas, D.H. McDaniel, J. J. Alexander, Concepts and Models of Inorganic Chemistry, 3rd Edn., Wiley-India, 2007.
6. B.D. Gupta, A.J Elias, Basic Organometallic Chemistry, Universities Press, 2010.
7. R.W. Hay, Bio Inorganic Chemistry, Ellis Horwood, 1984.
8. SumitBhaduri, DobleMukesh, Homogeneous Catalysis: Mechanism and Industrial Applications, Wiley Interscience, 2000.
9. Astruc, D.; Organometallic Chemistry and Catalysis, Springer Verlag, 2007.

10. Robert H. Crabtree, *The Organometallic Chemistry of the Transition Metals*, 4th Edn., Wiley Interscience, 2005.
11. R. M. Roat-Malone, *Bioinorganic Chemistry A Short Course*, Wiley Interscience, 2007.
12. Robert R. Crichton, *Biological Inorganic Chemistry A New Introduction to Molecular Structure and Function*, Elsevier, 2012.
13. H.J. Arnikar, *Essentials of Nuclear Chemistry*, Wiley Eastern, 1982.
14. S.N. Goshal, *Nuclear Physics*, S. Chand and Company, 2006.

Course	Details				
Code	AC1921102				
Title	INTRODUCTION TO PHYSICAL ORGANIC CHEMISTRY AND STEREOCHEMISTRY				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	1/I				
Type	Core Course				
Credits	4	Hrs/Week	4	Total Hours	72

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	To describe and analyse the organic reactions by physical methods	Ap	1
2	Understand and analyse reactions based on stereochemical aspects and applications	An	1 2
3	To acquaint the student with conformational aspects, to understand and analyse photochemical reactions	C	1
4	To understand the organic reaction mechanisms	AP	4
5	To analyse the photochemistry of organic compounds	Ap	3

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	Physical Organic Chemistry	9	
1.1	Energy profiles. Kinetic versus thermodynamic control of product formation, Hammond postulate, kinetic isotope effects with examples. Linear free energy relationships-Hammet equation, Taft equation.	3	1
1.2	Catalysis by acids,bases and nucleophiles with examples from acetal, cyanohydrin.Ester formation and hydrolysis reactions of esters-AAC2, AAC1, AAL1, BAC2and BAL1 mechanisms. Hard and soft acids, bases - HSAB principle and its applications (organic reactions only)	6	1
2.0	Stereochemistry of Organic Compounds	18	
2.1	Introduction to molecular symmetry and chirality: examples from common objects to molecules. Axis, plane, center, alternating axis of symmetry.	3	2
2.2	Center of chirality: Molecules with C, N, S based chiral centers, absolute configuration, enantiomers, racemic modifications, R and S nomenclature using Cahn-Ingold-Prelog rules, molecules with a chiral center and Cn, molecules with more than one center of chirality, definition of diastereoisomers, constitutionally symmetrical and unsymmetrical chiral molecules, erythro and threo nomenclature.	3	2
2.3	Axial, planar and helical chirality with examples, stereochemistry and absolute configuration of allenes, biphenyls and binaphthyls, ansa and cyclophanic compounds, spiranes, exo-cyclic alkylidene	3	2

	cycloalkanes.		
2.4	Topicity and prostereoisomerism, topicity of ligands and faces as well as their nomenclature, NMR distinction of enantiotopic/diastereotopic ligands.	3	2
2.5	Geometrical isomerism: nomenclature, E-Z notation, methods of determination of geometrical isomers, interconversion of geometrical isomers.	3	2
2.6	Stereoisomerism: definition based on symmetry and energy criteria, configuration and conformational stereoisomers.	3	2
3.0	Conformational Analysis	18	
3.1	Conformational descriptors : Factors affecting conformational stability of molecules, conformational analysis of substituted ethanes, cyclohexane and its derivatives, decalins, adamantane, congressane, norbornane, sucrose and lactose.	6	3
3.2	Conformation and reactivity of elimination (dehalogenation, dehydrohalogenation, semipinacolic deamination and pyrolytic elimination - Saytzeff and Hofmann eliminations), substitution and oxidation of 2° alcohols.	9	3
3.3	Chemical consequence of conformational equilibrium - Curtin Hammett principle.	3	3
4.0	Organic Reaction Mechanisms	18	
4.1	Review of organic reaction mechanisms with special reference to nucleophilic and electrophilic substitution at aliphatic carbon (SN1, SN2, SNi, SE1, SE2), elimination (E1 and E2) and addition reactions (regioselectivity: Markovnikov's addition-carbocation mechanism, anti-Markovnikov's addition-radical mechanism). Elimination vs substitution.	6	4
4.2	A comprehensive study on the effect of substrate, reagent, leaving group, solvent and neighbouring group on nucleophilic substitution (SN2 and SN1) and elimination (E1 and E2) reactions.	3	4
4.3	Concept of aromaticity: Delocalization of electrons - Hückel's rule, criteria for aromaticity, examples of neutral and charged aromatic systems - annulenes. NMR as a tool, carbon nanotubes and grapheme. Mechanism of electrophilic and nucleophilic aromatic substitution reactions with examples. Arenium ion intermediates. SN1, SNAr, SRN1 and benzyne mechanisms	9	4
5.0	Photoreactions of Functional Groups	9	
5.1	Photoreactions of carbonyl compounds: Norrish reactions of ketones. Paterno-Buchi reaction. Barton (nitrite ester reaction); Di- π -methane, oxa-di- π -methane and Photo Fries rearrangements, photochemistry of butadiene	9	5

References:

1. R. Bruckner, *Advanced Organic Chemistry: Reaction Mechanisms*, Academic Press, 2002.
2. F.A. Carey, R.A. Sundberg, *Advanced Organic Chemistry, Part A: Structure and Mechanisms*, 5thEdn., Springer, 2007.
3. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, Oxford University Press, 2004.
4. T.H. Lowry, K.S. Richardson, *Mechanism and Theory in Organic Chemistry*, 2ndEdn., Harper & Row, 1981.
5. N.S. Isaacs, *Physical Organic Chemistry*, ELBS/Longman, 1987.
6. D. Nasipuri, *Stereochemistry of Organic Compounds: Principles and Applications*, 3rdEdn., New Age Pub., 2010.
7. D.G. Morris, *Stereochemistry*, RSC, 2001.
8. E.L. Eliel, S.H. Wilen, *Stereochemistry of Organic Compounds*, John Wiley & Sons, 1994.
9. N.J. Turro, V. Ramamurthy, J.C. Scaiano, *Principles of Molecular Photochemistry: An Introduction*, University Science books, 2009.
10. N.J. Turro, *Modern Molecular Photochemistry*, Benjamin Cummings, 1978.
11. K.K.R. Mukherjee, *Fundamentals of Photochemistry*, New Age Pub., 1978.
12. Jerry March, *Advanced Organic Chemistry: Reactions, Mechanisms, and Structure*
13. *Nature Chemistry*, Vol 10, 2018, pp 618 – 624.

Course	Details				
Code	AC1921103				
Title	APPLIED QUANTUM MECHANICS AND GROUP THEORY				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	1/I				
Type	Core Course				
Credits	4	Hrs/Week	4	Total Hours	72

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
1	Understand and Familiarize with the main aspects of the historical development of quantum mechanics and understand the central concepts and principles in quantum mechanics	U	1,3
2	Solve the Schrödinger equation for simple systems in one to three dimensions	An	1,3
3	Understand the concepts of angular momentum and spin, as well as the rules for quantization and addition of these.	U	1,3
4	Evaluate symmetry elements in a molecule and classify molecules into point groups	E, An	1, 3
5	Apply group theoretical rules to derive group multiplication tables, matrix representations, classes, character tables of point groups	Ap	1, 3
6	Apply group theory to analyze vibration, Raman spectra and electronic spectra of polyatomic molecules.	Ap, An	1, 3

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	Foundation of Quantum Mechanics	9	
1.1	Historical background: Blackbody Radiation, Photoelectric effect, Compton effect, Hydrogen atom spectra, Matter waves	2	1
1.2	Operators: Linear operators, eigen functions and eigen values, commutation and non-commutation, construction of operators, normalization concept, Hermitian operators.	3	1
1.3	Postulates of quantum mechanics, time independent and time dependent Schrödinger equation.	3	1
1.4	Evolution of states, Uncertainty principle, Characteristics of wavefunction	1	1
2.0	Application of Schrödinger's Equations to Exactly Solvable Model Problems	22	
2.1	Translational motion: free particle in one-dimension.	2	2
2.2	Penetration into and through barriers: infinitely thick potential well, barrier of finite width	2	2
2.3	Particle in a box: one-dimensional box, particle in a three dimensional box- separation of variables, degeneracy.	4	2

2.4	Vibrational motion: one-dimensional harmonic oscillator (complete treatment), Hermite equation(solving by method of power series), Hermite polynomials, recursion relation, wave functions and energies	4	2
2.5	Rotational motion: Particle on a ring and its solution	2	2
2.6	Non-planar rigid rotor (or particle on a sphere) and their solutions, Legendre and associated Legendre equations, Legendre and associated Legendre polynomials. Spherical harmonics (imaginary and real forms)	4	2
2.7	Hydrogen-like Atoms: Schrodinger equation and its solutions, wave functions and energies of hydrogen-like atoms. Probabilities and radial distribution functions, atomic orbitals, degeneracy.	4	2
3.0	Angular momentum	5	
3.1	Quantization of angular momentum, quantum mechanical operators corresponding to angular momenta (L_x , L_y , L_z and L^2),	2	3
3.2	Commutation relations between these operators, shift operators, eigenvalues of angular momentum, Spin: Spin orbitals, construction of spin orbitals from orbitals and spin functions.	3	3
4.0	Molecular symmetry and group theory	27	4,5
4.1	Symmetry elements, symmetry operations, point groups and their symbols, sub groups, classes, abelian and cyclic groups, group multiplication tables-classes in a group and similarity transformation.	5	4,5
4.2	Matrices: addition and multiplication of matrices, inverse and orthogonal matrices, character of a matrix, block diagonalization, matrix representation of symmetry operations, representation of groups by matrices, construction of representation using vectors and atomic orbitals as basis, representation generated by cartesian coordinates positioned on the atoms of a molecule (H_2O and SO_2 as examples).	10	5
4.3	Reducible and irreducible representations-construction of irreducible representation by standard reduction formula. Statement of Great Orthogonality Theorem (GOT). Properties of irreducible representations. Construction of irreducible representation using GOT-construction of character tables for C_{2v} , C_{2h} , C_{3v} , C_3 and C_{4v} . Direct product of representations.	12	5
5.0	Application of Group Theory in Spectroscopy	9	6
5.1	Applications in vibrational spectra: transition moment integral, vanishing of integrals, symmetry aspects of molecular vibrations, vibrations of polyatomic molecules-selection rules for vibrational absorption. Determination of the symmetry of normal modes of H_2O , Trans- N_2F_2 and NH_3 using Cartesian coordinates and internal coordinates. Complementary character of IR and Raman spectra-determination of the number of active IR and Raman lines.	4	6
5.2	Application in electronic spectra: types of electronic transitions in organic molecules, transition moment integral, vanishing of integrals, term symbols, selection rules for electronic transition, electronic transitions due to the carbonyl chromophore in formaldehyde and π - π^* electronic transition in benzene.	5	6

Course texts:

1. P.W. Atkins, R.S. Friedman, Molecular Quantum Mechanics, 4th Edn., Oxford University Press, 2005.
2. F.A. Cotton, Chemical Applications of Group Theory, 3rd Edn., Wiley Eastern, 1990.
3. A.S. Kunju, G. Krishnan, Group Theory and its Applications in Chemistry, PHI Learning, 2010
4. R. Ameta, Symmetry and Group Theory in Chemistry, New Age International, 2013

References:

1. I.N. Levine, Quantum Chemistry, 6th Edn., Pearson Education Inc., 2009.
2. D.A. McQuarrie, Quantum Chemistry, University Science Books, 2008.
3. J.P. Lowe, K Peterson, Quantum Chemistry, 3rd Edn., Academic Press, 2006.
4. T. Engel, Quantum Chemistry and Spectroscopy, Pearson Education, 2006.
5. H. Metiu, Physical Chemistry: Quantum Mechanics, Taylor & Francis, 2006.
6. L. H. Hall, Group Theory and Symmetry in Chemistry, McGraw Hill, 1969
7. V. Ramakrishnan, M.S. Gopinathan, Group Theory in Chemistry, Vishal Publications, 1992.
8. S. Swarnalakshmi, T. Saroja, R.M. Ezhilarasi, A Simple Approach to Group Theory in Chemistry, Universities Press, 2008.
9. S.F.A. Kettle, Symmetry and Structure: Readable Group Theory for Chemists, 3rd Edn., Wiley, 2007.
10. A Vincent, Molecular Symmetry and Group Theory: A Programmed Introduction to Chemical Applications, 2nd Edn., Wiley, 2000.

