KARNATAK UNIVERSITY, DHARWAD
ACADEMIC (S&T) SECTION

ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಧಾರವಾಡ
ವಿದ್ಯಾಮಂಡಳ (ಎಸ್&ಟಿ) ವಿಭಾಗ

ಸ್ವಾತಂತ್ರ್ಯದ ಅಮೃತ ಮಹೋತ್ಸವ

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NAAC Accredited
'A' Grade 2014

website: kud.ac.in

No. KU/Aca(S&T)/JS/MGJ(Gen)/2024-25/436 Date: 11 NOV 2024

ಅಧಿಸೂಚನೆ

ವಿಷಯ: ರಾಷ್ಟ್ರೀಯ ಶಿಕ್ಷಣ ನೀತಿಯನುಸಾರ 2024–25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ಪದವಿಗಳಿಗೆ / ಸ್ನಾತಕೋತ್ತರ ಡಿಪ್ಲೋಮಾಗಳಿಗೆ ಪಠ್ಯಕ್ರಮವನ್ನು ಪ್ರಕಟಣೆ ಕುರಿತು.

ಉಲ್ಲೇಖ: 1. ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ನಿರ್ಣಯ ಸಂಖ್ಯೆ: 2 ರಿಂದ 9, ದಿ: 08.11.2024.

2. ಮಾನ್ಯ ಕುಲಪತಿಗಳ ಅನುಮೋದನೆ ದಿನಾಂಕ: 11.11.2024.

ರಾಷ್ಟ್ರೀಯ ಶಿಕ್ಷಣ ನೀತಿಯನುಸಾರ 2024–25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಅನ್ವಯವಾಗುವಂತೆ, ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯದ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ಪದವಿಗಳಾದ M.A./ M.Sc / M.Com / MBA / M.Ed 1 ರಿಂದ 4ನೇ ಸೆಮೆಸ್ಟರ್‌ಗಳಿಗೆ ಮತ್ತು 1 & 2ನೇ ಸೆಮೆಸ್ಟರ್‌ಗಳ ಸ್ನಾತಕೋತ್ತರ ಡಿಪ್ಲೋಮಾಗಳಿಗೆ ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ಅನುಮೋದನೆಯೊಂದಿಗೆ ಈ ಕೆಳಗಿನಂತೆ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಅಳವಡಿಸಿಕೊಳ್ಳಲಾಗಿದೆ. ಕಾರಣ, ಸಂಬಂಧಪಟ್ಟ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ವಿಭಾಗಗಳ ಅಧ್ಯಕ್ಷರು / ಸಂಯೋಜಕರು / ಆಡಳಿತಾಧಿಕಾರಿಗಳು / ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳು / ಶಿಕ್ಷಕರು ಸದರಿ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಅನುಸರಿಸುವುದು ಮತ್ತು ಸದರಿ ಪಠ್ಯಕ್ರಮವನ್ನು ಕ.ವಿ.ವಿ. ಅಂತರ್ಜಾಲ www.kud.ac.in ದಲ್ಲಿ ಭಿತ್ತರಿಸಲಾಗಿದನ್ನು ಸಂಬಂಧಪಟ್ಟ ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ ಸೂಚಿಸುವುದು.

Arts Faculty

Sl.No	Programmes	Sl.No	Programmes
1	Kannada	8	MVA in Applied Art
2	English	9	French
3	Folklore	10	Urdu
4	Linguistics	11	Persian
5	Hindi	12	Sanskrit
6	Marathi	13	MPA Music
7	MVA in Painting		

Faculty of Science & Technology

Sl.No	Programmes	Sl.No	Programmes
1	Geography	10	M.Sc (CS)
2	Chemistry	11	MCA
3	Statistics	12	Marine Biology
4	Applied Geology	13	Criminology & Forensic Science
5	Biochemistry	14	Mathematics
6	Biotechnology	15	Psychology
7	Microbiology	16	Applied Genetics
8	Zoology	17	Physics
9	Botany	18	Anthropology

-2-

Faculty of Social Science

Sl.No	Programmes	Sl.No	Programmes
1	Political Science	8	Journalism m & Mass Commn.
2	Public Administration	9	M.Lib. Information Science
3	History & Archaeology	10	Philosophy
4	A.I.History & Epigraphy	11	Yoga Studies
5	Economics	12	MTTM
6	Sociology	13	Women's Studies
7	MSW		

Management Faculty

Sl.No	Programmes	Sl.No	Programmes
1	MBA	2	MBA (Evening)

Faculty of Commerce

Sl.No	Programmes	Sl.No	Programmes
1	M.Com	2	M.Com (CS)

Faculty of Education

Sl.No	Programmes	Sl.No	Programmes
1	M.Ed	2	M.P.Ed

OEC subject for PG

Sl.No	Programmes	Sl.No	Programmes
1	Russian	5	Veman Peetha
2	Kanaka Studies	6	Ambedkar Studies
3	Jainology	7	Chatrapati Shahu Maharaj Studies
4	Babu Jagajivan Ram	8	Vivekanand Studies

PG Diploma

Sl.No	Programmes	Sl.No	Programmes
1	PG Diploma in Chatrapati Shahu Maharaj Studies	2	P.G. Diploma in Women's Studies
3	P.G. Diploma in Entrepreneurial Finance		

ಅಡಕ: ಮೇಲಿನಂತೆ

ಕುಲಸಚಿವರು.

ಗೆ,

1. ಕ.ವಿ.ವಿ. ಸ್ನಾತಕೋತ್ತರ ಅಧ್ಯಕ್ಷರುಗಳಿಗೆ / ಸಂಯೋಜಕರುಗಳಿಗೆ / ಆಡಳಿತಾಧಿಕಾರಿಗಳಿಗೆ / ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳಿಗೆ
2. ಎಲ್ಲ ನಿಖಾಯದ ಡೀನರು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.