Course	Details				
Code	AC1921104				
Title	EQUILIBRIUM THERMODYNAMICS				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	1/I				
Type	Core Course				
Credits	3	Hrs/Week	3	Total Hours	54

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Understand the concepts of classical and statistical thermodynamics	U	1
2	Analyze the macroscopic properties of matter using classical and statistical thermodynamics	An	1, 3
3	Relate microscopic and macroscopic properties using classical and statistical thermodynamics	An	1, 3
4	Calculate change in thermodynamic properties and absolute values of thermodynamic quantities and equilibrium constants	Ap	1, 3
5	Analyze the thermodynamic properties of biological systems	An	1, 3

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	Thermodynamics of ideal systems	9	1,2,3,4
1.1	Brief review on the basic concepts in thermodynamics: First law of thermodynamics (work, heat, energy, internal energy, enthalpy: definition), State and path functions and their significance.	1	1,2,3
1.2	Second law of thermodynamics: Entropy (basic concept, definition) Clausius inequality, variation of entropy with T,P,V	3	1,2,4
1.3	Helmholtz energy, Gibbs energy, Criterion for spontaneity, Maxwell relations and its significance, Fundamental equations, variation of G with T&P(Gibbs Helmholtz equation, applications of Gibbs Helmholtz equation).	5	1,2,3
2.0	Thermodynamics of non-ideal systems	16	1,2,4
2.1	Partial molar quantities, chemical potential and Gibbs-Duhem equations, determination of partial molar volume and enthalpy.	3	1,2,4
2.2	Fugacity, relation between fugacity and pressure, determination of fugacity of a real gas, variation of fugacity with temperature and pressure. Activity (solute, solvent, ideal dilute solution), dependence of activity on temperature and pressure.	3	1,2,4
2.3	Thermodynamics of mixing (entropy of mixing & free energy of mixing), Margules relations, excess thermodynamic functions-free energy, enthalpy, entropy and volume. Determination of excess enthalpy and volume.	3	1,2,4
2.4	Chemical affinity and thermodynamic functions, equilibrium	4	1,2,4

	constant- for ideal gas, general equation, relation connecting K with various TD variables, effect of temperature and pressure on chemical equilibrium- Van Hoff equation.		
2.5	Third law of thermodynamics, Nernst heat theorem, determination of absolute entropies using third law, entropy changes in chemical reactions.	3	1,2,4
3.0	Thermodynamics of biological systems	2	1,2,4,5
3.1	Coupled reactions, ATP and its role in bioenergetics, high energy bond, free energy and entropy change in ATP hydrolysis, thermodynamic aspects of metabolism and respiration, glycolysis, biological redox reactions.	2	1,2,4,5
4.0	Fundamentals of Statistical Mechanics	23	1,2,3,4
4.1	Mathematical Preliminaries: Basic probability theory: fundamental counting principle, permutations, configurations, binomial probabilities, Stirling's approximation	3	1,2,3
4.2	Probability distribution functions, Probability distribution involving discrete and continuous variable, Characterizing distribution functions: Average value, distribution moments, variance.	4	1,2,3,4
4.3	Boltzmann distribution: microstates and configuration, Derivation of Boltzmann distribution, Physical meaning of the Boltzmann distribution law, Definition of beta.	3	1,2,3
4.4	Ensemble: Canonical ensemble, relating q to Q for an ideal gas, translation partition function, rotational partition function: diatomic and polyatomic, Vibrational partition function, equipartition theorem, Electronic partition function.	4	1,2,3
4.5	Thermodynamic information in the partition function: Energy, heat capacity, entropy, Helmholtz energy, enthalpy, Gibbs energy	4	1,2,3
4.6	Quantum statistics: Indistinguishable particles and quantum statistics, Bose-Einstein statistics, Fermi-Dirac statistics.	2	1,2,3
4.7	Fundamental concepts and Postulates of statistical mechanics: Phase space and trajectory, Time average equals ensemble average, equal a priori probability, ergodic hypothesis, measure of ergodicity, Liouville theorem and Liouville equation, phase space density, Hamilton's equation of motion	3	1,2,3
5.0	Computer simulation methods in statistical mechanics	4	1,2,3
5.1	Monte Carlo simulations: Importance sampling, Metropolis method	2	1,2,3
5.2	Molecular Dynamics simulations: Force calculation, Integrating equations of motion: Verlet algorithm, Velocity Verlet algorithm	2	1,2,3

Course Texts:

1. P.W. Atkins, Physical Chemistry, Oxford University press, 8th edition
2. Thomas Engel and Philip Reid, Thermodynamics, Statistical Thermodynamics & Kinetics, Pearson (4th Edition), 2018
3. Mark Tuckerman, Statistical Mechanics: Theory and Molecular Simulation, Oxford university Press, 2010.

References:

1. A.M Glazer, J. S Wark, Statistical Mechanics: A survival guide, Oxford University Press (1st edition), 2001.
2. J. Rajaram, J.C. Kuriakose, Thermodynamics, S Chand and Co., 1999.
3. K.J. Laidler, J.H. Meiser, B.C. Sanctuary, Physical Chemistry, 4th Edn., Houghton Mifflin, 2003.
4. L.K. Nash, Elements of Classical and Statistical Mechanics, 2nd Edn., Addison Wesley, 1972.
5. D.A. McQuarrie, J.D. Simon, Physical Chemistry: A Molecular Approach, University Science Books, 1997
6. Kalidas, M.V. Sangaranarayanan, Non-equilibrium Thermodynamics, Macmillan India, 2002.
7. R.K. Murray, D.K. Granner, P. A. Mayes, V.W. Rodwell, Harper's Biochemistry, Tata McGraw Hill, 1999.
8. Tinoco, K. Sauer, J.C. Wang, J.D. Puglisi, Physical Chemistry: Principles and Applications in Biological Science, Prentice Hall, 2002
9. F.W. Sears, G.L. Salinger, Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Addison Wesley, 1975.
10. J. Kestin, J.R. Dorfman, A Course in Statistical Thermodynamics, Academic Press, 1971.

Course	Details				
Code	AC1922601				
Title	INORGANIC CHEMISTRY PRACTICAL-I				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	1/I&II				
Type	Practical				
Credits	3	Hrs/Week	3	Total Hours	54

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Understanding of major concepts, theoretical principles and experimental findings in chemistry	U	1
2	Develop advanced laboratory skills used in inorganic synthesis including spectroscopic and analytical techniques for identification and characterization of inorganic molecules	Ap	4
3	Application of safety and chemical hygiene regulations and practices.	Ap	3

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	Separation and identification of two less familiar metal ions	54	
1.1	Separation and identification of two less familiar metal ions such as Tl, W, Se, Mo, Ce, Th, Ti, Zr, V, U and Li. (Anions which need elimination not to be given. Minimum eight mixtures to be given.)	54	1,2,3
2.0	Colorimetric Estimation of Metal Ions	27	
2.1	Colorimetric estimation of Fe, Cu, Ni, Mn, Cr, NH ₄ ⁺ , nitrate and phosphate ions.	27	1,2,3
3.0	Preparation and Characterization of Metal Complexes	27	
3.1	Preparation and characterization complexes using IR, NMR and electronic spectra. (a) Tris (thiourea)copper(I) complex (b) Potassium tris (oxalate) aluminate (III). (c) Hexammine cobalt (III) chloride. (d) Tetrammine copper (II) sulphate. (e) Schiff base complexes of various divalent metal ions.	27	1,2,3

References:

1. A.I. Vogel, G.Svehla, Vogel's Qualitative Inorganic Analysis, 7thEdn., Longman,1996.
2. A.I. Vogel, A Text Book of Quantitative Inorganic Analysis, Longman,1966.
3. I.M. Koltoff, E.B. Sandell, Text Book of Quantitative Inorganic Analysis, 3rdEdn.,McMillian, 1968.
4. V.V. Ramanujam, InorganicSemimicro Qualitative Analysis, The NationalPub.Co., 1974.

Course	Details				
Code	AC1922602				
Title	ORGANIC CHEMISTRY PRACTICAL-I				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	1/I&II				
Type	Practical				
Credits	3	Hrs/Week	3	Total Hours	54

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Qualitatively separate the organic components	An	3
2	Provide hands on experience in the preparation of TLC, column chromatography	An	3
3	Develop skills in separating techniques	C	3
4	Acquire advanced knowledge in chemical drawing	C	4

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	PART I	27	
1.1	General methods of separation and purification of organic compounds such as: Solvent extraction, Soxhlet extraction, Fractional crystallization	07	1,4
1.2	TLC and Paper Chromatography Column Chromatography Membrane Dialysis	20	
2.0	PART II	54	
2.1	Separation of Organic binary mixtures by chemical/solvent separation methods	24	3,4
2.2	Separation of organic mixtures by TLC	10	3,4
2.3	Separation/ purification of organic mixtures by column chromatography	10	3,4
2.4	Test for detection of rosin in soaps. Estimation of rosin in soaps	10	3,4

3.0	PART III	27	
3.1	Drawing the structures of organic molecules and reaction schemes by ChemDraw, Symyx Draw and Chems sketch.	10	1,4
3.2	Draw the structures and generate the IR and NMR spectra of the substrates and products in the following reactions: Cycloaddition of diene and dienophile (Diels-Alder reaction) Oxidation of primary alcohol to aldehyde and then to acid Benzoin condensation Esterification of simple carboxylic acids Aldol condensation	17	1,4

References:

1. A.I. Vogel, A Textbook of Practical Organic Chemistry, Longman, 1974.
2. A.I. Vogel, Elementary Practical Organic Chemistry, Longman, 1958.
3. F.G. Mann, B.C Saunders, Practical Organic Chemistry, 4th Edn., Pearson Education India, 2009.
4. R. Adams, J.R. Johnson, J.F. Wilcox, Laboratory Experiments in Organic Chemistry, Macmillan, 1979.

Course	Details				
Code	AC1922603				
Title	PHYSICAL CHEMISTRY PRACTICAL				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	1/I & II				
Type	Practical				
Credits	3	Hrs/Week	4	Total Hours	72

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Interpret data from various experiments, including the construction of appropriate graphs and evaluation of errors.	An	3, 4
2	Quantitatively analyze the extent of adsorption of liquids by solids.	An	1
3	Understand the concept of surface forces in various liquids and the effect of reaction conditions on it.	An	3
4	Apply the terms of phase diagrams in binary and tertiary systems which are used in material science and engineering field.	Ap	1
5	Develop skills in applying the distribution law for various solutes between different appropriate solvent pairs in liquid phase chemical reactions.	C	3
6	Compare and apply theoretical approaches such as HF, MP2, DFT in stimulating various scientific problems and calculating various properties of molecules using Gaussian 09	C	3

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	Adsorption	12	1,2
1.1	Verification of Freundlich and Langmuir adsorption isotherm: charcoal-acetic acid or charcoal-oxalic acid system.	6	1,2
1.2	Determination of the concentration of the given acid using the isotherms.	6	1,2
2.0	Surface Tension	18	1,3
2.1	Determination of the surface tension of a liquid by a) Capillary rise method b) Drop number method c) Drop weight method	6	1,3
2.2	Determination of parachor values.	6	1,3
2.3	Determination of the composition of two liquids by surface tension measurements	6	1,3
3.0	Phase Diagrams	24	1,4
3.1	Construction of phase diagrams of simple eutectics.	6	1,4
3.2	.	6	1,4

	Construction of phase diagram of compounds with congruent melting point: diphenyl amine-benzophenone system.		
3.3	Effect of (KCl/succinic acid) on miscibility temperature.	6	1,4
3.4	Construction of phase diagrams of three component systems with one pair of partially miscible liquids.	6	1,4
4.0	Distribution Law	18	1,5
4.1	Distribution coefficient of iodine between an organic solvent and water.	6	1,5
4.2	Distribution coefficient of benzoic acid between benzene and water	6	1,5
4.3	Determination of the equilibrium constant of the reaction $KI + I_2 \leftrightarrow KI_3$	6	1,5
5.0	Computational Chemistry Experiments	72	1,5
5.1	Single point energy calculations	12	1,5
5.2	Geometry optimization calculations	12	1,5
5.3	3. Frequency calculations	12	1,5
5.4	Basis set effects	12	1,5
5.5	Predicting Ionization energy, electron affinity, proton affinity and atomization energies.	12	1,5
5.6	Studying chemical reactions and reactivity	12	1,5

References:

1. J.B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.
2. G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th Edn., McGraw Hill, 2009.
3. J.B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.
4. G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th Edn., McGraw Hill, 2009.
5. James B. Foresman and Aeleen Frisch, Exploring Chemistry With Electronic Structure Methods: A Guide to Using Gaussian, Gaussian, second edition, 1996
6. Gaussian 09, Revision A.02, M. J. Frisch *et al.*,

SEMESTER II

Course	Details				
Code	AC1922105				
Title	STRUCTURAL ASPECTS AND STEREOCHEMISTRY OF INORGANIC COMPLEXES				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	1/II				
Type	Core Course				
Credits	4	Hrs/Week	4	Total Hours	72

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Demonstrate knowledge of advanced content in the areas of inorganic chemistry such as in coordination compounds, its key features such as structure, bonding, stereochemistry, mechanism of reactions, kinetics, spectral and magnetic properties etc.	U	1
2	Categorize the structural aspects and bonding of coordination compounds.	An	4
3	Identify the influence of the strength of metal ligand bonds to the spectral and magnetic properties of metal complexes.	An	2
4	Analyze the kinetics and mechanism of reactions in metal complexes.	An	3, 4
5	Evaluate the stereo chemical aspects of coordination compounds.	E	2
6	Integrate knowledge with different types of coordination compounds of lanthanoids and actinoids.	Ap	2

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	Structural Aspects and Bonding	18	
1.1	Classification of complexes based on coordination numbers and possible geometries. Sigma and pi bonding ligands such as CO, NO, CN ⁻ , R ₃ P, and Ar ₃ P. Stability of complexes, thermodynamic aspects of complex formation-Irving William order of stability, chelate effect.	6	1,2
1.2	Splitting of d orbitals in octahedral, tetrahedral, square planar, square pyramidal and trigonalbipyramidal fields, LFSE, Dq values, Jahn Teller (JT) effect, theoretical failure of crystal field theory, evidence of covalency in the metal-ligand bond, nephelauxetic effect, ligand field theory, molecular orbital theory- M.O energy level diagrams for	12	1,2

	octahedral and tetrahedral complexes without and with π -bonding, experimental evidences for pi-bonding.		
2.0	Spectral and Magnetic Properties of Metal Complexes	18	
2.1	Electronic Spectra of complexes-Term symbols of dn system, Racah parameters, splitting of terms in weak and strong octahedral and tetrahedral fields. Correlation diagrams for d1 and d9 ions in octahedral and tetrahedral fields (qualitative approach), d-d transition, selection rules for electronic transition-effect of spin orbit coupling and vibronic coupling.	6	1,3
2.2	Interpretation of electronic spectra of complexes-Orgel diagrams, demerits of Orgel diagrams, Tanabe- Sugano diagrams, calculation of Dq, B and β (Nephelauxetic ratio) values, spectra of complexes with lower symmetries, charge transfer spectra, luminescence spectra.	4	1,3
2.3	Magnetic properties of complexes-paramagnetic and diamagnetic complexes, molar susceptibility, Gouy method for the determination of magnetic moment of complexes, spin only magnetic moment. Temperature dependence of magnetism- Curie's law, Curie-Weiss law. Temperature Independent Paramagnetism (TIP), Spin state cross over, Antiferromagnetism-inter and intra molecular interaction. Anomalous magnetic moments.	8	1,3
3.0	Kinetics and Mechanism of Reactions in Metal Complexes	18	
3.1	Thermodynamic and kinetic stability, kinetics and mechanism of nucleophilic substitution reactions in square planar complexes- trans effect-theory and applications, effect of entering ligand, effect of leaving group and effect of ligands already present on reaction rate, effect of solvent and reaction pathways. Substitution in tetrahedral and five-coordinate complexes.	6	1,4
3.2	Kinetics and mechanism of octahedral substitution- water exchange, dissociative and associative mechanisms, base hydrolysis, racemization reactions, solvolytic reactions (acidic and basic). Replacement reactions involving multidentate ligands- The formation of chelates, effect of H ⁺ on the rates of substitution of chelate complexes, metal ion assisted and ligand assisted dechelation.	6	1,4
3.3	Electron transfer reactions: outer sphere mechanism-Marcus theory, inner sphere mechanism-Taube mechanism. Mixed outer and inner sphere reactions. Two electron transfer and intramolecular electron transfer.	6	1,4
4.0	Stereochemistry of Coordination Compounds	9	
4.1	Geometrical and optical isomerism in octahedral complexes, resolution of optically active complexes, determination of absolute configuration of complexes by ORD and circular dichroism, stereoselectivity and conformation of chelate rings, asymmetric synthesis catalyzed by coordination compounds.	5	1,5
4.2	Linkage isomerism-electronic and steric factors affecting	4	1,5

	linkage isomerism. Symbiosis-hard and soft ligands, Prussian blue and related structures, Macrocycles-crown ethers.		
5.0	Coordination Chemistry of Lanthanoids and Actinoids	9	
5.1	Term symbols for lanthanide ions, Inorganic compounds and coordination complexes of the lanthanoids- halides, oxides and hydroxides, 3, 5, 6, 7, 8 and 9, 10, 11 and 12-coordinate complexes of lanthanoids. Electronic spectra and magnetic properties of lanthanoid complexes. Organometallic complexes of the lanthanoids- σ -bonded complexes, cyclopentadienyl complexes, organolanthanoid complexes as catalysts.	5	1,6
5.2	General characteristics of actinoids-difference between 4f and 5f orbitals, coordination complexes of the actinoids-sandwich complexes, coordination complexes and organometallic compounds of thorium and uranium. Comparative account of coordination chemistry of lanthanoids and actinoids with special reference to electronic spectra and magnetic properties.	4	1,6

References:

1. F.A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry: A Comprehensive Text, 3rd Edn., Interscience, 1972.
2. J.E. Huheey, E.A. Keiter, R.A. Keiter, Inorganic Chemistry Principles of Structure and Reactivity, 4th Edn., Pearson Education India, 2006.
3. K.F. Purcell, J.C. Kotz, Inorganic Chemistry, Holt-Saunders, 1977.
4. F. Basolo, R.G. Pearson, Mechanisms of Inorganic Reaction, John Wiley & Sons, 2006.
5. B.E. Douglas, D.H. McDaniel, J.J. Alexander, Concepts and Models of Inorganic Chemistry, 3rd Edn., Wiley-India, 2007.
6. R.S. Drago, Physical Methods in Chemistry, Saunders College, 1992.
7. B.N. Figgis, M.A. Hitchman, Ligand Field Theory and its Applications, Wiley-India, 2010.
8. J.D. Lee, Concise Inorganic Chemistry, 4th Edn., Wiley-India, 2008
9. R. G. Wilkins, Kinetics and Mechanisms of Reactions of Transition Metal Complexes, Wiley VCH, 2002.
10. G. A. Lawrance, Introduction to Coordination Chemistry, John Wiley & Sons Ltd, 2010.
11. E. Housecroft, A. G. Sharpe, Inorganic Chemistry, Pearson, 2012.

Course	Details				
Code	AC1922106				
Title	CHEMISTRY OF REACTIVE INTERMEDIATES AND REACTION MECHANISMS				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	1/II				
Type	Core Course				
Credits	4	Hrs/Week	4	Total Hours	72

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Remember basic concepts and apply	Ap	2
2	To understand and analyse the chemistry of reactive intermediates	An	1
3	Describe the chemistry of carbonyl compounds	C	3
4	Understand Concerted reactions and evaluate	U	4

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	Chemistry of Carbanions and applications of basic concepts	18	
1.1	Formation, structure and stability of carbanions; Reactions of carbanions: C-X bond (X = C, O, N) formations through the intermediary of carbanions. Chemistry of enolates and enamines. Kinetic and Thermodynamic enolates- lithium and boron enolates in aldol and Michael reactions, alkylation and acylation of enolates.	3	2
1.2	Nucleophilic additions to carbonyls groups: Name reactions under carbanion chemistry-mechanism of Claisen, Dieckmann, Knoevenagel, Stobbe, Darzen and acyloin condensations, Shapiro reaction and Julia elimination. Favorski rearrangement.	6	2
1.3	Ylids: chemistry of phosphorous and sulphyrylids - Wittig and related reactions, Peterson olefination.	3	1
1.4	Problems based on bonding, inductive effect, electromeric effect, resonance effect, hyperconjugation, steric effect, H bonding.	6	1
2.0	Chemistry of Carbocations and Free Radicals	18	
2.1	Formation, structure and stability of carbocations. Classical and non-classical carbocations.C-X bond (X = C, O, N) formations through the intermediary of carbocations. Molecular rearrangements including Wagner-Meerwein, Pinacol-pinacolone, Semi-pinacol, Dienone-phenol and Benzilic acid rearrangements, Noyori annulation, Prins reaction.C-C bond formation involving carbocations: Oxymercuration, Halolactonisation.	9	2
2.2	Generation of radical intermediates and its (a) addition to alkenes, alkynes (inter and intramolecular) for C-C bond formation - Baldwin's rules (b) fragmentation and rearrangements - Hydroperoxide: formation, rearrangement and reactions. Autooxidation.Name reactions involving radical intermediates:	9	2

	Barton deoxygenation and decarboxylation, McMurry coupling		
3.0	Carbenes, Carbenoids, Nitrenes and Arynes	9	
3.1	Structure of carbenes (singlet and triplet), Generation of carbenes, Addition and Insertion reactions.	2	2
3.2	Reactions of carbenes such as Wolff rearrangement, Reimer-Tiemann reaction. Reactions of ylides by carbenoid decomposition	3	2
3.2	Structure, generation and reactions of nitrene and related electron deficient nitrene intermediates. Hoffmann, Curtius, Lossen, Schmidt and Beckmann rearrangement reactions.	2	2
3.3	Arynes: Generation, structure, stability and reactions. Orientation effect - amination of haloarenes	2	2
4.0	Chemistry of Carbonyl Compounds	9	
4.1	Reactions of carbonyl compounds: Oxidation, reduction (Clemmensen and Wolf-Kishner), addition (addition of cyanide, ammonia, alcohol) reactions, Aldol condensation, Cannizzaro reaction, Addition of Grignard reagent. Structure and reactions of α , β -unsaturated carbonyl compounds involving electrophilic and nucleophilic addition - Michael addition, Mannich reaction, Robinson annulation.	9	3
5.0	Concerted Reactions	18	
5.1	Classification - electrocyclic, sigmatropic, cycloaddition, chelotropic, ene and dyotropic reactions. Woodward Hoffmann rules - Frontier orbital and orbital symmetry correlation approaches - PMO method (for electrocyclic and cycloaddition reactions only).	3	4
5.2	Highlighting pericyclic reactions in organic synthesis such as Claisen, Cope, Wittig, Mislow-Evans and Sommelet-Hauser rearrangements. Diels-Alder and Ene reactions (with stereochemical aspects), dipolar cycloaddition (introductory).	6	4
5.3	Unimolecular pyrolytic elimination reactions: Chelotropic elimination, decomposition of cyclic azo compounds, β -eliminations involving cyclic transition states such as N-oxides (Cope reaction), Acetates and Xanthates (Chugaev reaction). Problems based on the above topics	9	4

References:

1. R. Bruckner, *Advanced Organic Chemistry: Reaction Mechanism*, Academic Press, 2002.
2. F.A. Carey, R.A. Sundberg, *Advanced Organic Chemistry, Part B: Reactions and Synthesis*, 5th Edn., Springer, 2007.
3. W. Carruthers, I. Coldham, *Modern Methods of Organic Synthesis*, Cambridge University Press, 2005.
4. J. March, M.B. Smith, *March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure*, 6th Edn., Wiley, 2007.
5. A. Fleming, *Frontier Orbitals and Organic Chemical Reactions*, Wiley, 1976.
6. S. Sankararaman, *Pericyclic Reactions-A Text Book*, Wiley VCH, 2005.
7. R.T. Morrison, R.N. Boyd, S.K. Bhattacharjee, *Organic Chemistry*, 7th Edn., Pearson, 2011.
8. J. Clayden, N. Greeves, S. Warren, P. Wothers, *Organic Chemistry*, Oxford University Press, 2004

Course	Details				
Code	AC1922107				
Title	ADVANCED QUANTUM MECHANICS AND MOLECULAR MODELING				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	1/II				
Type	Core Course				
Credits	4	Hrs/Week	4	Total Hours	72

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Understand different approximation techniques used in molecular quantum mechanics	Ap	1, 2
2	Identify and explain the main similarities and differences between computational approaches such as HF (Hartree-Fock), semi-empirical, DFT (Density Functional Theory) and force field methods.	Ap	1, 2
3	Describe and identify the various methods' advantages/disadvantages for simulating/modelling various scientific problems.	Ap	1, 2
4	Understand Quantum Mechanical and principles of Molecular Orbital theory, Hückel Molecular Orbital Theory, Valence bond theory and hybridization	U	1
5	Understand Group theoretical principles of Molecular Orbital theory, Valence bond theory and hybridization	U	1
6	Apply the concept of linear combination of atomic orbitals to produce Molecular Orbitals, Hückel Molecular Orbitals and hybrid orbitals to understand the molecular structure and geometry.	Ap	1, 2

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	Techniques of Approximation in Quantum Mechanics	10	1
1.1	Many-body problem and the need of approximation methods, independent particle model.	2	1
1.2	Variation method: variation theorem with proof	2	1
1.3	illustration of variation theorem using the trial function $\psi(a-x)$ for particle in a 1D-box and using the trial function e^{-ar} for the hydrogen atom	2	1
1.4	Perturbation method: time-independent perturbation method (non-degenerate case), first order correction to energy, illustration by application to particle in a 1D-box with slanted bottom	3	1
1.5	Perturbation treatment of the ground state of the helium atom.	1	1
2.0	Computational Chemistry	26	2,3
2.1	Introduction to computational chemistry: what you can do with computational chemistry, tools of computational chemistry.	1	2

2.2	Hartree-Fock Self-Consistent Field (HF-SCF) method (Derivation): Pauli's principle, Slater determinants, Coulomb and exchange Operators, Fock operator, Roothan-Hall equation.	5	2
2.3	Basis functions, Slater type orbitals (STO), Gaussian type orbitals (GTO), sketches of STO and GTO, Classification of basis sets - minimal, double zeta, triple zeta, split valence, polarization and diffuse basis sets, contracted basis sets, Pople style basis sets and their nomenclature, Hartree-Fock limit.	4	2,3
2.4	Electron correlation, Post Hartree-Fock methods: Qualitative ideas on Configuration Interaction(CI) and Møller Plesset approaches to electron correlation.	5	2,3
2.5	Semi-empirical methods: General introduction to semi-empirical methods: basic principles and terminology.	3	2,3
2.6	Introduction to Density Functional Theory (DFT) methods: Hohenberg-Kohn theorems. Kohn-Sham orbitals. Exchange correlation functional. Local density approximation.	4	2,3
2.7	Molecular mechanics methods: Basic principle, Force fields, potential energy functions, inter and intramolecular interactions, empirical parameters, basic idea of QM/MM methods	4	2,3
3.0	Computational Chemistry Calculations	9	3
3.1	Potential energy surface: stationary point, transition state or saddle point, local and global minima, geometry optimisation.	3	3
3.2	Molecular geometry input: cartesian coordinates and Z- matrix. Z-matrix of diatomic molecules, non-linear triatomic molecule, linear triatomic molecule, polyatomic molecules like ammonia.	3	3
3.3	Comparison and applications of Ab initio, DFT, Semi-empirical and Molecular mechanics methods.	3	3
4.0	Chemical Bonding	18	4,6
4.1	Brief review of Schrödinger equation for molecules and Born-Oppenheimer approximation. Valence Bond (VB) theory, VB theory of H ₂ molecule, singlet and triplet state functions (spin orbitals) of H ₂ .	4	4,6
4.2	Molecular Orbital (MO) theory, MO theory of H ₂ ⁺ ion, MO theory of H ₂ molecule, MO treatment of homonuclear diatomic molecules and hetero nuclear diatomic molecules. Comparison of MO and VB theories – ionic terms and configuration interaction. Bond order. Correlation diagrams, non-crossing rule. MOs of diatomic molecules – H ₂ , Li ₂ , B ₂ , C ₂ , N ₂ , O ₂ and F ₂ , paramagnetism of O ₂ .	7	4,6
4.3	Quantum mechanical treatment of sp, sp ² and sp ³ hybridization. Hückel Molecular Orbital (HMO) theory of ethene, allyl systems, butadiene and benzene. Calculation of charge distributions, bond orders and free valency.	7	4,6
5.0	Applications of Group Theory in Chemical Bonding	9	5,6
5.1	Projection operator, generation of SALCs, transformation properties of atomic orbitals, construction of hybrid orbitals with BF ₃ , CH ₄ , PCl ₅ as examples. Symmetry adapted linear combinations (SALC) of C _{2v} , C _{2h} , C ₃ , C _{3v} and D _{3h} point groups. MO diagram for water and ammonia.	9	5,6

Course Texts:

1. Molecular Quantum Mechanics, Peter Atkins and Ronald Friedman, Oxford University Press, 2005
2. Errol Lewar, Computational Chemistry: Introduction to theory and application of Molecular Quantum Mechanics, Second edition, Springer
3. Attila Szabo and Neil S. Ostlund, Modern Quantum Chemistry: Introduction to Advanced Electronic Structure Theory, Dover Books in Chemistry, 1996
4. D.A. McQuarrie, Quantum Chemistry, University Science Books, 2008.
5. A.S. Kunju, G. Krishnan, Group Theory and its Applications in Chemistry, PHI Learning, 2010

References:

1. I.N. Levine, Quantum Chemistry, 6th Edn., Pearson Education, 2009.
2. R.K. Prasad, Quantum Chemistry, 3rd Edn., New Age International, 2006.
3. F.A. Cotton, Chemical Applications of Group Theory, 3rd Edn., Wiley Eastern, 1990.
4. V. Ramakrishnan, M.S. Gopinathan, Group Theory in Chemistry, Vishal Publications, 1992.
5. J.H. Jensen, Molecular Modeling Basics, CRC Press, 2010.
6. F. Jensen, Introduction to computational chemistry, 2nd Edn., John Wiley & Sons, 2007.
7. Leach, Molecular Modelling: Principles and Applications, 2nd Edn., Longman, 2001.
8. J.P. Fackler Jr., L.R. Falvello (Eds.), Techniques in Inorganic Chemistry: Chapter 4, CRC Press, 2011.
9. C.J. Cramer, Essentials of Computational Chemistry: Theories and Models, 2nd Edn., John Wiley & Sons, 2004.