ಪ್ರತಿ:

1. ಕುಲಪತಿಗಳ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
2. ಕುಲಸಚಿವರ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
3. ಕುಲಸಚಿವರು (ಮೌಲ್ಯಮಾಪನ) ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
4. ಅಧೀಕ್ಷಕರು, ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆ / ಗೌಪ್ಯ / ಜಿ.ಎ.ಡಿ. / ವಿದ್ಯಾಂಡಳ (ಪಿ.ಜಿ.ಪಿಎಚ್.ಡಿ) ವಿಭಾಗ/ ಸಿಸ್ಟಮ್ ಅನಾಲೆಸಿಸ್ಟ್ / ಸಂಬಂಧಿಸಿದ ಪದವಿಗಳ ವಿಭಾಗಗಳು, ಪರೀಕ್ಷಾ ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
5. ನಿರ್ದೇಶಕರು, ಕಾಲೇಜು ಅಭಿವೃದ್ಧಿ / ವಿದ್ಯಾರ್ಥಿ ಕಲ್ಯಾಣ ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
6. ನಿರ್ದೇಶಕರು, ಐ.ಟಿ. ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ ಇವರಿಗೆ ಕ.ವಿ.ವಿ. ಅಂರ್ತಜಾಲದಲ್ಲಿ ಪ್ರಕಟಿಸುವುದು.

KARNATAK UNIVERSITY, DHARWAD

NAAC Reaccredited with A Grade - 2022

M.Sc. General Chemistry

As per NEP - 2020

With effect from 2024-25

Department of Chemistry

About the Department

The Department of Chemistry was one of the earliest Centers of post–graduate teaching and research under the Bombay University (1953). Later, the newly formed Karnatak University has trodden the path of more than five decades. Presently, the Department offers four semester Masters (M.Sc.) program in the four branches of Chemistry viz., Inorganic, Organic, Physical & Analytical Chemistry with a unique blend of high quality teaching and rigorous student training.

PG Program in General Chemistry

Karnatak University, Dharwad offers Post-Graduate Programme (NEP) in General Chemistry at the following colleges.

1) Karnatak Science College, Dharwad (Constituent College).

2) JSS College, Dharwad (Affiliated College).

3) KSS College, Gadag (Affiliated College).

4) GC College, Ankola (Affiliated College).

5) SDM College, Honnavar (Affiliated College).

Theory question paper format for NEP Semester Examinations:

i) Each theory paper has following pattern of questions:

Questions	Particulars	Questions
Q: 1 (Compulsory)	Eight sub questions carry two marks each (2 questions from each unit).	**16 Marks**
Q: 2 to Q: 7	Six questions from four units will be given. Each question carries 16 marks. Any four questions are to be answered. There may be mixing of questions from different units in question numbers 6 and 7.	**16 × 4 = 64 Marks**
	Total	**80 Marks**
	Internal Assessment (Conducted during each semester)	**20 Marks**
	Grand Total	**100 Marks**

Each theory paper (except Open Elective Course) has a corresponding Practical Paper.

ii) Scheme of Practical Examination in all the four semesters is as follows:

Sl. No.	Particulars	Marks
1.	Experiment	**35 Marks**
2.	Viva-voce and Journal	**05 Marks**
3.	Internal assessment*	**10 Marks**
4.	Total	**50 Marks**
Duration of Examination: 4 hours		

*Conducted during the semester. Practical Internal Assessment will be conducted out of 40 marks and will be reduced to out of 10 Marks.

Basis for Internal Assessment:

Internal assessment marks in theory papers shall be based on tests. The tests may be conducted 8 to 12 weeks after the start of a semester. Internal assessment marks in practicals shall be based on tests. The practical test may be conducted 10 weeks after the start of a semester.

The other general academic regulations will be same as laid by University.

GENERAL INSTRUCTIONS

I. CREDIT, WORKLOAD AND SYLLABUS EQUIVALENCE

1. One credit is equal to 1 hour theory teaching per week.
2. One credit is equal to 2 hour practical teaching per week.
3. One credit is equal to 15 hours theory syllabus per semester (1 Unit is equal to 15 Hours)
4. One credit is equal to 30 hours practical syllabus per semester (1 credit practical is equal to 2 hours/ week)

A. Workload for theory subjects

1. There shall be 16 hrs/week workload for Assistant Professor
2. There shall be 14 hrs/week workload for Associate Professor/ Professor/Senior Professor.
3. There shall be 2hrs/week workload relaxation for Guiding Ph.D. students

B. Workload for practical subjects

1. There shall be 20 hrs/week workload for Assistant Professor
2. There shall be 18 hrs/week workload for Associate Professor/ Professor/Senior Professor.
3. There shall be 2hrs/week workload relaxation for Guiding Ph.D. students

C. Workload for practical batches

1. A batch of 10-12 students shall have 1 teacher

D. Workload for Project

1. Students for projects / internship shall be preferably guided by permanent faculty for atleast10 students by sharing equally among the permanent faculty. If remained excess shall be allotted to other teacher's on roll on temporary basis.
2. If there are no permanent faculty, the students shall be distributed among the temporary teachers on roll.
3. There shall be maximum of 4 hrs/week workload for guiding the students for project work irrespective of number of students.

II. ALLOTMENT OF SPECIALIZATION: While allotting specialization in 3rd and 4th semester, minimum of 10 students shall have to select the specialization.

III. ATTENDANCE: 75% attendance is mandatory for every course (paper). No marks are reserved for attendance. If the candidates fail to fulfill 75% attendance in any one

of the course (paper) in the given semester, such candidate is not eligible to appear for examination in all the papers and candidate has to get the readmission for such semester. However, up to 20% attendance may be condoned with the supportive documents for a student who represents University /State / National level sports, cultural and other events. Monthly attendance shall be displayed on notice board.

IV. CREDIT AND MARKS EQUIVALENCE

1. Generally, 20% weightage for Formative assessment and 80% weightage for Summative assessment.
2. Up to 2 credits equal to 50 marks (10 marks Formative assessment and 40 marks summative assessment).
3. 3-4 credits equal to 100 marks (20 marks Formative assessment and 80 marks summative assessment).
4. 5-6 credits equal to 150 marks (30 marks Formative assessment and 120 marks summative assessment).
5. Example for 100 marks out of which 20 marks for Formative assessment i.e., Formative Assessment shall be in two internal assessments i.e.: 10 marks I.A. for 8^{th} week and 10 marks for 14^{th}week of every semester.

V. Conduct of Examination

1. Formative assessment examination shall be conducted for 1hr. There shall not be any provision for improvement. A special Formative assessment examination shall be conducted for a student who represents University /State / National level sports, cultural and other events if a schedule is overlapping.

2. 80 marks summative theory examination shall be conducted for 3 hrs and 40 marks for 1.5 hrs.

3. 80/ 40 marks Formative / Summative Practical examination shall be conducted for 4 hrs.