Course	Details				
Code	AC1922108				
Title	FUNDAMENTALS OF MOLECULAR SPECTROSCOPIC TECHNIQUES				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	1/II				
Type	Core Course				
Credits	3	Hrs/Week	3	Total Hours	54

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Understand the concepts of spectroscopy	U	1
2	Analyze the relationship between rotational, vibrational and electronic spectroscopy	An	1, 3
3	Understand and relate the concepts of NMR, EPR and Mossbauer spectroscopy	An	1, 3
4	Comprehend the relationship between quantum mechanics, group theory and spectroscopy	An	1, 3
5	Solve problems based on the theory of various spectroscopic techniques	An	1, 3

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	Basics of Spectroscopic Techniques	9	1,4,5
1.1	Brief review of Electromagnetic spectrum: nature of radiation, Maxwell's equations in free space and in isotropic nonmagnetic media, wave amplitude, angular frequency, phase, period, wavelength, wavenumber, wave vector, velocity of propagation, Black-body radiation, quantum theory of electromagnetic radiation, wave-particle duality, nature of photon – energy, rest mass, momentum, charge, spin, radiant energy, radiant energy density, radiant flux (power), radiant flux density, radiant intensity and radiance.	3	1,4,5
1.2	Radiation-matter interaction: basic concepts of absorption, emission, transmission, reflection, refraction, dispersion, polarization and scattering, absorption cross section, Einstein's coefficients, signal to noise ratio, natural line width, line broadening factors, Doppler broadening, time-dependent perturbation theory (no proof required) and its consequences in spectroscopy, transition moment integral, symmetry and selection rules, intensity of spectral lines, Born-Oppenheimer approximation, rotational, vibrational and electronic energy levels, radiative and non-radiative transitions, relaxation time.	6	1,4,5
2.0	Microwave spectroscopy	9	1,2,4,5
2.1	Microwave spectroscopy: classical description of molecular rotation, the rigid diatomic rotor – energy Eigen values and Eigen states, principal moments of inertia and classification (linear,	9	1,2,4,5

	symmetric tops, spherical tops and asymmetric tops), rotational transitions, selection rules, intensity of rotational lines, relative population of energy levels, derivation of J_{\max} , effect of isotopic substitution, calculation of intermolecular distance, general layout and working principle of a microwave spectrometer, spectrum of non-rigid rotors, rotational spectra of polyatomic molecules, Stark effect and its application, nuclear spin and electron spin interaction.		
3.0	Infrared spectroscopy	9	1,2,4,5
3.1	Infrared spectroscopy: Morse potential energy diagram, anharmonicity – electrical and mechanical, vibrational term values, fundamentals, overtones and hot bands, determination of force constants, diatomic vibrating rotator, break down of the Born-Oppenheimer approximation, effect of nuclear spin, general layout and working principle of an infrared spectrometer, vibrational spectra of polyatomic molecules, potential energy surfaces, normal modes of vibrations, local modes of vibrations, potential energy functions with more than one minimum, combination and difference bands, Fermi resonance, finger print region and group vibrations, principles of FTIR spectroscopy.	9	1,2,4,5
4.0	Raman and Electronic spectroscopy	18	1,2,4,5
4.1	Raman spectroscopy: scattering of light, classical theory of Raman spectrum, quantum theory of Raman spectrum, general layout and working principle of a Raman spectrometer, rotational and vibrational Raman spectrum, complementary nature of Raman and IR spectra, group theory and mutual exclusion principle, polarized and depolarized Raman lines, basic principles of resonance Raman spectroscopy.	6	1,2,4,5
4.2	Electronic spectroscopy: classical theory of electronic spectroscopy, quantum theory of electronic spectroscopy, general layouts and working principles of an absorption spectrometer and an emission spectrometer, term symbols, selection rules, oscillator strength of transitions, vibronic transitions, Franck-Condon principle, electronic spectra of polyatomic molecules, $n-\pi^*$ and $\pi-\pi^*$ transitions, Jablonski diagram, fluorescence and phosphorescence, free electron model of conjugated systems, bathochromic shift and hypsochromic shifts, theory of solvation and spectral shifts, fluorescence quenching, Förster-resonance energy transfer (FRET) – dipole-dipole approximation, Fermi-Golden rule, rate equation of energy transfer, orientation factor, Dexter energy transfer, electron transfer – Marcus classical and semiclassical theory.	8	1,2,4,5
4.3	Lasers – different types of lasers: solid state lasers – Ti:Sapphire, Nd:YAG and semiconductor lasers, gas lasers – helium-neon, argon ion and N_2 lasers. Cavity modes, continuous wave and pulsed lasers, Q-switching, mode locking, harmonic generation, Applications of lasers in spectroscopy: Single vibronic level fluorescence spectroscopy, Stark spectroscopy, cavity ring-down spectroscopy	4	
5.0	Resonance Spectroscopy	9	1,3,4,5
5.1	NMR spectroscopy: interaction between nuclear spin and applied magnetic field, nuclear energy levels (Hamiltonian and energy), population of energy levels, Larmor precession, Bloch equations and its solutions, Master equation and its implications, rotating	5	1,3,4,5

	frame of reference, relaxation methods, correlation function, spectral density function, magic angle spinning, chemical shift, theory of spin coupling		
5.2	EPR spectroscopy: electron spin in molecules, interaction with magnetic field, g factor, factors affecting g values, fine structure and hyperfine structure, Kramers' degeneracy, McConnell equation.	3	1,3,4,5
5.3	Mossbauer spectroscopy: working principle, chemical shift, factors determining chemical shift	1	1,3,4,5

References:

1. C.N. Banwell, E.M. McCash, Fundamentals of Molecular Spectroscopy, 4th Edn., Tata McGraw Hill, 1994.
2. J. M. Hollas, Modern spectroscopy, Wiley, 2014.
3. C. Harris, M. D. Bertolucci, Symmetry and Spectroscopy: An Introduction to Vibrational and Electronic Spectroscopy, Dover Books, 1989.
4. Principles of fluorescence spectroscopy, J. R. Lakowicz, Springer, 2006.
5. W. Kemp, NMR in chemistry-A Multinuclear Introduction, McMillan, 1986.
6. H. Friebolin, Basic One- and Two-Dimensional NMR-Spectroscopy, Wiley, 1993.
7. H. Gunther, NMR Spectroscopy, Wiley, 1995.
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9. N. Sathyanarayana, Introduction to Magnetic Resonance Spectroscopy ESR, NMR, NQR, IK International, 2009.
10. S. K. Dogra, H. S. Randhawa, Atomic and Molecular Spectroscopy, Pearson, 2014.
11. P.W. Atkins, Physical Chemistry, ELBS, 1994.
12. A. McQuarrie, J. D. Simon, Physical Chemistry: A Molecular Approach, University Science Books, 1997.
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Course	Details				
Code	AC1922601				
Title	INORGANIC CHEMISTRY PRACTICAL				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	1/I&II				
Type	Practical				
Credits	3	Hrs/Week	3	Total Hours	54

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
1	Upon completion of this course, the students will be able to: Understanding of major concepts, theoretical principles and experimental findings in chemistry	U	1,2
2	Develop advanced laboratory skills used in inorganic synthesis including spectroscopic and analytical techniques for identification and characterization of inorganic molecules	Ap	2
3	Application of safety and chemical hygiene regulations and practices.	Ap	3

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	Separation and identification of two less familiar metal ions	54	
1.1	Separation and identification of two less familiar metal ions such as Tl, W, Se, Mo, Ce, Th, Ti, Zr, V, U and Li. (Anions which need elimination not to be given. Minimum eight mixtures to be given.)	54	1,2,3
2.0	Colorimetric estimation of metal ions	27	
2.1	Colorimetric estimation of Fe, Cu, Ni, Mn, Cr, NH ₄ ⁺ , nitrate and phosphate ions.	27	1,2,3
3.0	Preparation and characterization of metal complexes	27	
3.1	Preparation and characterization complexes using IR, NMR and electronic spectra. (a) Tris (thiourea)copper(I) complex (b) Potassium tris (oxalate) aluminate (III). (c) Hexammine cobalt (III) chloride. (d) Tetrammine copper (II) sulphate. (e) Schiff base complexes of various divalent metal ions.	27	1,2,3

References:

1. A.I. Vogel, G.Svehla, Vogel's Qualitative Inorganic Analysis, 7thEdn., Longman,1996.
2. A.I. Vogel, A Text Book of Quantitative Inorganic Analysis, Longman,1966.
3. I.M. Koltoff, E.B. Sandell, Text Book of Quantitative Inorganic Analysis, 3rdEdn.,McMillian, 1968.
4. V.V. Ramanujam, InorganicSemimicro Qualitative Analysis, The NationalPub.Co., 1974.

Course	Details				
Code	AC1922602				
Title	ORGANIC CHEMISTRY PRACTICAL				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	1/I&II				
Type	Practical				
Credits	3	Hrs/Week	3	Total Hours	54

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Qualitatively separate the organic components	An	3
2	Provide hands on experience in the preparation of TLC, column chromatography	An	3
3	Develop skills in separating techniques	C	3
4	Acquire advanced knowledge in chemical drawing	C	4

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	PART I	27	
1.1	General methods of separation and purification of organic compounds such as: Solvent extraction, Soxhlet extraction, Fractional crystallization	07	1,4
1.2	TLC and Paper Chromatography, Column Chromatography Membrane Dialysis	20	1,4
2.0	PART II	54	
2.1	Separation of Organic binary mixtures by chemical/solvent separation methods	24	3,4
2.2	Separation of organic mixtures by TLC	10	3,4
2.3	Separation/ purification of organic mixtures by column chromatography	10	3,4
2.4	Test for detection of rosin in soaps. Estimation of rosin in soaps	10	3,4
3.0	PART III	27	
3.1	Drawing the structures of organic molecules and reaction schemes by ChemDraw, Symyx Draw and Chems sketch.	10	1,4

3.2	Draw the structures and generate the IR and NMR spectra of the substrates and products in the following reactions: Cycloaddition of diene and dienophile (Diels-Alder reaction) Oxidation of primary alcohol to aldehyde and then to acid Benzoin condensation Esterification of simple carboxylic acids Aldol condensation	17	1,4

References:

1. A.I. Vogel, A Textbook of Practical Organic Chemistry, Longman, 1974.
2. A.I. Vogel, Elementary Practical Organic Chemistry, Longman, 1958.
3. F.G. Mann, B.C Saunders, Practical Organic Chemistry, 4th Edn., Pearson Education India, 2009.
4. R. Adams, J.R. Johnson, J.F. Wilcox, Laboratory Experiments in Organic Chemistry, Macmillan, 1979.

Course	Details				
Code	AC1922603				
Title	PHYSICAL CHEMISTRY PRACTICAL				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	1/I & II				
Type	Practical				
Credits	3	Hrs/Week	4	Total Hours	72

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Interpret data from various experiments, including the construction of appropriate graphs and evaluation of errors.	An	3, 4
2	Quantitatively analyze the extent of adsorption of liquids by solids.	An	1
3	Understand the concept of surface forces in various liquids and the effect of reaction conditions on it.	An	3
4	Apply the terms of phase diagrams in binary and tertiary systems which are used in material science and engineering field.	Ap	1
5	Develop skills in applying the distribution law for various solutes between different appropriate solvent pairs in liquid phase chemical reactions.	C	3
6	Compare and apply theoretical approaches such as HF, MP2, DFT in stimulating various scientific problems and calculating various properties of molecules	C	3

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	Adsorption	12	1,2
1.1	Verification of Freundlich and Langmuir adsorption isotherm: charcoal-acetic acid or charcoal-oxalic acid system.	6	1,2
1.2	Determination of the concentration of the given acid using the isotherms.	6	1,2
2.0	Surface Tension	18	1,3
2.1	Determination of the surface tension of a liquid by a) Capillary rise method b) Drop number method c) Drop weight method	6	1,3
2.2	Determination of parachor values.	6	1,3
2.3	Determination of the composition of two liquids by surface tension measurements	6	1,3
3.0	Phase Diagrams	24	1,4
3.1	Construction of phase diagrams of simple eutectics.	6	1,4
3.2	Construction of phase diagram of compounds with	6	1,4

	congruent melting point: diphenyl amine-benzophenone system.		
3.3	Effect of (KCl/succinic acid) on miscibility temperature.	6	1,4
3.4	Construction of phase diagrams of three component systems with one pair of partially miscible liquids.	6	1,4
4.0	Distribution Law	18	1,5
4.1	Distribution coefficient of iodine between an organic solvent and water.	6	1,5
4.2	Distribution coefficient of benzoic acid between benzene and water	6	1,5
4.3	Determination of the equilibrium constant of the reaction $KI + I_2 \leftrightarrow KI_3$	6	1,5
5.0	Computational Chemistry Experiments	72	1,5
5.1	Single point energy calculations	12	1,5
5.2	Geometry optimization calculations	12	1,5
5.3	3. Frequency calculations	12	1,5
5.4	Basis set effects	12	1,5
5.5	Predicting Ionization energy, electron affinity, proton affinity and atomization energies.	12	1,5
5.6	Studying chemical reactions and reactivity	12	1,5

References:

1. J.B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.
2. G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th Edn., McGraw Hill, 2009.
3. J.B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.
4. G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th Edn., McGraw Hill, 2009.
5. James B. Foresman and Aeleen Frisch, Exploring Chemistry With Electronic Structure Methods: A Guide to Using Gaussian, Gaussian, second edition, 1996
6. Gaussian 09, Revision A.02, M. J. Frisch *et al.*,

SEMESTER III

Course	Details				
Code	AC1923109				
Title	ESSENTIAL OILS AND AROMATICS				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	2/III				
Type	Core Course				
Credits	4	Hrs/Week	4	Total Hours	72

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
	<i>Upon completion of this course, the students will be able to:</i>		
1	Understand the basic chemistry of essential oils and the techniques used for the extraction and refining of oils.	U	3
2	Understand terpenoid chemistry and identify mechanisms involved in their biosynthesis	U	2
3	Recognize properties, chemical constituents, methods of production of essential oils as well as their uses in industry	An	3
4	Apply spectroscopic techniques to study the structure of terpenoids	Ap	3
5	Implement the techniques of extraction and production of spice oils and their oleoresins	Ap	3

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	Essential oils (7 Hrs)	18	
1.1	Production and isolation of essential oils. General methods for the production of essential oils- methods of isolation- hydro distillation, solvent extraction, enfleurage, maceration, expression, supercritical fluid extraction.	8	1
1.2	Sources, nature, chemical constituents, method of isolation and uses of the following essential oils: lemongrass oil, lemon oil, rosemary oil, camphor oil, eucalyptus oil, turpentine oil, jasmine oil, lavender oil, rose oil, sandal wood oil, clove oil, cinnamon oil, vetiver oil, peppermint oil.	10	1
2.0	Terpenoids	9	
2.1	Introduction and classification of terpenoids, isoprene rule, general methods of determining structure	3	2
2.2	Biosynthesis of terpenoids: formation of mevalonic acid as intermediate. Biosynthesis of monoterpenoids and sesquiterpenoids.	6	2
3.0	Study of Essential Oil Constituents-I (18 Hrs)	18	
3.1	Natural sources, production, structure, properties, reactions and synthesis of the following essential oil constituents. Hydrocarbons: ocimene, α -pinene p-Cymene, Caryophyllene. Alcohols: Geraniol, Citronellol, Terpeneol, Menthol. Aldehydes: Citral. Ketones: Menthone, Pulegone, Camphor.	13	3

3.2	UV-visible, IR and mass spectral analysis of the following compounds: ocimene, α -pinene geraniol, citral, camphor.	5	4
4.0	Study of Essential Oil Constituents- II	9	
4.1	Natural source, production, structure, properties and uses of aromatics and essential oil constituents such as: Alcohols: Cinnamyl alcohol, leaf alcohol, Aldehyde: Anisaldehyde, Vanillin. Phenols: Eugenol, Isoeugenol, Methyl eugenol. Esters: Cinnamyl acetate, Geranyl acetate, Linalyl acetate. Miscellaneous compounds : Coumarin, Muscone, Civetone, Artificial Musk.	9	3
5.0	Spices and Spice Oils	18	
5.1	Sources, production, nature, chemical constituents and uses of the following spices: Cardamom, pepper, clove, nutmeg, mace, cinnamon, ginger, turmeric, coriander, garlic, vanilla, saffron, curry leaf and peppermint.	10	5
5.2	Spice oils and oleoresins - Methods of production, chemistry of the constituents and uses of the following spice oils and oleoresins- Pepper, ginger, turmeric.	8	5

References:

1. F. Rosengarten, The Book of Spices, Jove, 1981.
2. J.W. Parry, Hand Book of Spices, Chemical Publishing, 1969.
3. J.S. Pruthi, Spices and Condiments Chemistry, Microbiology and Technology, Academic Press, 1980.
4. E. Guenther, The Essential Oils, Vol I-VI, Van Nostrand, 1972.
5. L.H. Meyer, Food Chemistry, Reinhold, 1960.
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8. A.R. Pinder, The Chemistry of Terpenes, Chapman and Hall, 1960.
9. J. Varghese, Terpene Chemistry, Tata McGraw Hill, 1982.
10. P. De Mayo, Mono and Siquiterpenoids, Interscience, 1969.
11. A.A. Newman, The chemistry of terpenes and terpenoids, Academic press, 1972.
12. V. K. Ahluwalia, Terpenoids, Ane Books, 2009.
13. Y. Masada, Analysis of essential oils by gas chromatography and mass spectrometry, Wiley, 1976.
14. Y. Masada, Analysis of essential oils by gas chromatography and mass spectrometry, Wiley, 1976.

Course	Details				
Code	AC1923110				
Title	ADVANCED SYNTHETIC ORGANIC CHEMISTRY				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	2/III				
Type	Core Course				
Credits	4	Hrs/Week	4	Total Hours	72

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
1	Upon completion of this course, the students will be able to: To understand the concept of asymmetric synthesis and its application in organic synthesis	Ap	1
2	Learn, Analyse and Apply retrosynthetic analysis	An	1
3	To understand the various oxidizing and reducing agents and their application in organic synthesis	Ap	1
4	To familiarize the modern synthetic methods and reagents and to apply the knowledge to various problems in synthetic organic chemistry.	Ap	1
5	To describe the chemistry of supramolecules	U	1
6	Illustrate the synthesis, structure, classification and functions of natural products and biomolecules	An	1

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	Asymmetric Synthesis	9	
1.1	Stereoselectivity: Classification, terminology and principle.	1	1
1.2	Asymmetric synthesis and asymmetric induction- Double diastereo-selection and double asymmetric induction- chiral auxiliaries and chiral pool	5	1
1.3	Asymmetric aldol condensation pioneered by Evans.	1	1
1.4	Asymmetric Diels Alder reactions.	1	1
1.5	Enantioselective catalytic hydrogenation developed by Noyori	1	1
2.0	Retrosynthetic Analysis and Construction of rings	18	
2.1	Basprinciples and terminology of retrosynthesis, important strategies of retrosynthesis, FGI, FGA, FGR, FGT.Synthesis of aromatic compounds- One group and two group C-X disconnection.	3	2
2.2	One group C-C disconnection:- Alcohols & Carbonyl compounds Synthesis of amines and alkenes.Two group C-C disconnections:- 1,3 difunctionalised compounds & α,β – unsaturated carbonyl compounds. 1,5 – difunctionalised cpds-Michael addition & Robinson Annelation. Diels Alder reaction.	3	2
2.3	Different approaches towards the synthesis of three, four, five and six-membered rings. Photochemical approaches for the synthesis of four membered rings oxetanes and cyclobutanes, ketene cycloaddition (inter and intra molecular). Inter-conversion of ring systems (contraction and expansion)-	4	2

	Demjenov reaction		
2.4	Cycyclisation reactions: Pauson-Khand reaction, Volhardt reaction, Bergman cyclization, Nazarov cyclization	3	2
2.5	Formation of heterocyclic rings: 5-membered ring heterocyclic compounds with one or more than one hetero atom like N, S or O - pyrrole, furan, thiophene, imidazole, thiazole and oxazole.	3	2
2.6	Synthesis of some complex molecules using disconnection approach: (+) Heliotridine, Juvabione, luciferin	2	2
3.0	Organic Synthesis via Oxidation and Reduction and Modern Synthetic Methods and Reagents	27	
3.1	Survey of organic reagents and reactions in organic chemistry with special reference to oxidation and reduction. Metal based and non-metal based oxidations of (a) alcohols to carbonyls (Chromium, Manganese, Aluminium and DMSO based reagents), (b) alkenes to epoxides (peroxides/per acids based), Sharpless asymmetric epoxidation, Jacobsen epoxidation, Shi epoxidation, (c) alkenes to diols (Manganese and Osmium based), Prevost reaction and Woodward modification, (d) alkenes to carbonyls with bond cleavage (Manganese and Lead based, ozonolysis), (e) alkenes to alcohols/carbonyls without bond cleavage (hydroboration-oxidation, Wacker oxidation, Selenium/Chromium based allylic oxidation) (f) ketones to esters/lactones (Baeyer-Villiger).	9	3
3.2	Survey of organic reagents and reactions in organic chemistry with special reference to reduction: (a) Catalytic hydrogenation (Heterogeneous: Pd /Pt /Rh /Ni; Homogeneous: Wilkinson), Noyori asymmetric hydrogenation (b) Metal based reductions using Li/Na/Ca in liquid ammonia, Sodium, Magnesium and Zinc (Birch, Pinacol formation, McMurry, Acyloin formation, dehalogenation and deoxygenations) (c) Hydride transfer reagents from Group III and Group IV in reductions (i) NaBH ₄ triacetoxymethylborohydride; LiAlH ₄ and DIBAL-H, Meerwein-Ponndorf-Verley reduction) (ii) Stereo/enantioselective reductions (Chiral Boranes, Corey-Bakshi-Shibata).	9	3
3.3	Baylis-Hillman reaction, Henry reaction, Nef reaction, Sakurai reaction, Tischenko reaction, Metal mediated C-C and C-X coupling reactions: Heck, Stille, Suzuki, Negishi, Sonogashira, Nozaki-Hiyama, Buchwald-Hartwig, Ullmann and Glaser coupling reactions. Reagents such as: NBS, DDQ, DCC, Gilman reagent.	6	4
3.4	Introduction to multicomponent reactions- Three component reactions (Mannich reaction, Passerini reaction, Biginelli reaction), Four component reactions (Ugi reaction). Click reactions (Elementary idea only).	3	4
4.0	Molecular Recognition and Supramolecular Chemistry	9	
4.1	Concept of molecular recognition, host-guest complex formation, forces involved in molecular recognition.	2	5
4.2	Molecular receptors: Cyclodextrins, Crown ethers, Cryptands, Spherands, Tweezers, Carcerands, Cyclophanes, Calixarenes, Carbon nanocapsules.	3	5

4.3	Importance of molecular recognition in biological systems like DNA and protein, Controlled release phenomena.	3	5
4.4	Applications of supramolecular complexes in medicine and perfumery industries.	1	5
5.0	Chemistry of Natural Products and Biomolecules	9	
5.1	Synthesis of camphor, atropine, papavarine, quinine, cyanin, quercetin, β -carotene, testosterone, Vitamin A1.	4	6
5.2	Methods of primary structure determination of peptides, proteins and nucleic acids. Replication of DNA. Protein biosynthesis – transcription and translation, DNA sequencing. Polymerase chain reaction and human genome project.	5	6

References:

1. M.B. Smith, Organic Synthesis, 3rd Edn., Wavefunction Inc., 2010.
2. F.A. Carey, R. I. Sundberg, Advanced Organic Chemistry, Part A and B, 5th Edn., Springer, 2007.
3. S. Warren, P. Wyatt, Organic Synthesis: The Disconnection Approach, 2nd Edn., Wiley, 2008.
4. V.K. Ahluwalia, Oxidation in Organic Synthesis, CRC Press, 2012.
5. Ojima, Catalytic Asymmetric Synthesis, 3rd Edn., John Wiley & Sons, 2010.
6. W. Carruthers, I. Coldham, Modern Methods of Organic Synthesis, 4th Edn., Cambridge University Press, 2004.
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8. R. Noyori, Asymmetric Catalysis in Organic Synthesis, John Wiley & Sons, 1994.
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14. W. Carruthers, I. Coldham, Modern Methods of Organic Synthesis, Cambridge University Press, 2004.
15. A.L. Lehninger, D.L. Nelson, M.M. Cox, Lehninger Principles of Biochemistry, 5th Edn., W.H. Freeman, 2008.
16. S.V. Bhat, B.A. Nagasampagi, M. Sivakumar, Chemistry of Natural Products, Narosa, 2005.

Course	Details				
Code	AC1923111				
Title	PHYSICAL CHEMISTRY				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	2/III				
Type	Core Course				
Credits	4	Hrs/Week	4	Total Hours	72

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Understand the kinetics of a chemical reaction and its mechanistic path from various theory/models	U	1
2	Analyze the effect of catalyst and its influence on the kinetics of a chemical reaction	An	1
3	Explain the fundamental aspects of surface chemistry and also to study the kinetics of surface reactions	An	1, 3
4	Discuss the fundamental topics in electrochemistry and the theory and mechanisms of various electro-kinetic phenomena	Ap	1, 3
5	Understand the photophysical process like fluorescence, phosphorescence from the energy transfer and also to study the kinetics of photochemical process	Ap	1, 3, 4

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	Chemical Kinetics and Catalysis	18	1
1.1	Absolute reaction rate theory (ARRT)-thermodynamic treatment, application of ARRT to simple bimolecular process- Mechanisms of Photochemical Reactions -chain reactions – general characteristics-study of kinetics of chain reaction like H_2-Br_2 reaction-decomposition of acetaldehyde and N_2O_5 , study of H_2-O_2 explosive reactions- Theory of unimolecular reactions-Lindemann-Hinshelwood, RRKM - steady state approximation, principle of microscopic reversibility - kinetic isotope effect- primary and secondary kinetic salt effect- influence of solvent on reaction rates - Significance of volume and entropy of activation- Study of fast reactions by Stopped flow method	10	1
1.2	Specific and general acid-base catalysis-Bronsted catalysis law-Acidity functions- Enzyme catalysis (single substrate reactions only).Michaelis-Menton kinetics.- Influence of pH and temperature on enzyme catalysis- Kinetics of heterogeneous catalysis (Langmuir Hinshelwood mechanism and Eley-Rideal mechanism)	8	2
2.0	Surface Chemistry	18	
2.1	Different types of surfaces-thermodynamics of surfaces- Adsorption isotherms- Freundlich – Langmuir isotherm and derivation-BET theory and kinetic derivation- surface area determination-Temkin adsorption isotherm-Adsorption on liquid surface-surface tension-	18	3

	Gibbs's adsorption isotherm- Application of Langmuir adsorption isotherm in surface catalysed reactions- the Eley-Rideal mechanism and the Langmuir-Hinshelwood mechanism, flash desorption- Colloids: Zeta potential- electrokinetic phenomena- sedimentation potential and streaming potential- Donnan membrane equilibrium- Surface Enhanced Raman Scattering, surfaces for SERS studies- Experimental methods of studying surfaces - Auger, LEED and ESCA		
3.0	Fundamental concepts in Electrochemistry	14	
3.1	Theories of ions in solution- Drude and Nernst's electrostriction model and Born's model Mechanism of electrolytic conductance, relaxation and electrophoretic effects, Debye – Huckel – Onsager (DHO) equation and its validity in aqueous and non -aqueous solutions. Deviations from the Onsager equation, conductance ratio and Onsager equation. Dispersion of conductance at high frequencies (Debye–Falkenhagen effect). Conductance with high potential gradients (Wien effect). Activity and activity coefficient, forms of activity coefficients, activities of electrolytes and mean ion activity coefficient. The Debye – Huckel Limiting law. Electrokinetic phenomena: Electrical double layer and its structure (Stern's theory), Electroosmosis, Streaming potential, Electrophoresis, Influence of ions on electrokinetic phenomena.	14	4
4.0	Analytical techniques based on electrochemistry	8	
4.1	Principles and applications of Cyclic voltammetry- Principles and Applications of impedance measurements- Electrode modification- Fluorescence, chemi and bio-luminescence sensors- Fluorescent tag molecules- Applications- Conductometric sensors- Coulometric sensors- Voltammetric sensors- Amperometric sensors- Neurotransmitters- Applications	8	4
5.0	Photochemistry	14	
5.1	Photophysical processes of electronically excited molecules- Franck – Condon principle– quantum mechanical treatment- Dissociation and pre – dissociation of diatomic molecules- Energy transfer from electronically excited molecules- Stern – Volmer mechanism only- Photophysical pathways: fluorescence, phosphorescence, E-type and P- type delayed fluorescence. Kinetic treatment of excimer and exciplex formation- lasers in photochemical kinetics- Photochemical splitting of water- organic light emitting devices.	14	5

References:

1. K.J. Laidler, Chemical kinetics, 3rd Edn., Harper & Row, 1987.
2. J. Rajaram, J.C Kuriakose, Kinetics and Mechanisms of Chemical Transformations, Macmillan India, 2000.
3. J.W Moore, R.G. Pearson, Kinetics and Mechanisms, John Wiley & Sons, 1981.
4. P. Atkins, J. Paula, Physical Chemistry, 9th Edn., Oxford University Press, 2010.
5. R.I Masel, Chemical kinetics and Catalysis, Wiley Interscience, 2001.
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12. B.K. Sharma, Electrochemistry, KrishnaPrakashan, 1985.
13. Praveen Tyagi, Electrochemistry, Discovery Publishing House, 2006.
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15. S. Glasstone, Introduction to Electrochemistry, Biblio Bazar, 2011.
16. K.K. Rohatgi-Mukherjee, Fundamentals of Photochemistry, 2nd Edn., New Age International, 1986.
17. Gabor Harsanyi, Sensors in Biomedical Applications - Fundamentals, Technology and Applications, CRC Press, 2000.
18. Raluca-Ioana Stefan, Electrochemical Sensors in Bioanalysis, CRC Press, 2001.
19. Dekker, A. J. Solid state physics, MacMillan Publishers.
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Course	Details				
Code	AC1923112				
Title	APPLIED MOLECULAR SPECTROSCOPY				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	2/III				
Type	Core Course				
Credits	3	Hrs/Week	3	Total Hours	54

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Learn the basic principles of interpret uv-visible, chiroptical, vibrational, 1-D and 2-D NMR and Mass spectroscopy for the structure identification of organic compounds	U	1, 3
2	Analyze and interpret uv-visible, chiroptical, vibrational, 1-D and 2-D NMR and Mass spectral data of organic compounds	An	1, 3
3	Evaluate various structural possibilities and arrive at the most logical structure of organic compounds by analysis and interpretation of spectroscopic data.	E	1, 3
4	Identify the structure of organic compounds by analysis and interpretation of spectroscopic data.	An	1, 3

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-ApPLY; An-AnALYZE; E-EVALUATE; C-CREATE.