4. There shall be a single examiner for both even and odd semesters' Formative Practical examination.

5. There shall be a single examiner for odd semester Summative Practical examination and two examiners for even semester Summative Practical

examination; one from internal and other shall be external examiner.

VI. Assessment

1. **Theory papers:** There shall be a single valuation for odd semester theory papers preferably internal examiner and double valuation for even semesters; one from internal and other shall be external examiner.
2. **Project/Internship assessment**

A) **For 100 marks Project/Internship assessment (Wherever applicable)**

i. **Formative Assessment**: Project/Internship assessment carrying 20 marks out of 100 marks Candidate has to submit two Progress Reports; each carries 10 Marks. i.e. 10 x 2= 20 marks.

ii. **Summative Assessment**: Project/Internship assessment carrying 80 marks out of 100 marks

   a. Project Report : 35
   b. Presentation : 25
   c. Viva-voce : 20

B) For150 marks **Project/Internship assessment (Wherever applicable)**

i. **Formative Assessment**: Project/Internship assessment carrying 30 marks out of 150 marks Candidate has to submit two Progress Reports; each carries 15 Marks. i.e. 15 x 2= 30 marks.

ii. **Summative Assessment:** Project/Internship assessment carrying 120 marks out of 150 marks

   a. Project Report : 60
   b. Presentation : 35
   c. Viva-voce : 25

VII. Passing criteria:

1. There shall be no minimum passing marks for Formative assessment.

2. Candidate has to score minimum 40% in summative examination and fulfill 40% of the maximum marks including Formative assessment marks. For example: for 80 marks summative examination, candidate has to score minimum of 32 marks (40%) and should score cumulatively 40 marks including formative assessment in every course.

VIII. DECLARATION OF RESULT

1. Candidate has to score 40% as above in all the courses to pass the semester end examination to declare pass.
2. **Percentage and Grading:** Result shall be declared in terms of SGPA and at the end of four semesters as CGPA. The calculation of CGPA is as under
3. If P is the percentage of marks secured (IA + semester end score) by the candidate in a course which is rounded off to the nearest integer, the grade point (GP) earned by the candidate in that course will be given as below.

Percentage (%)	Grade(GP)	Percentage (%)	Grade(GP)
40	4.0	71-75	7.5
41-45	4.5	76-80	8.0
46-50	5.0	81-85	8.5
51-55	5.5	86-90	9.0
56-60	6.0	91-95	9.5
61-65	6.5	96-100	10.0
66-70	7.0		

Grade point of less than 4 shall be considered as fail in the course, hence, GP=0 and for the absent candidate also GP=0

4. A student's level of competence shall be categorized by grade point (GP), Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) of the programme.
5. **Semester Grade Point Average (SGPA):** The SGPA is a ratio of sum of the number of Credit Grade Points scored from all the courses (subject) of given semester to the total credits of such semester in which the candidate studied. (Credit Grade Points of each course = Credits x GP).
6. **Cumulative Grade Point Average (CGPA):** It is calculated as below for 4 semester programme.

   CGPA=$(Credit_1 \times SGPA_1) + (Credit_2 \times SGPA_2) + (Credit_3 \times SGPA_3) + (Credit_4 \times SGPA_4)$ / Total credits of programme (sum of credits of 4 semesters).
7. After studying and passing, all the credits prescribed for the programme the degree shall be awarded with CGPA score after rounding off to second

decimal and class distinguishing as second class, first class, and distinction along with grade letter as under:

CGPA of the programme(Degree)	Class obtained	Grade Letter
9.5 to 10.00	Outstanding	A^{++}
7.00 to 9.49	Distinction	A^{+}
6.00 to 6.99	First Class	A
5.50 to 5.99	Second class	B^{+}
5.00 to 5.49		B
4.00 to 4.99	Pass	C
Less than 4.0	Fail/ Reappear	D

8. Each semester Grade Card shall have marks and SGPA and final Grade Card shall have semester wise marks obtained in all semesters, CGPA and % of cumulative marks obtained from all semesters.
9. There shall be Revaluation / Challenge valuations provisions as per the prevailing rules and regulations.
10. Marks obtained from the OEC shall not be considered for award of CASH PRIZE / RANK / GOLD MEDAL.

IX. MAXIMUM DURATION FOR COMPLETION OF THE PROGRAMME

A candidate admitted to any P.G. Programme shall complete it within a period, which is double the duration of the programme from the date of admission.

X. ANY OTHER TERMS AND CONDITIONS

Apart from the above, the prevailing rules and regulation are valid for any other matters which are not addressed in this regard

KARNATAK UNIVERSITY, DHARWAD
M.Sc. DEGREE PROGRAMME IN GENERAL CHEMISTRY
(With effect from 2024-25)
(NEP - 2020)
Course Structure and Scheme of Examination

FIRST SEMESTER

Semester	Type of Course	Theory / Practical	Course Code	Course Title	Credits	Instruction Hour /Week	Total Hours/Sem	Duration Of Exam	Marks		
									Formative	Summative	Total
I	DSC – 01	Theory	A1CHE001GT	Inorganic Chemistry - I	04	04	60	03	20	80	100
	DSC – 02	Theory	A1CHE002GT	Organic Chemistry - I	04	04	60	03	20	80	100
	DSC – 03	Theory	A1CHE003GT	Physical Chemistry - I	04	04	60	03	20	80	100
	DSC – 04	Theory	A1CHE004GT	Analytical Chemistry	04	04	60	03	20	80	100
	DSC – 05	Practical	A1CHE005GP	Lab Course in Inorganic Chemistry	02	04	60	04	10	40	50
	DSC – 06	Practical	A1CHE006GP	Lab Course in Organic Chemistry	02	04	60	04	10	40	50
	DSC – 07	Practical	A1CHE007GP	Lab Course in Physical Chemistry	02	04	60	04	10	40	50
	DSC – 08	Practical	A1CHE008GP	Lab Course in Analytical Chemistry	02	04	60	04	10	40	50
TOTAL									120	480	600

SECOND SEMESTER

Semester	Type of Course	Theory / Practical	Course Code	Course Title	Credits	Instruction Hour /Week	Total Hours/Sem	Duration Of Exam	Marks		
									Formative	Summative	Total
II	DSC – 09	Theory	A2CHE001GT	Inorganic Chemistry - I	04	04	60	03	20	80	100
	DSC – 10	Theory	A2CHE002GT	Organic Chemistry - I	04	04	60	03	20	80	100
	DSC – 11	Theory	A2CHE003GT	Physical Chemistry - I	04	04	60	03	20	80	100
	OEC - 01	Theory	A2CHE204GT	Applied Inorganic Chemistry	04	04	60	03	20	80	100
	DSC – 12	Practical	A2CHE005GP	Lab Course in Inorganic Chemistry	02	04	60	4	10	40	50
	DSC – 13	Practical	A2CHE006GP	Lab Course in Organic Chemistry	02	04	60	4	10	40	50
	DSC – 14	Practical	A2CHE007GP	Lab Course in Physical Chemistry	02	04	60	4	10	40	50
TOTAL									110	440	550

THIRD SEMESTER
GENERAL CHEMISTRY

Semester	Type of Course	Theory / Practical	Course Code	Course Title	Credits	Instruction Hour /Week	Total Hours/Sem	Duration Of Exam	Marks		
									Formative	Summative	Total
III	DSC – 15	Theory	A3CHE001GT	Inorganic Chemistry -III	04	04	60	03	20	80	100
	DSC– 16	Theory	A3CHE002GT	Organic Chemistry -III	04	04	60	03	20	80	100
	DSC – 17	Theory	A3CHE003GT	Physical Chemistry -III	04	04	60	03	20	80	100
	OEC – 02	Theory	A3CHE204GT OR A3CHE205GT	Applied Organic Chemistry OR Applied Physical Chemistry	02	04	60	04	10	40	50
	DSC – 18	Practical	A3CHE006GP	Lab Course in Inorganic Chemistry	02	04	60	04	10	40	50
	DSC – 19	Practical	A3CHE007GP	Lab Course in Organic Chemistry	02	04	60	04	10	40	50
	DSC – 20	Practical	A3CHE008GP	Lab Course in Physical Chemistry	02	04	60	04	10	40	50
TOTAL									110	440	550

FOURTH SEMESTER

GENERAL CHEMISTRY

Semester	Type of Course	Theory / Practical	Course Code	Course Title	Credits	Instruction Hour /Week	Total Hours/Sem	Duration Of Exam	Marks		
									Formative	Summative	Total
IV	DSC – 21	Theory	A4CHE001GT	Inorganic Chemistry -IV	04	04	60	03	20	80	100
	DSC - 22	Theory	A4CHE002GT	Organic Chemistry -IV	04	04	60	03	20	80	100
	DSC - 23	Theory	A4CHE003GT	Physical Chemistry -IV	04	04	60	03	20	80	100
	DSC – 24	Practical	A4CHE004GP	Project Work	06	04	60	08	30	120	150
	DSC – 25	Practical	A4CHE005GP	Lab Course in Inorganic Chemistry	02	04	60	04	10	40	50
	DSC – 26	Practical	A4CHE006GP	Lab Course in Organic Chemistry	02	04	60	04	10	40	50
	DSC – 27	Practical	A4CHE007GP	Lab Course in Physical Chemistry	02	04	60	04	10	40	50
TOTAL									120	480	600

***** Project Evaluation:

Dissertation – 60 Marks

Presentation and Viva-Voce – 60 Marks

Program Outcomes:

After the completion of this Program the student will

1. be able to appreciate the theory as well as practicals in such a way to foster their core competency and discovery learning.
2. Learnt to handle sophisticated equipments for the determination and characterization of chemical compounds.
3. have knowledge of the latest chemistry software to avoid the laborious work in research.
4. be sufficiently competent in the field to understand further discipline specific studies as well as to begin domine related employment.
5. will be able to design and carryout scientific experiments and accurately record and analyze the results of the experiments.
6. have global level research opportunities to pursue Ph.D. programme.
7. be able to explore new areas of research in both chemistry and allied fields such as Biochemistry, Material Chemistry, Pharmaceutical chemistry and chemical biology and related technology.
8. have enormous job opportunities at all levels of teaching, chemical, pharmaceutical, food products, life oriented material industries.
9. be moulded as a responsible citizen who will be aware of most basic domain-independent knowledge including critical thinking and communication.
10. prepare himself for national as well as international competitive examinations, especially UGC-CSIR-NET and UPSC civil service examinations.

KARNATAK UNIVERSITY, DHARWAD

DEPARTMENT OF CHEMISTRY

SYLLABUS FOR M.Sc. GENERAL CHEMISTRY

NEP - 2020

(With effect from the Academic Year 2024-25)

FIRST SEMESTER

Program learning outcomes:

After completion of this program successfully,

1. Students understand the structures of ionic crystals, simple molecules and coordination compounds through different theories.
2. Students learn acid-base concepts and chemical reactions in non-aqueous, ionic liquids and supercritical fluids as media.
3. Students understand the elements of solid state chemistry, molecular solids, band theory, non-stoichiometric compounds and quantitative analyses skills will be developed.
4. Students will understand the structural information which helps them to predict the mechanism, stereochemical aspects of the molecule and structure reactivity.
5. Students can design and synthesize required molecules for the various pharmaceutical as well as material science applications.
6. Students will understand the various reactions by performing various experiments as well as reagents properties, functions and its MSDS.
7. Understand the mathematical aspects of quantum mechanics and their application.
8. Impart the students with different laws and concepts of thermodynamic.
9. Understand the theories of reaction kinetics, chain reaction and factors affecting reaction kinetics.
10. Students understand the theory behind ion-solvent and ion-ion interaction in solutions.
11. Imparting the importance of effect of temperature on chemical reaction.
12. Understand the heat of neutralization of acids and bases.
13. Understand the fundamentals of analytical chemistry with emphasis on validation parameters and statistical data treatment.
14. Learn different titrimetric methods of analysis.

M.Sc. Semester – I
Inorganic Chemistry (Theory)

Course Title: Inorganic Chemistry-I
Course Code: A1CHE001GT

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC - 01	**Theory**	**04**	**04**	**60 Hrs.**	**3 Hrs.**	**20**	**80**	**100**

Course outcomes (COs):

After completion of this course successfully,

1. Students will understand the structures of ionic solids, simple molecules/ions and transition metal complexes.
2. Students will understand the CFT and MOT bonding theories of metal complexes.
3. Students will be able to interpret the electronic spectra of coordination compounds.
4. Students will gain the knowledge of preparation, geometries of different coordination numbers and stability of complexes.
5. Students will appreciate various acid-base concepts and their applications in different fields besides the reactions in non-aqueous solvents.
6. Students will understand fundamentals of lattices, crystal systems, atomic packing, molecular solids and non-stoichiometric compounds.
7. Students will understand the chemistry of lanthanides, actinides and their applications.