Module	Course Description	Hrs	CO No.
1.0	Electronic and Chiroptical Spectroscopic techniques	9	1,2
1.1	Energy levels and selection rules, Woodward-Fieser and Fieser-Kuhn rules.	2	1
1.2	Influence of substituent, ring size and strain on spectral characteristics. Solvent effect, Stereochemical effect, non-conjugated interactions.	3	1
1.3	Chiroptical properties - ORD, CD, plane curves, Cotton effect, octant rule, axial haloketone rule, assignment of configuration of chiral molecules.	3	1
	Problems based on the above topics.	1	2
2.0	Vibrational Spectroscopic techniques	9	1,2,3
2.1	Fundamental vibrations, characteristic regions of the spectrum (fingerprint and functional group regions), influence of substituent, ring size, hydrogen bonding, vibrational coupling and field effect on frequency, determination of stereochemistry by IR technique.	7	1
2.2	IR spectra of C=C bonds (olefins and arenes) and C=O bonds.	1	1
2.3	Problems on spectral interpretation with examples.	1	2,3
3.0	Nuclear Magnetic Resonance Spectroscopic techniques	18	1,2,3
3.1	NMR phenomenon, ¹ H nucleus, Zeeman splitting, RF absorption, Larmor precession, relaxation processes, Chemical shift and shielding/deshielding, factors affecting chemical shift,	4	1

	chemical and magnetic non-equivalence, local diamagnetic shielding and magnetic anisotropy.		
3.2	Spin coupling: Spin coupling and peak splitting pattern, Pascal's triangle, Pople notation - AX, AX ₂ , AX ₃ , A ₂ X ₃ , AB, ABC, AMX type coupling, first order and non-first order spectra, coupling constant, mechanism of coupling, geminal, vicinal and long range coupling, Dirac model, Karplus curve, quadrupole broadening and decoupling, homoallylic coupling, propargylic coupling, deceptive simplicity, virtual coupling, diastereomeric protons.	6	1
3.3	¹³ C NMR: ¹³ C nucleus, natural abundance, sensitivity, ¹³ C chemical shift and structure correlation, proton coupled ¹³ C spectra, proton decoupled ¹³ C spectra, broad band decoupling, rotating frame of reference, mechanism of heteronuclear decoupling, cross polarization, NOE.	3	1
3.4	Simplification non-first order spectra to first order spectra: spin decoupling and double resonance, off resonance decoupling, Polarization transfer, DEPT	1	1
3.5	2D NMR and COSY, HOMOCOSY and HETEROCOSY – HETCOR and HMQC.	1	1
3.6	Brief introduction to NMR spectroscopy of biomolecules: biopolymers, proteins, nucleic acids.	2	1
3.7	Problems on spectral interpretation with examples.	1	2,3
4.0	Mass Spectrometric techniques	9	1,2,3
4.1	Molecular ion: basic principles, ion production methods (EI). Soft ionization methods: SIMS, FAB, CA, MALDI, PD, Field Desorption, Electrospray Ionization, isotope abundance, Fragmentation patterns-nitrogen and ring rules. McLafferty rearrangement and its applications. HRMS, MS-MS, LC-MS, GC-MS.	8	1
4.2	Problems on spectral interpretation with examples.	1	2,3
5.0	Determination of molecular structure using spectroscopic methods	9	1,2,3,4
5.1	Index of hydrogen deficiency, rule of thirteen	1	1
5.2	Identification of structures of unknown organic compounds based on the data from UV-Vis, IR, ¹ H NMR and ¹³ C NMR spectroscopy (HRMS data or Molar mass or molecular formula may be given).	6	2,3,4
5.3	Interpretation of the given UV-Vis, IR and NMR spectra.	2	2

References:

1. D.L. Pavia, G.M. Lampman, G.S. Kriz, Introduction to Spectroscopy, 3rd Edn., Brooks Cole, 2000.
2. A.U. Rahman, M.I. Choudhary, Solving Problems with NMR Spectroscopy, Academic Press, 1996.
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4. D.F. Taber, Organic Spectroscopic Structure Determination: A Problem Based Learning Approach, Oxford University Press, 2007.

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6. R. S. Macomber, A Complete Introduction to Modern NMR Spectroscopy, Wiley 1998.
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8. D.H. Williams, I. Fleming, Spectroscopic Methods in Organic Chemistry, 6th Edn., McGraw-Hill, 2008.
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11. E.B. Wilson Jr., J.C. Decius, P.C. Cross, Molecular Vibrations: The Theory of Infrared and Raman Vibrational Spectra, Dover Pub., 1980.,

Course	Details				
Code	AC1924604				
Title	INDUSTRIAL OILS AND FAT PRODUCTS				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	2/III				
Type	Practical				
Credits	3	Hrs/Week	3	Total Hours	54

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Quantitatively analyze various parameters in fat products	An	3
2	Provide hands on experience in the preparation of cleaning agents	Ap	3
3	Develop skills in analyzing and grading soaps	C	3
4	Acquire advanced knowledge about industrially important oils and fats which would be helpful in pursuing a carrier in such industries	C	4

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	Analysis of Vanaspati: (7 Hrs)	30	
1.1	Determination of the physical and chemical constants of hydrogenated fats.	10	1,4
1.2	Estimation of Vitamin A and Vitamin E content of Vanaspati	10	1,4
1.3	Detection of animal fats in Vanaspati.	5	1,4
1.4	Estimation of nickel in catalyst mixture and spent catalyst	5	1,4
2.0	Soap analysis	40	
2.1	Complete analysis of washing soaps, toilet soaps and transparent soaps: Moisture, alcohol soluble and insoluble's, free caustic alkali, combined alkali, anhydrous soap, titer, mean molecular weight and Iodine value of total fatty acids derived from soaps.	10	3,4
2.2	TFM value of toilet soaps.	10	3,4
2.3	Estimation of glycerine content of toilet soaps and transparent soaps.	10	3,4
2.4	Test for detection of rosin in soaps. Estimation of rosin in soaps	10	3,4
3.0	Estimation of Glycerol	20	
3.1	Estimation of glycerol in the given sample.	20	1,4
4.0	Preparation of different types of soaps	15	
4.1	Washing soap, toilet soap, transparent soap, liquid soap, shaving soap.	15	3,4
5.0	Preparation of detergents	3	
5.1	Preparation detergent powder, shampoo, vanishing cream.		3,4

References:

1. F. Shahidi, Bailey's Industrial Oil and Fat Products, 6th Edn., John Wiley & Sons, 2005.
2. I. Ash, M. Ash, Formulary of Detergents and other Cleaning Agents, Chemical Publishing, 1999.
3. H. Butler, Poucher's Perfumes, Cosmetics and Soaps, 10th Edn., Springer, 2000.

Course	Details				
Code	AC1924605				
Title	ESSENTIAL OILS AND AROMATICS PRACTICAL				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	2/III				
Type	Practical				
Credits	3	Hrs/Week	3	Total Hours	54

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Separate aromatics from essential oils	Ap	3
2	Analyze the physical properties of Essential oils	An	3
3	Produce essential oils from plant materials	An	3
4	Use various synthetic methodologies for the production of aromatics	Ap	3
5	Recommend suitable method for the estimation of aromatics	E	3
6	Plan methods for the detection of adulteration in essential oils	C	3

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	Extraction of some essential oils	9	3
1.1	Extraction of Lemongrass oil,	3	3
1.2	Extraction of cinnamon oil	3	3
1.3	Extraction of clove oil	3	3
2.0	Assay of essential oils and perfumery materials	44	2
2.1	Determination of specific gravity.	3	2
2.2	Determination of refractive index.	3	2
2.3	Determination of optical rotation, boiling point and boiling range.	3	2
2.4	Fractionation and solubility	3	2
2.5	Estimation of essential oil constituents such as alcohols, esters, aldehydes, ketones, phenols and others. Examples: Estimation of: Acids in essential oils Geraniol in palmarosa oil. Citronellol in citronella oil. Linalool in bergamot or lavender oil. Citral in lemongrass oil. Citronellal in citronella oil. Cinnamic aldehyde in cinnamon oil. Methyl salicylate in wintergreen oil. Geranyl acetate in palmarosa oil. Camphor in camphor oil. Cineole in eucalyptus oil.	32	5

	Eugenol in clove oil. Estimation of vanillin. Estimation of aldehydes and ketones components in a mixture.		
3.0	Detection and estimation of common adulterants: Alcohol, rosin, fatty oil and mineral oil in essential oils.	12	6
4.0	Preparation of some typical isolates from essential oils	21	1
4.1	Citral from lemongrass oil.	3	1
4.2	Geraniol from palmarosa oil.	3	1
4.3	Santalols from sandalwood oil.	3	1
4.4	Cineol from eucalyptus oil.	3	1
4.5	Linalool from bergamot oil.	3	1
4.6	Cinnamic aldehyde from cinnamon oil.	3	1
4.7	Eugenol from clove oil.	3	1
5.0	Synthesis and spectral analysis of aromatics and perfumery compounds	22	4
5.1	01. Nerolin. 02. B- ionone. 03. Methyl heptenone. 04. Camphor. 05. Methyl cinnamate. 06. Methyl anthranilate. 07. Benzyl acetate. 08. Amyl benzoate. 09. Coumarin. 10. Amyl salicylate	22	4

References:

01. E. Guenther, The Essential Oils-Vol.1, Jepson Press, 2007.
02. W.A. Poucher, Perfumes, Cosmetics and Soaps, 9th Edn., Springer, 1993.
03. M. Billot, F.V. Wells, Perfumery Technology: Art, Science, Industry, E. Horwood, 1975.
04. J.S. Pruthi, Spices and Condiments: Chemistry, Microbiology, Technology, Academic Press, 1980.
05. R.F. Venn, Principles and Practice of Bioanalysis, Taylor & Francis, 2007.
06. G. Reineccius, Flavour Chemistry and Technology, 2nd Edn., 2005.
07. V.C. Mehlenbacher, Official and Tentative Methods of the American Oil Chemists Society Vol.1, 3rd Edn., The Society, 1954.
08. H.A. Boekenooen, Analysis and Characterization of Oils, Fats and Fat Products, Interscience, 1954
09. V.K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions, Ane Books, 2009.
10. Monograph on Green Chemistry Laboratory Experiments, Green Chemistry Task Force Committee, DST, 2009.
11. R. M. Silverstein, F. X. Webster, D. J. Kiemle, D. L. Bryce, Spectroscopic Identification of Organic Compounds, 8th Edn., Wiley, 2015.
12. F. G. Mann and B.C. Saunders, Practical Organic Chemistry, Pearson.
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Course	Details
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Code	AC1924606				
Title	Fixed Oils and Fats Practical				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	2/III				
Type	Practical				
Credits	3	Hrs/Week	4	Total Hours	72

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	To analyse of the physical and chemical constants of common oils and fats .	An	3
2	To analyse milk ,milk products and different parameters of water.	An	3
3	To familiarise and synthesise some common drugs like aspirin and paracetamol	An	3
4	To colorimetrically estimate the cholesterol in fats.	An	3
5	To isolate individual fatty acids from oils.	An	3

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	Determination of the physical and chemical constants of common oils and fats	60	1
1.1	Moisture, Specific gravity, Refractive index, Acid value and free fatty acid, Saponification value, Iodine value, Non-saponifiable matter, Acetyl and hydroxyl value, Reichert Meissl value, Polenske and Kirschner value, peroxide value and color measurement of the following: 1. Coconut oil 2. Sesame oil 3. Palm oil 4. Olive oil 5. Castor oil 6. Ghee 7. Tallow	60	1
2.0	Analysis of milk, milk products, ghee and water	24	1,2
2.1	Detection of starch in milk	2	2
2.2	Detection of formalin in milk	2	2
2.3	Estimation of added glucose in milk	2	2
2.4	Estimation of starch in milk	2	2
2.5	Determination of total solids in milk	2	2
2.6	Determination of fat in milk	2	2
2.7	Determination of moisture in ghee	2	1
2.8	Determination of free fatty acids in ghee	2	1
2.9	Detection of vanaspathi in ghee	2	1
2.10	Determination of RM and Polenske-values of ghee	2	1
2.11	Determination of P ^H , TS, DO, TDS, COD, Hardness, Alkalinity,	4	2

	Chloride, Conductance etc. of water.		
3.0	Simple experiments in Drug Chemistry	10	3
3.1	Preparation of aspirin	5	3
3.2	Preparation of paracetamol.	5	3
4.0	Colorimetric estimation of cholesterol in fats.	10	4
5.0	Preparation based on oils and fats	40	5
	Preparations involving epoxidation, hydroxylation, bromination and chain scission of fatty acids.		
5.1	1. Epoxystearic acids 2. Erythro-9, 10-dihydroxystearic acid 3. Threo-9, 10dihydroxystearic acid. 4. Tetrabromostearic acid. 5. Azelaic acid. 6. Sebacic acid. 7. Undecylenic acid.	25	5
5.2	Isolation of individual fatty acids from oils. 1. Isolation of palmitic acid from palm oil. 2. Isolation of erucic acid from mustard oil.	10	5
5.3	Preparation of rice bran oil by solvent extraction method.	5	5

References:

1. V.C. Mehlenbacher, Official and Tentative Methods of the American Oil Chemists Society Vol.1, 3rd Edn., The Society, 1954.
2. H.A. Boekenooen, Analysis and Characterization of Oils, Fats and Fat Products, Interscience, 1954.
3. L.V. Cocks, C.V. Rede, Laboratory Hand Book for Oil and Fat Analysis, Academic Press, 1966.
4. F.D. Gunstone, An Introduction to the Chemistry and Biochemistry of Fatty Acids and their Glycerides, Chapman and Hall, 1968.
5. F.D. Gunstone, Topics in Lipid Chemistry, Logos, 1970.
6. AOCS (American Oil Chemists' Society)
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8. D. Roy, P. Dinakar and M. P. Mathur, Text book of dairy chemistry, Indian council of agricultural, 2008
9. M. Zaffer Ahmad and Muhammed Ali, Text book of pharmaceutical drug analysis, CBS publishers, 2009.
10. Ashutosh Kar, Pharmaceutical drug analysis, New Age International Pvt. Ltd., 2005.