Inorganic Chemistry - I : A1CHE001GT	**60 Hrs.**
UNIT I : Structures and energetics of Inorganic molecules	**15 Hrs.**
Chemical Periodicity: Review of periodic properties Structures and energetics of ionic crystals: Properties of ionic compounds, crystal lattices, closed packed structures, coordination number of an ion, radius ratio rule, structures of crystal lattices- NaCl, CsCl, ZnS, fluorite and rutile. Lattice enthalpies- Born Lande equation, Born-Haber cycle, Uses of Born-Haber type of calculations. Covalent character in ionic bonds, Fajan's rules, hydration energy and solubility of ionic solids. Structures and energetics of inorganic molecules: Resonance, hybridisation and energetics of hybridization.VSEPR theory- Deduction of molecular shapes. M.O. theory of homo and heteronuclear molecules and M.O. treatment for the molecules/ions (BF_3, H_2O, $NO_2^-$and CO_2). Walsh diagrams and Bent's rule.	
UNIT II: Coordination chemistry	**15 Hrs.**
Coordination numbers (2-10) and their geometries. Isomerism in metal complexes (structural and stereoisomerism). Crystal field theory of coordination compounds: octahedral, square planar, tetrahedral, trigonal bipyramidal and square pyramidal fields, measurement of crystal field splitting energy(10 Dq) and factors affecting it, CFSE, Spectrochemical series, Jahn-Teller effect.	

Structural evidences for ligand field splittings – hydration and lattice energies. Evidences for covalency in M-L bonding. MO theory of coordination compounds- MO energy level diagrams for octahedral and tetrahedral complexes with and without pi-bonding. Electronic spectra: Spectroscopic ground state term symbols for free metal ions (3d-series), Selection rules, electronic spectra of octahedral and tetrahedral complexes (3d series) based on Orgel diagrams. Calculation of spin-only magnetic moments of tetrahedral, square planar and octahedral complexes.	
UNIT III: Metal complexes, concepts of acids and bases, and non-aqueous solvents	**15 Hrs.**
Review of IUPAC nomenclature of coordination compounds. Preparation of coordination compounds-simple addition reactions, substitution reactions and oxidation-reduction reactions, Step-wise and overall formation constants, factors affecting stability of metal complexes, Thermodynamic aspects: the Irving-William series, chelate effect. Determination of stability constants of metal complexes by spectrophotometric methods. Concept of acids and bases: Modern Theories of acids and bases – Lewis acids and bases, Lux-Flood theory, Usanovich concept, solvent system, differentiating solvent and leveling effect of solvents. HSAB concept and its applications. Non-aqueous solvents: Classification of solvents, Properties of non-aqueous solvents. Reactions in non-aqueous media; liquid ammonia, anhydrous sulphuric acid, anhydrous HF, liquid sulphur dioxide. Reactions in molten salts. Super acids and super bases. Supercritical fluids: Properties of supercritical fluids and their uses as solvents. Supercritical fluids as media for inorganic chemistry.	
UNIT IV: Solid state chemistry	**15 Hrs.**
Space lattice and basic unit cells, Crystal systems and Bravais lattices, classification of space lattice by crystal systems and their structures, the relation between interatomic distance (d) and atomic radius(R) of cubic unit cells. The Atomic packing factor of BCC, FCC and primitive unit cell and their examples, atomic positions in cubic unit cells with origin at eight corners of the cube, directions in cubic unit cells, direction of indices in cubic unit cells, Miller indices for crystallographic planes in cubic unit cells. Volume, planar and linear density calculations of cubic unit cells. X-ray diffraction method. Molecular solids: Hydrogen bonding, metallic, covalent and ionic solids; structural classification of binary and tertiary compounds, Determination of simple structure-spinel and perosvskite structures. Band theory, conductors, semiconductors and insulators, energy bands, intrinsic and extrinsic semiconductors. Conductivity: electrons and holes, temperature dependence on conductivity, industrial applications of semiconductors. Non stoichiometric compounds: Perfect and imperfect crystals, intrinsic and extrinsic defects, point, line and plane defects. Vacancy, Schottky and Frenkel defects. Schottky and Frenkel defect formation, F- centres, non-stoichiometric defects.	

Recommended Books:

1. Inorganic Chemistry-Principles of Structure and Reactivity, 4th Ed. J. E. Huheey, E. A. Keiter, R. L. Keiter and O. K. Medhi. Pearson Education, 2009.
2. Shriver & Atkins' Inorganic Chemistry, 5th Ed. P. Atkins, Tina Overton, J. Rourke, Mark Weller and F. Armstrong. Oxford University Press, 2010.
3. Inorganic Chemistry, 5th Ed. Catherine E. Housecroft and A.G. Sharpe, Pearson Prentice Hall, 2018.
4. Concise Inorganic Chemistry-J. D. Lee, 5th Ed, New Age International, 1996.
5. Solid State Chemistry and its Applications- A. R. West, John-Wiley and sons, 2007.
6. Inorganic Chemistry- Gary L. Miessler and Donald A. Tarr, 3rd Ed, Pearson, 2016.
7. Fundamental Concepts of Inorganic Chemistry – A. K. Das, Vol. 3, 2nd Ed, CBS publishers, New Delhi, 2010.
8. Fundamental Concepts of Inorganic Chemistry, Vol. 4, A. K. Das and Mahua Das, CBS publishers, New Delhi, 2014.

Formative Assessment for Theory		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
02	Internal Assessment test 2	10
	Total	20 Marks
Formative Assessment as per the guidelines		

M.Sc. Semester – I
Inorganic Chemistry (Practical)

Course Title: Lab Course in Inorganic Chemistry
Course Code: A1CHE005GP

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC - 05	**Practical**	**02**	**04**	**60 Hrs.**	**4 Hrs.**	**10**	**40**	**50**

Course outcomes:

After completion of this course successfully,

1. Students understand the determination of various analytes present in binary mixtures, different ore/alloy samples by volumetric and gravimetric methods.
2. Students understand the chemistry of redox, complexometric and indirect methods.

Lab Course in Inorganic Chemistry : A1CHE005GP	**60 Hrs.**
Experiments 1. Determination of iron in hematite ore using cerium (IV) solution (0.02M) as the titrant and gravimetric determination of insoluble residue. 2. Determination of calcium and magnesium carbonates in dolomite ore using EDTA titration and gravimetric analysis of insoluble residue. 3. Quantitative analysis of copper-nickel in alloy/mixture: i. Copper volumetrically using KIO_3 ii. Nickel gravimetrically using DMG 4. Determination of lead and tin in a mixture: Analysis of solder using EDTA. 5. Determination of Cr (III) and Fe (III) in a mixture: Kinetic masking. 6. Quantitative determination of iron (III) gravimetrically and calcium(II) volumetrically in a mixture. 7. Determination of iron (II) and nickel (II) in a mixture: i) Iron (II) volumetrically using $K_2Cr_2O_7$ solution ii) Nickel gravimetrically using DMG solution 8. Quantitative analysis of chloride and iodide in a mixture: i) Iodide volumetrically using KIO_3 ii) Total halide gravimetrically 9. Preparation of complexes: i) Tris (thiourea)copper(I) sulphate monohydrate ii) Mercury tetrathiocyanatocobaltate(II) 10. Demonstration: Colorimetric determination of Fe (II) using 1,10-phenanthroline.	

Recommended Books:

1. Fundamental of Analytical Chemistry, D. A. Skoog, D.M. West, Holler and Crouch 8th Ed, Saunders College Publishing, New York, 2005.
2. Analytical Chemistry, G.D. Christian, 5th Ed, John Wiley & Sons, Inc, India, 2001.
3. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R. C. Denney, J. D., 6th Ed, Pearson, 2009.
4. Practical Inorganic Chemistry– G. Pass and H. Sutcliff, Chapman and Hall Ltd, 1968.

Formative Assessment for Practical		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
	Total	10 Marks
Formative Assessment as per the guidelines		

M.Sc. Semester – I
Organic Chemistry (Theory)

Course Title: Organic Chemistry-I
Course Code: A1CHE002GT

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC - 02	**Theory**	**04**	**04**	**60 Hrs.**	**3 Hrs.**	**20**	**80**	**100**

Course Outcomes :

After completion of this course successfully, the student will be able to

1. Provide an insight into physical concepts of structure and bonding.
2. Understand the concepts related to the structure and reactivity.
3. Predict the reactivity based on physical concepts.
4. Understand the insights of aromaticity.
5. Have an idea about the basic stereochemistry and isomerism of organic molecules.

Organic Chemistry-I : A1CHE002GT	**60 Hrs.**
UNIT–I: Bonding in Organic Molecules	**15 Hrs.**
Localized chemical bonding: Hybridization index, bonding in cyclopropane, bond distances, bond angles, bond energies, bond polarity, dipole moment and calculation of heat of reactions. M.O. and V.B. methods (Huckel's MO Method, pictorial representation of MOs for organic molecules, Qualitative application of MO theory to reactivity). Delocalized chemical bonding: Conjugation, cross conjugation, steric inhibition of resonance, hyperconjugation, tautomerism, valence tautomerism. Bonding in fullerenes. **Bonding weaker than covalent:** Hydrogen bonding, EDA complexes, inclusion compounds, complexes of crown ethers, catenanes and rotaxanes. Supramolecular chemistry: Host-guest systems, crowns, cryptands, clathrates and inclusion complexes. Structure and reactivity: Brönsted-Lowry concept of organic acids, conjugate acids and bases, pH, pKa values. Electronic, steric, and solvent effects on their strengths. General and specific acid base catalysis, running scale of acidity. Lewis acids and bases. HSAB concept.	
UNIT–II: Organic Reaction Mechanisms	**15 Hrs.**
Classification of organic reactions: Meaning and importance of reaction mechanism. Methods of determination of reaction mechanisms. **Kinetic methods:** order and molecularity, mechanistic implications from rate laws. **Non–kinetic methods:** Product identification, cross over experiments, study of intermediates, isotopic labeling, kinetic isotope effects and stereochemical studies.	

Nucleophilic substitutions (aliphatic): Mechanisms of S_N2, S_N1 (rearrangements in S_N1 reactions) and S_Ni, $S_{RN}1$ pathways. Effects of structure, leaving groups and ambident nucleophiles. **Elimination Reactions:** E_2, E_1, E_1CB pathways. Stereochemistry, product proportions in dehydration of alcohols, alkyl halides (chiral and achiral), Hoffmann and Saytzeff rules. Substitution v/s elimination and pyrolytic eliminations.	
UNIT-III: Stereochemistry and Conformational Analysis	**15 Hrs.**
Elements of symmetry and chirality, optical isomerism, optical activity, specific rotation. molecules with one asymmetric center. Fischer, Wedge and 3D representations, DL and RS systems indicating configuration. Ring compounds, molecules with two chiral centers: Fischer, Saw–Horse, Newmann projections and their transformations. Enantiomers, diastereomers, epimers, racemization, resolution. Stereochemical correlation. Pseudo–asymmetric compounds. **Geometrical isomerism:** E–Z nomenclature, properties of geometrical isomers, configuration of geometrical isomers and *syn*– & *anti*– isomers. **Conformational analysis:** Conformational study of n–Butane, ethylene glycol, chlorohydrin, 1,2–dichloroethane, 2-aminoethanol, and Curtin–Hammett principle. Effect of Conformation on reactivity: Stereo electronic effects.	
UNIT–IV: Aromaticity	**15 Hrs.**
Aromaticity and Huckel's rule: HMO theory, energy level diagrams, möbius systems, benzenoid and non–benzenoid aromatic compounds. Tropones, tropolones, borazine and azulene. **Heterocyclic Systems:** Systems of the type pyrrole, pyridines, pyrilium cation, ferrocene. alternant and non-alternant hydrocarbons. Aromaticity of charged rings (3-8 membered), non aromatic, anti–aromatic and homo aromatic systems. **Physical methods to study aromaticity:** X-ray, UV and ^{1}H NMR methods. **Ring current as criteria for aromaticity:** Annulenes and heteroannulenes [10-18].	