SEMESTER IV

Course	Details				
Code	AC1924301				
Title	INDUSTRIAL OILS AND FAT PRODUCTS				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	2/IV				
Type	Elective				
Credits	4	Hrs/Week	5	Total Hours	90

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
1	Reproduce the properties of oils, fats and waxes	R	2
2	Explain various processes related to fats and oils and their products	U	2
3	Decide the suitable method for the analysis of fats and oils	E	2
4	Plan suitable technique for the extraction of oils and fats	C	2
5	Interpret the results of adulteration tests	Ap	2

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	Extraction and Processing of oils and fats	18	1,2,4
1.1	Mechanical pre-treatment and heat treatment of oil bearing materials.	3	2
1.2	Rendering of animal fats and cooking of oil seeds. Mechanical expression of oils.	3	2
1.3	Solvent extraction- theory and practice, type of extractors, solvent recovery, alternative solvents for extraction, super critical fluid extraction of oils and fats.	3	4
1.4	Refining, bleaching, deodorization, fractionation, winterization, stabilization, solidification, homogenization, emulsification and dewaxing.	3	2
1.5	Study of the sources, composition, characteristics and utilization of commercially important oils and fats- butter, tallow, coconut oil, palm oil, cocoa butter, olive oil, rice bran oil, sesame oil, soybean oil, sunflower oil, linseed oil, mustard oil, castor oil.	6	1
2.0	Oils and fats as food materials and their Rancidity Process	18	1,2
2.1	Cooking oil, salad oil, and salad dressings	2	1
2.2	Quality evaluation of cooking oils and salad oils.	2	2
2.3	Margarine and Shortenings	2	2
2.4	Essential fatty acids: ω -3 and ω -6 fatty acids and their dietary sources, significance to human nutrition and health.	2	2
2.5	Fat-related diseases: atherosclerosis, arthritis. Nutritional significance of EFA, HDL, LDL and VLDL.	2	2

2.6	Concept of autoxidation, theories of autoxidation, tests for rancidity, stability of oils, induction period.	4	2
2.7	Pro oxidants and antioxidants.	2	2
2.8	Drying, semidrying and non-drying oils.	2	2
3.0	Hydrogenation of Oils & Fat Splitting and Esterification	27	2
3.1	Catalytic hydrogenation: chemistry of hydrogenation, hydrogenolysis, influence of various factors in hydrogenation, mechanism, kinetics and thermodynamics of hydrogenation reactions, hydrogenation catalysts-theory of catalysis	5	2
3.2	Manufacture of catalyst for hydrogenation-Hydrogenation of vegetable and marine oils-manufacture of vanaspati	3	2
3.3	Fat splitting: Twitchell process- low pressure splitting with catalysts, medium pressure autoclave splitting with catalyst, continuous uncatalysed high pressure counter current splitting, enzymatic splitting,	5	2
3.4	Recovery of glycerine from fat splitting process and spent lye.	2	2
3.5	Different grades of glycerine, chemistry and synthesis of glycerine.	2	2
3.6	Uses of glycerine, glycerine substitutes.	1	2
3.7	Esterification: mechanism of esterification and ester hydrolysis. Esterification of fatty acids with glycerol and other alcohols.	4	2
3.8	Inter esterification, acidolysis, alcoholysis, glycolysis, glycerolysis	3	2
3.9	Transesterification and its mechanism, applications of esterification and inter esterification.	2	2
4.0	Analysis of fats and oils	18	3,5
4.1	Test methods for physical properties: melting point, softening point, slipping point, titer, congeal point	2	3
4.2	Flow test, cloud test, consistency test, penetration method.	1	3
4.3	Liquid and solid fatty acid determination, solid fat index.	2	3
4.4	Specific gravity, refractive index, viscosity, color, odor.	2	3
4.5	Test methods for chemical properties: Iodine value, thiocyanogen number,	2	3
4.6	Saponification value, acid value and free fatty acid.	2	3
4.7	Oxirane oxygen, hydroxyl and acetyl value, peroxide value.	2	3
4.8	Reichert-Meissel value, Polenski value and Kirschner value, diene value. Estimation of poly unsaturated fatty acids-Kries test, thiobarbituric acid test	3	3
4.9	Adulteration of oils fats – detection of adulteration	2	5
5.0	Waxes and Fatty alcohols	9	1,2
5.1	Occurrence, classification, properties and composition of waxes.	2	1
5.2	Synthetic waxes.	2	2
5.3	Analysis and utilization of waxes.	2	2
5.4	Naturally occurring fatty alcohols – production, uses and applications .	2	1
5.5	Alcohol ethers.	1	1

References:

1. Swern, Bailey's Industrial Oil and Fat Products, Vol. I and II, 4th Edn., John Wiley, 1982.
2. T.H. Applewhite, Bailey's Industrial Oil and Fat Products, Vol. III 4th Edn. John Wiley, 1985.
3. E.S. Pattison, Fatty acids and their Industrial Applications, Marcel Dekker, 1968
4. A.J.C. Andersen, Refining for Oils and Fats for Edible Purposes, Pergamon Press, 1962.
5. F.D. Gunstone, An introduction to Chemistry and Biochemistry of Fatty acids and their Glycerides, Chapman and Hall, 1968.
6. T.P. Hilditch, P.N. Williams, The Chemical Constitution of Natural Fats, 4th Edn., John Wiley & Sons, 1964
7. H.A. Boekennoogen, Analysis and Characterization of Oils, Fats and Fat Products Vol. I, Interscience, 1964
8. P. Tooley, Chemistry in Industry-Fats, Oils and Waxes, John Murray, 1971.
9. W.W. Christie, Lipid Analysis, 3rd Edn., Oily Press, 2003.
10. F. Rosengarten, The Book of Spices, Jove, 1981.
11. W. Parry, Hand Book of Spices, Chemical Publishing, 1969
12. J.S. Pruthi, Spices and Condiments Chemistry, Microbiology and Technology, Academic Press, 1980
13. Guenther, The Essential Oils, Vol I-VI, Van Nostrand, 1972.
14. L.H. Meyer, Food Chemistry, Reinhold, 1960.

Course	Details				
Code	AC1924302				
Title	BIOCHEMISTRY OF FATTY ACIDS				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	2/IV				
Type	Elective				
Credits	4	Hrs/Week	5	Total Hours	90

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	To understand the concept of lipids and glyceride structure.	U	2
2	To analyse different methods for the isolation and characterization of fatty acids.	An	2
3	To familiarize about the nomenclature systems of fatty acids and its industrial applications.	Ap	2
4	To describe the sources, structure and synthesis of the different types of fatty acids occurring in nature.	U	2
5	To analyse the physical and chemical properties of fatty acids.	An	2
6	To understand and describe the biochemistry and metabolism of fats	U	2

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	Lipids	27	
1.1	Classification of lipids-sources and classification of oils and fats.	4	1
1.2	Nomenclature of triglycerides, stereospecific numbering.	4	1
1.3	Nutritional functions of fats and oils, Caloric and non-caloric functions, Non nutritional functions of edible fats.	4	1
1.4	Non-glyceride constituents of fats and oils: Occurrence, chemistry and function of carotenes, vitamins, tocopherols, steroids, phospholipids, sphingolipids, antioxidants. Constituents contributing flavor and odor.	7	1
1.5	Glyceride composition of natural fats. Methods of investigation of glycerides.	5	1
1.6	Theories of glyceride structure.	3	1
2.0	Isolation and Characterization of Fatty Acids	9	
2.1	Crystallisation methods, Chromatographic techniques: TLC, paper chromatography, GLC, HPLC.	3	2
2.2	Use of IR, UV, NMR and mass spectrometry.	3	2
2.3	Nomenclature of fatty acids- IUPAC and omega reference systems, uses of fatty acids in textiles, leather, pharmaceuticals and petroleum processing.	3	3

3.0	Fatty Acids Occurring in Nature	18	
3.1	Saturated fatty acids: important sources, structure and synthesis of naturally occurring straight chain and branched chain saturated fatty acids.	6	4
3.2	Unsaturated fatty acids: monoethenoid fatty acids-their occurrence and general methods of synthesis. Oleic acid and petroselenic acid-properties and constitution.	6	4
3.3	Polyunsaturated fatty acids, cyclopropenoid acids, conjugated acids, epoxy acids, keto acids, cyclopentenoid acids, hydroxy acids, acetylenic acids, furanoid acids, artificially produced fatty acids.	6	4
4.0	Physical and Chemical properties of Fatty Acids	27	
4.1	Crystal properties, thermal properties, spectral properties.	5	5
4.2	Solubility and solution properties of fatty acids in the liquid state.	5	5
4.3	Salt formation, esterification, halogenation.	5	5
4.4	Oxidation uses of various oxidizing agents like chromic acid, ozone, peroxides, potassium permanganate, periodic acid and lead tetra acetate.	6	5
4.5	Hydrogenation, dehydration, pyrolysis, polymerization, addition reactions to double bond.	6	5
5.0	Biochemistry and Metabolism of Fats	9	
5.1	Biochemical transformation of fats in the body-biosynthesis of fats in plants and animal organisms.	4	6
5.2	Prostaglandins: synthesis, biosynthesis, applications of prostaglandins as drugs.	5	6

References:

1. M.G. Wohl, R.S. Goodhart, M.E. Shils, Modern Nutrition in Health and Disease, 6th Edn., Lea & Febiger, 1980.
2. K.S. Markley, Fatty acids: Their Chemistry, Properties, Production and Uses, Parts I- V, Interscience, 1960.
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4. T.H. Aplewhite, Bailey's Industrial Oil and Fat Products, Vol. III, 4th Edn., John Wiley-Interscience, 1985
5. T.P. Hilditch, P.N. Williams, The Chemical Constitution of Natural Fats, 4th Edn., John Wiley & Sons, 1964
6. F.D. Gunstone, An introduction to Chemistry and Biochemistry of Fatty acids and their Glycerides, Chapman and Hall, 1968.
7. H.B. Bull, The Biochemistry of Lipids, John Wiley, 1937.
8. T. Galliard, E.I. Mercer, Recent Advances in the Chemistry and Biochemistry of Plant Lipids, Academic Press, 1975.
9. F.D. Gunstone, Topics in Lipid Chemistry, Vol. I-II, Logos Press, 1970.
10. H.M. Sinclair, Essential Fatty Acids, Butterworths, 1958.
11. E.E. Conn, P.K. Stumpf, G. Bruening, R.H. Doi, Outlines of Biochemistry, 5th Edn., John Wiley, 1987.
12. H.A. Boekennoogen, Analysis and Characterization of Oils, Fats and Fat Products, Vol. I, Interscience, 1964.

Course	Details				
Code	AC1924303				
Title	ADVANCED APPLIED CHEMISTRY				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	2/IV				
Type	Elective				
Credits	4	Hrs/Week	5	Total Hours	90

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Make soaps and detergents and classify them into various groups. Determine the TFM values.	Ap, E	2
2	Explain the merits and demerits of syndets over soaps. Explain the role of surfactants in synthesis of nanoparticles.	U	1
3	Analyse the composition of milks and estimate fat, acidity and solids in milk.	An	2
4	Distinguish paints, varnishes and lacquers. Explain the mechanism of polymerization of copolymers and resins.	U	1
5	Identify perfumes, odour and flavors. Explain perfume technology, blending and sensory analysis.	An,U	2
6	Discuss the sources and chemical nature of Gums, Balsams and Resins.	E	2
7	Explain the General Principles of Drug Therapy. Stereochemistry and biological activity. Antibiotics: Synthesis of Phytochemicals: Importance and applications of phytochemicals in pharmacology.	An	2
8	Illustrate the Principles of green chemistry, basic concepts, twelve laws of green chemistry, principles of green organic synthesis.	Ap	2
9	Illustrate the Basic principles of nanochemistry, Types of nanomaterials, general methods of synthesis of nanomaterials, Applications of nanomaterials in medicine.	Ap	2

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	Soaps and detergents	18	
1.1	Theory of surface action-Soap manufacture: raw materials, characteristics of cold process, semi boiled process and boiled process, additives of soap, detergent action of soap, influence of fatty acid composition of the oil on properties of soap.	4	1
1.2	Manufacture of soap for different purposes-laundry soaps, toilet soaps, liquid soaps, transparent soaps, baby soaps, shaving soaps,	4	1

	medicated soaps, textile soaps, naphtha soaps, marine soaps.		
1.3	T.F.M value of soaps, Shampoos.	2	1
1.4	Anionic, cationic, amphoteric and nonionic detergents used in modern industries and for household purposes-their chemistry, manufacture and applications- Agglomeration.	4	1
1.5	Merits and demerits of syndets over soaps, biodegradability of Detergents. Role of surfactants in synthesis of nano particles, enzyme detergents, Green detergents, compact detergents.	4	2
2.0	Diary Chemistry and Paints and Varnishes	18	
2.1	Milk - definition-general composition of milk - constituents of milk – lipids, proteins, carbohydrates ,vitamins and minerals – physical properties of milk - colour, odour, acidity, specific gravity, viscosity and conductivity.	2	3
2.2	Factors affecting the composition of milk - adulterants, preservatives and neutraliser-examples and their detection - estimation of fat, acidity and total solids in milk	2	3
2.3	Processing of Milk: destruction of micro organisms in milk - physico - Chemical changes taking place in milk due to processing – boiling. , pasteurisation - types of pasteurisation - Bottle, Batch and HTST (High Temperature Short Time) - Vacuum pasteurisation – Ultra High Temperature Pasteurisation.	3	3
2.4	Milk products: Cream-definition-composition-chemistry of creaming process-gravitational and centrifugal methods of separation of cream-estimation of fat in cream. Butter - definition – composition - theory of churning - estimation of acidity and moisture content in butter. Ghee - major constituents - common adulterants added to ghee and their detection.	2	3
2.5	Paints as protective coatings, paints and enamels, materials for paint manufacture, oils used-unmodified oils and their pre-treatment.	3	4
2.6	Modified drying oils, resins and copolymers-natural resins, phenolic resins, alkyd resins, urethane resins, epoxy resins-Driers, thinners, pigments and miscellaneous ingredients.	3	4
2.7	Mechanism of polymerization and drying of oils-Varnishes and lacquers: composition and uses, oleo-resinous varnishes, defects in varnish films.	3	4
3.0	Flavour and perfume chemistry	18	
3.1	Concept of flavor, difference between perfumes and flavour. Flavour Characterisation.	3	5
3.2	Sensory analysis-descriptive and discriminant Sensory Analysis.	1	5
3.3	Flavour of Coffee, Tea, Cocoa, Onion and Garlic. Synthetic ingredients of food flavourings	3	5