Books Recommended:

1. Organic Chemistry - P. Y. Bruice, 8th Ed, Pearson Education Pvt. Ltd., New Delhi (2020).
2. Organic Chemistry - S. H. Pine, 5th Ed, McGraw-Hill, London (2006).
3. Mechanism and Structure in Organic Chemistry - E. S. Gould. Holt, Rinehart & Winston of Canada Ltd. (1969)
4. Organic Chemistry–R. T. Morrison and R.T. Boyd, Prentice Hall, New Delhi (2008).
5. Organic Chemistry–T. W. Graham Solomons, 4th Ed, John Wiley and Sons (1988).
6. Organic Chemistry–G. M. Loudon, 4th Edition, Oxford University Press, New York (2002).
7. Organic Chemistry Volume–I, II–I. L. Finar, 6th Ed, ELBS London (2004).
8. Organic Chemistry–F.A. Carey, 4th Edition, McGraw Hill (2000).
9. Advanced Organic Chemistry, Reactions, Mechanism and Structure - J. March, 7th Ed, Wiley Eastern Ltd. (2015).
10. Stereochemistry–Conformation and Mechanism - P. S. Kalsi, New Age International Pvt Ltd, New Delhi (2022).

11. Guidebook to Mechanism in Organic Chemistry - P. Sykes. 6th Ed, Orient Longman, London (2003).
12. Aromaticity – P. J. Garratt, McGraw Hill Book Company (1971).

Formative Assessment for Theory		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
02	Internal Assessment test 2	10
	Total	20 Marks
Formative Assessment as per the guidelines		

M.Sc. Semester – I
Organic Chemistry (Practical)

Course Title: Lab Course in Organic Chemistry
Course Code: A1CHE006GP

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 06	**Practical**	**02**	**04**	**60 Hrs.**	**4 Hrs.**	**10**	**40**	**50**

Course outcomes (COs)

After completion of this course successfully, the students will be able to

1. Understand the methods preparation of various organic molecules involving aromatic electrophilic substitution reactions, oxidation of ketones, rearrangement reactions etc.
2. Various techniques of organic reactions such as room temperature and reflux reactions.
3. Purify the impure organic solids by crystallization.
4. Determine the melting point of pure organic solids.

Lab Course in Organic Chemistry : A1CHE006GP	**60 Hrs.**
Experiments **Preparation of the following organic compounds:** 1. Benzoic acid and benzyl alcohol from benzaldehyde (Cannizarro reaction). 2. Cyclohexanone from cyclohexanol. 3. Reduction of *p*-nitrobenzaldehyde to *p*-nitrobenzylalcohol. 4. 2,4-Dinitrophenol from chlorobezene. 5. Benzil from benzaldehyde. 6. *m*-Nitroaniline from nitrobenzene. 7. *m*-Nitro benzoic acid from ethyl benzoate. 8. Benzanilide from benzophenone (Beckmann rearrangement). 9. *p*–Bromoaniline from acetanilide. 10. *p-Nitroaniline* from acetanilide.	

Recommended Books:

1. Vogel's Textbook of Practical Organic Chemistry Revised–B. S. Furniss, A. J. Hannaford, P.W.G. Smith, A. R. Tatchell, 5th Ed, Addison Wesley Longman Limited, UK, 1997.
2. A Hand book of Organic Chemistry – by H. T. Clarke.
3. A Laboratory Manual of Organic Chemistry by B. B. Dey and M. V. Govindachari.

4. Lab Experiments in Organic Chemistry–by Arun Sethi, New Age International Ltd. New Delhi. 2010.

Formative Assessment for Practical		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
	Total	10 Marks
Formative Assessment as per the guidelines		

M.Sc. Semester – I
PHYSICAL CHEMISTRY (Theory)

Course Title: PHYSICAL CHEMISTRY-I
Course Code: A1CHE003GT

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 03	**Theory**	**04**	**04**	**60 Hrs.**	**3 Hrs.**	**20**	**80**	**100**

Course Outcomes

The completion of this course will enable students to understand

1. The concepts and theoretical basis underlining Quantum Mechanics, Thermodynamics, Reaction kinetics and Electrochemistry which will create a base and facilitate students' comprehension of universal physics concepts at the chemistry interface.
2. This will help students to gain an insight to describes the ambiguous behavior of nature at the scale of sub-atomic particles and the solution to handle such behavior, universal principles of energy transfer, transformation, predicting the feasibility, spontaneity of chemical reactions, investigations on the influence of experimental conditions on the speed of a chemical reaction and the rinciples, dynamics and activities of electrochemical systems.
3. The students will also be introduced to the modern techniques developed for the practical applications of these concepts in various scientific and technological fields of relevance.

PHYSICAL CHEMISTRY-I (Theory): A1CHE003GT	**60 Hrs.**
UNIT–I: Quantum Mechanics – I	**15 Hrs.**
Review of Classical Mechanics, Newtonian, Lagrange's and Hamiltonian's equation of motion, Blackbody radiation, Photoelectric effect, de Broglie wave-particle duality hypothesis, uncertainty principle and its experimental evidence, Inadequacy of classical mechanics and development of quantum mechanics, Postulates of quantum mechanics, Schrodinger's, and Heisenberg's formulation of quantum mechanics. Need for operators, Linear and Hermitian operators, operator algebra, eigen value and eigen functions, commutation relations Dynamics of microscopic systems: Schrödinger wave equation, time-independent and time dependent Schrödinger wave equation, interpretation of wave function, properties of wave function, Solution of Schrödinger's equation for the particle in ID-, 2D- and 3D-boxes and applications, degeneracy, normalization and orthogonality of wave function,Superpositions and expectation values, Potential energy barrier, quantum mechanical tunneling and its experimental evidences.	
UNIT–II: Thermodynamics	**15 Hrs.**
Review of the basic thermodynamic concepts. Laws of thermodynamics.	