3.4	Odour, Odorants, Olfaction, Classification of odour. General Physiology of Olfaction.	3	5
3.5	Perfume Raw materials-Terpenes and sesquiterpenes, oils, Concrete oils, Absolute oils, Isolates from essential oils, Tincture, Balsams and Resins.	3	5
3.6	Source and Chemical nature of commercially important Gums(Gum Arabic, Gum Tragacanth, Karaya Gum, British gum, Gum Myrrh), Balsams (Balsam of Peru, Balsam of Tolu, Styrax) and Resins (Copals, Turpentine, Dragon's Blood, Damars, Amber, Lacquer, Shellac, Kinins, Asafetida).	3	6
3.7	Perfume Technology-blending and formulation of perfumes. Aerosol Spray Perfumes	2	6
4.0	Drug Chemistry and Phyto-chemicals	18	
4.1	General Principles of Drug Therapy. Relationship between chemical structure, lipid solubility and biological activity of drugs. Stereochemistry and biological activity.	6	7
4.2	Antibiotics: Cell wall biosynthesis, inhibitors, β -lactam rings, antibiotics inhibiting protein synthesis. Synthesis of Penicillin G, Chloramphenicol and streptomycin.	6	7
4.3	Phytochemicals: Introduction to phytochemistry, Common phytochemicals and chemical defence, Importance and applications of phytochemicals in pharmacology	6	7
5.0	Green Chemistry and Nanotechnology	18	
5.1	Principles of green chemistry, basic concepts, atom economy, twelve laws of green chemistry, principles of green organic synthesis. Green solvents: ionic liquids, supercritical CO ₂ , fluorinated chemistry.	3	8
5.2	Green alternatives of organic synthesis: Condensation reactions like aldol condensation & Benzoin condensation, Oxidation reactions like Baeyer-Villiger oxidation & oxidation of ethyl alcohol to acetic acid, Reduction reactions like Clemmensen reduction & reduction of carbonyl compounds, Rearrangement reactions like pinacol-pinacolone rearrangement & benzil-benzilic acid rearrangement	3	8
5.3	Coenzyme catalysed reactions like oxidation of primary alkyl halide to carboxylic acid & oxidation of primary amine to carboxylic acid, Clay catalysed reactions like Beckmann rearrangement & oxidation of alcohol to carboxylic acid, Microwave assisted reactions like Cannizzaro reaction & Wittig reaction, Green photochemical reactions like photo reduction of benzophenone to benzopinacol & Paterno-Buchi reaction.	3	8
5.4	Basic principles of nanochemistry, Types of nanomaterials – carbon nanotubes, fullerenes, quantum dots, nanowires, nanocones, haeckelites, graphenes and metal nanoparticles.	3	9
5.5	Brownian motion, surface forces, self assembly, general methods of synthesis of nanomaterials – Top-down production, Bottom-up	3	9

	production (Any two methods).		
5.6	Applications of nanomaterials in medicine: Immunogold labelling. Applications in medical diagnosis, nano based drug delivery. biomimetic nanotechnology, DNA nanotechnology.	3	9

References:

1. Burger: Medicinal Chemistry (I. W.)
2. W. O. Foye: Principle of Medicinal Chemistry(I. E)
3. Lendieer and Metscher : The Organic Chemistry of Drug Synthesis(I. W.)
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5. Wilson and Gisvold: Text Book of Organic Medicinal and Pharmaceutical Chemistry
6. BhogavathiSomdavi: Applied Chemistry, MJP Publications, 2006
7. K. Sharma: Industrial Chemistry, GoelPublishingHouse, Meerut, 2011
8. K. Venkatraman: The Chemistry of Synthetic Dyes Vol. 1-7 (A.P)
9. Allan: Color Chemistry
10. M Ash & I Ash: A formulary of paints & other coatings
11. V.K. Ahluwalia, Methods and Reagents of Green Chemistry: An Introduction by Green Chemistry.
12. V. K. Ahluwalia, Green Chemistry- Greener alternatives to synthetic organicTransformations.

Course	Details			
Code	AC1924604			
Title	INDUSTRIAL OILS AND FAT PRODUCTS PRACTICAL			
Degree	M.Sc.			
Branch(s)	Applied Chemistry			
Year/Semester	2/IV			
Type	Practical			
Credits	4	Hrs/Week	3	Total Hours 54

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Reproduce the properties of oils, fats and waxes.	R	2
2	Explain various processes related to fats and oils and their products.	U	2
3	Decide the suitable method for the analysis of fats and oils.	E	2
4	Plan suitable technique for the extraction of oils and fats.	C	2
5	Interpret the results of adulteration tests.	Ap	2

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	Extraction and Processing of oils and fats	18	
1.1	Mechanical pre-treatment and heat treatment of oil bearing materials.	3	2
1.2	Rendering of animal fats and cooking of oil seeds. Mechanical expression of oils.	3	2
1.3	Solvent extraction- theory and practice, type of extractors, solvent recovery, alternative solvents for extraction, super critical fluid extraction of oils and fats.	3	4
1.4	Refining, bleaching, deodorization, fractionation, winterization, stabilization, solidification, homogenization, emulsification and dewaxing.	3	2
1.5	Study of the sources, composition, characteristics and utilization of commercially important oils and fats- butter, tallow, coconut oil, palm oil, cocoa butter, olive oil, rice bran oil, sesame oil, soybean oil, sunflower oil, linseed oil, mustard oil, castor oil.	6	1
2.0	Oils and fats as food materials and their Rancidity Process	18	
2.1	Cooking oil, salad oil, and salad dressings	2	1
2.2	Quality evaluation of cooking oils and salad oils.	2	2
2.3	Margarine and Shortenings	2	2
2.4	Essential fatty acids: ω -3 and ω -6 fatty acids and their dietary sources, significance to human nutrition and health.	2	2
2.5	Fat-related diseases: atherosclerosis, arthritis. Nutritional significance of EFA, HDL, LDL and VLDL.	2	2
2.6	Concept of autoxidation, theories of autoxidation, tests for	4	2

	rancidity, stability of oils, induction period.		
2.7	Pro oxidants and antioxidants.	2	2
2.8	Drying, semidrying and non-drying oils.	2	2
3.0	Hydrogenation of Oils & Fat Splitting and Esterification	27	
3.1	Catalytic hydrogenation: chemistry of hydrogenation, hydrogenolysis, influence of various factors in hydrogenation, mechanism, kinetics and thermodynamics of hydrogenation reactions, hydrogenation catalysts-theory of catalysis	5	2
3.2	Manufacture of catalyst for hydrogenation-Hydrogenation of vegetable and marine oils-manufacture of vanaspati.	3	2
3.3	Fat splitting: Twitchell process- low pressure splitting with catalysts, medium pressure autoclave splitting with catalyst, continuous uncatalysed high pressure counter current splitting, enzymatic splitting.	5	2
3.4	Recovery of glycerine from fat splitting process and spent lye.	2	2
3.5	Different grades of glycerine, chemistry and synthesis of glycerine.	2	2
3.6	Uses of glycerine, glycerine substitutes.	1	2
3.7	Esterification: mechanism of esterification and ester hydrolysis. Esterification of fatty acids with glycerol and other alcohols.	4	2
3.8	Inter esterification, acidolysisalcoholysis, glycolysis, glycerolysis.	3	2
3.9	Transesterification and its mechanism, applications of esterification and inter esterification.	2	2
4.0	Analysis of fats and oils	18	
4.1	Test methods for physical properties: melting point, softening point, slipping point, titer, congeal point.	2	3
4.2	Flow test, cloud test, consistency test, penetration method.	1	3
4.3	Liquid and solid fatty acid determination, solid fat index.	2	3
4.4	Specific gravity, refractive index, viscosity, color, odor.	2	3
4.5	Test methods for chemical properties: Iodine value, thiocyanogen number.	2	3
4.6	Saponification value, acid value and free fatty acid.	2	3
4.7	Oxirane oxygen, hydroxyl and acetyl value, peroxide value.	2	3
4.8	Reichert-Meissel value, Polenski value and Kirschner value, diene value. Estimation of poly unsaturated fatty acids-Kries test, thiobarbituric acid test	3	3
4.9	Adulteration of oils fats – detection of adulteration.	2	5
5.0	Waxes and Fatty alcohols	9	
5.1	Occurrence, classification, properties and composition of waxes.	2	1
5.2	Synthetic waxes.	2	2
5.3	Analysis and utilization of waxes.	2	2
5.4	Naturally occurring fatty alcohols – production, uses and applications .	2	1
5.5	Alcohol ethers.	1	1

References:

1. Swern, Bailey's Industrial Oil and Fat Products, Vol. I and II, 4th Edn., John Wiley, 1982.
2. T.H. Applewhite, Bailey's Industrial Oil and Fat Products, Vol. III 4th Edn. John Wiley, 1985.
3. E.S. Pattison, Fatty acids and their Industrial Applications, Marcel Dekker, 1968
4. A.J.C. Andersen, Refining for Oils and Fats for Edible Purposes, Pergamon Press, 1962.
5. F.D. Gunstone, An introduction to Chemistry and Biochemistry of Fatty acids and their Glycerides, Chapman and Hall, 1968.
6. T.P. Hilditch, P.N. Williams, The Chemical Constitution of Natural Fats, 4th Edn., John Wiley & Sons, 1964
7. H.A. Boekenogen, Analysis and Characterization of Oils, Fats and Fat Products Vol. I, Interscience, 1964
8. P. Tooley, Chemistry in Industry-Fats, Oils and Waxes, John Murray, 1971.
9. W.W. Christie, Lipid Analysis, 3rd Edn., Oily Press, 2003.
10. F. Rosengarten, The Book of Spices, Jove, 1981.
11. W. Parry, Hand Book of Spices, Chemical Publishing, 1969
12. J.S. Pruthi, Spices and Condiments Chemistry, Microbiology and Technology, Academic Press, 1980
13. Guenther, The Essential Oils, Vol I-VI, Van Nostrand, 1972.
14. L.H. Meyer, Food Chemistry, Reinhold, 1960.

Course	Details				
Code	AC1924605				
Title	ESSENTIAL OILS AND AROMATICS PRACTICAL				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	2/III&IV				
Type	Practical				
Credits	3	Hrs/Week	3	Total Hours	54

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Quantitatively analyze various parameters in fat products	An	3
2	Provide hands on experience in the preparation of cleaning agents	An	3
3	Develop skills in analyzing and grading soaps	C	3
4	Acquire advanced knowledge about industrially important oils and fats which would be helpful in pursuing a carrier in such industries	C	4

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	Analysis of Vanaspati (7 Hrs)	30	
1.1	Determination of the physical and chemical constants of hydrogenated fats.	10	1,4
1.2	Estimation of Vitamin A and Vitamin E content of Vanaspati.	10	1,4
1.3	Detection of animal fats in Vanaspati.	5	1,4
1.4	Estimation of nickel in catalyst mixture and spent catalyst	5	1,4
2.0	Soap Analysis	40	
2.1	Complete analysis of washing soaps, toilet soaps and transparent soaps: Moisture, alcohol soluble and insoluble's, free caustic alkali, combined alkali, anhydrous soap, titer, mean molecular weight and Iodine value of total fatty acids derived from soaps.	10	3,4
2.2	TFM value of toilet soaps.	10	3,4
2.3	Estimation of glycerine content of toilet soaps and transparent soaps.	10	3,4
2.4	Test for detection of rosin in soaps. Estimation of rosin in soaps	10	3,4
3.0	Estimation of Glycerol	20	
3.1	Estimation of glycerol in the given sample.	20	1,4
4.0	Preparation of different types of soaps	15	3&4
4.1	Washing soap, toilet soap, transparent soap, liquid soap, shaving soap.	15	3,4
5.0	Preparation of Detergents	03	
5.1	Preparation detergent powder, shampoo, vanishing cream.	03	3,4

References:

1. F. Shahidi, Bailey's Industrial Oil and Fat Products, 6th Edn., John Wiley & Sons, 2005.
2. I. Ash, M. Ash, Formulary of Detergents and other Cleaning Agents, Chemical Publishing, 1999.
3. H. Butler, Poucher's Perfumes, Cosmetics and Soaps, 10th Edn., Springer, 2000.

Course	Details				
Code	AC1924606				
Title	FIXED OILS AND FATS PRACTICAL				
Degree	M.Sc.				
Branch(s)	Applied Chemistry				
Year/Semester	2/III&IV				
Type	Practical				
Credits	3	Hrs/Week	4	Total Hours	72

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	To analyse of the physical and chemical constants of common oils and fats .	An	3
2	To analyse milk ,milk products and different parameters of water.	An	3
3	To familiarise and synthesise some common drugs like aspirin and paracetamol	An	3
4	To colorimetrically estimate the cholesterol in fats.	An	3
5	To isolate individual fatty acids from oils.	An	3

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C- Create.

Module	Course Description	Hrs	CO No.
1.0	Determination of the physical and chemical constants of common oils and fats	60	1
1.1	Moisture, Specific gravity, Refractive index, Acid value and free fatty acid, Saponification value, Iodine value, Non-saponifiable matter, Acetyl and hydroxyl value, Reichert Meissl value, Polenske and Kirschner value, peroxide value and color measurement of the following: 1. Coconut oil 2. Sesame oil 3. Palm oil 4. Olive oil 5. Castor oil 6. Ghee 7. Tallow	60	1
2.0	Analysis of milk, milk products, ghee and water	24	1,2
2.1	Detection of starch in milk.	2	2
2.2	Detection of formalin in milk.	2	2
2.3	Estimation of added glucose in milk.	2	2
2.4	Estimation of starch in milk.	2	2
2.5	Determination of total solids in milk.	2	2
2.6	Determination of fat in milk.	2	2
2.7	Determination of moisture in ghee.	2	1
2.8	Determination of free fatty acids in ghee.	2	1
2.9	Detection of vanaspathi in ghee.	2	1

2.10	Determination of RM and Polenske-values of ghee.	2	1
2.11	Determination of P ^H , TS, DO, TDS, COD, Hardness, Alkalinity, Chloride, Conductance etc. of water.	4	2
3.0	Simple experiments in Drug Chemistry	10	3
3.1	Preparation of aspirin	5	3
3.2	Preparation of paracetamol	5	3
4.0	Colorimetric estimation of cholesterol in fats	10	4
5.0	Preparation based on oils and fats	40	5
5.1	Preparations involving epoxidation, hydroxylation, bromination and chain scission of fatty acids. 1. Epoxystearic acids 2. Erythro-9, 10-dihydroxystearic acid 3. Threo-9, 10dihydroxystearic acid. 4. Tetrabromostearic acid. 5. Azelaic acid. 6. Sebacic acid. 7. Undecylenic acid.	25	5
5.2	Isolation of individual fatty acids from oils. 1. Isolation of palmitic acid from palm oil. 2. Isolation of erucic acid from mustard oil.	10	5
5.3	Preparation of rice bran oil by solvent extraction method.	5	5

References:

1. V.C. Mehlenbacher, Official and Tentative Methods of the American Oil Chemists Society Vol.1, 3rd Edn., The Society, 1954.
2. H.A. Boekenoogen, Analysis and Characterization of Oils, Fats and Fat Products, Interscience, 1954.
3. L.V. Cocks, C.V. Rede, Laboratory Hand Book for Oil and Fat Analysis, Academic Press, 1966.
4. F.D. Gunstone, An Introduction to the Chemistry and Biochemistry of Fatty Acids and their Glycerides, Chapman and Hall, 1968.
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9. M. Zaffer Ahmad and Muhammed Ali, Text book of pharmaceutical drug analysis, CBS publishers, 2009.
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