Standard states. Thermodynamic functions and their relationships: Gibbs-Helmholtz and Maxwell relations, Gibbs-Duhem equation, Van't Hoff equation. Criteria of spontaneity and equilibrium. Nernst equation and its application in relating electrode potential and thermodynamic quantities. Partial molar quantities. Thermodynamics of mixing. Chemical potential. Fugacity, activity and activity coefficients. Ideal and Non-ideal solutions, Deviations in Raoult's Law and Henry's Law, Chemical equilibria. Calculating $\Delta G_{reaction}$ and introducing equilibrium constant for mixture of ideal gases. Dependence of equilibrium constant on temperature and pressure.	
UNIT–III: Reaction Kinetics	**15 Hrs.**
A critical account of collision and transition state theories, Arrhenius and Eyring equations and their applications. Kinetics and mechanism: Steady state approximation and simple examples relating kinetics to mechanism, theories of unimolecular reactions: Hinshelwood and RRKM treatments, isomerization of methyl isocyanides. Chain Reactions: Chain reactions and examples, general aspects of chain reactions. Chain-length, chain transfer reactions, chain inhibition, kinetics of branching chain reactions and explosion limits.	
UNIT–IV: Electrochemistry – I	**15 Hrs.**
Introduction to electrochemistry, Ion solvent interaction: Structure of most common solvent water, size and dipole moment of water molecules in solution, Born model for calculating the free energy of ion-solvent interaction and its modifications.Ion- Ion interaction: nature of the electrolyte and the relevance of ion-ion interactions, the Debye Huckel theory of ion-ion interaction Ionics, The Debye-Hückel–Onsager theory for non-aqueous solutions, thesolvent effect on mobility at infinite dilution and on the concentration of free ions: Ion Association, effect of ion association on conductivity, Ion-Pair formation and columbicforces, Triple ions and Higher aggregates formed in nonaqueous solutions.	

Books Recommended

1. Introduction to Quantum Chemistry by A. K. Chandra, Ed. 3, Tata McGraw Hill, New Delhi, 1988.
2. Quantum Chemistry by R. K. Prasad, New Age International Publications, New Delhi, 1997.
3. Quantum Chemistry by Eyring, Walter and Kimball, John-Wiley, New York, 1961.
4. Physical Chemistry by G. M. Barrow, McGraw Hill, New York, 1996.
5. Fundamentals of Physical Chemistry by Maron and Lando, 1979.
6. Physical Chemistry by P. W. Atkins, ELBS, London, 1990 (Ed. 4).
7 The Elements of Physical chemistry, 2dn ed., Peter Atkins, W.H. Freeman and Company, New York, 1998.

8 Physical Chemistry, Hu Ying, Scientific International China, 2017.
9. Principles of Physical Chemistry, 4th ed., Samuel H. Maron, and Carl F. Prutton, Oxford and IBH, New Delhi, 1972.
10. Physical Chemistry by K. Vamulapalli, Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
11. Physical Chemistry by Daniels and Alberty, Wiley, New York, 1961.
12. Physical Chemistry through Problems by S. K. Dogra and S. Dogra, Wiley Eastern, New Delhi, 1984.
13. A Text Book of Physical Chemistry by Samuel Glasstone, McMillan, London, 1943.
14. Atomic Structure and Chemical Bonding by Manas Chanda, Tata McGraw Hill Publishing Co., New Delhi, 2019.
15. Chemical Kinetics by K. J. Laidler, Tata McGraw Hill Publishing Co., New Delhi, 1965.
16. Kinetics and Reaction Mechanisms by Frost and Pearson, Wiley, New York, 1961.
17. An Introduction to Electrochemistry by S. Glasstone, Van Nostrand, London, 1942.
18. A Text book of Electrochemistry by G.F.A. Kortum and J.O.M. Bockris, *Elsevier*, New York, 1951.
19. Modern Electrochemistry by J.O.M. Bockris and A. K. N. Reddy Vol. I and Vol. II, Butterworth, London, 1970.

Formative Assessment for Theory		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
02	Internal Assessment test 2	10
	Total	20 Marks
Formative Assessment as per the guidelines		

M.Sc. Semester – I
Physical Chemistry (Practical)

Course Title: Lab Course in Physical Chemistry
Course Code: A1CHE007GP

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 07	**Practical**	**02**	**04**	**60 Hrs.**	**4 Hrs.**	**10**	**40**	**50**

Course Outcomes

This practical course typically includes a variety of skills and knowledge areas like
At the end of the course student will be able to

1. Understand the practical aspects of reaction kinetics, thermochemistry, phase equilibria, viscosity measurements, determination of order of a reaction, various effects on reaction rates, various activation parameters and study mechanism, enthalpy and ionization energies, solubility, association and dissociation effects of solute between immiscible solvents and molecular parameters like radius of molecules.
2. Application of instrumentation techniques: practical skills in using instruments like conductometers, spectrophotometers, potentiometers, pH-meters and refractometers.

Lab Course in Physical Chemistry: A1CHE007GP	**60 Hrs.**
Experiments 1. General information and chemical mathematics: Calibration of glassware, concentration measures of solutions: concept of normality, molarity, molality and mole fraction, and preparation of standard solution. 2. Statistical treatment of experimental data: Errors, type of errors, accuracy and precision, mean deviation, standard deviation, significant figures, methods of average and least squares. **Non-Instrumental** 3. Chemical Kinetics: Determination of activation parameters for the acid hydrolysis of methyl acetate at two distinct temperatures. 4. Density of liquids: a. Determination of molar and partial molar volumes of given liquids (methanol, ethanol etc.) at room temperature b. Determination of apparent molal and partial molal volumes of given liquids (methanol, ethanol, acetone etc.) in dilute aqueous solutions. 5. Phase equilibria: Studying the distribution of a given solute (benzoic acid, succinic acid etc.) between water and benzene and to determine the	

degree of association of benzoic acid in benzene.

6. Viscosity: Determination of radius of glycerol molecule by viscosity measurements relative to water.
7. Thermochemistry: Determination of the heat of neutralization of a strong acid (HCl, H_2SO_4 etc.) and a weak acid (acetic acid, formic acid etc.) and calculation of the heat of ionization of the weak acid.
8. Self-generated experiment.

Instrumental

9. Spectrophotometry:
   a. Verification of the Beer–Lambert law by obtaining the absorption curve of $KMnO_4$ solution on a colorimeter.
   b. To obtain the calibration curve for the Fe^{3+}-KCNS and Cu^{2+}-NH_3 system anddetermination of unknown concentration of Fe^{3+} and Cu^{2+} in a given solution.
10. Potentiometry: Determination of the dissociation constant of
    a. weak monobasic acid (Acetic acid, Formic acid etc.)
    b. weak dibasic acid (Oxalic acid, Succinic acid etc.)
11. Conductometry: Conductometric titrations of
    a. Weak acid with weak base, strong acid with weak base and weak acid with strong base.
    b. Mixture of strong and weak monobasic acidwith strong base and to estimate the composition and concentration of strong and weak acids
    c. Mixture of strong monobasic acidand weak dibasic acid (oxalic acid/succinic acid) with strong base and to estimate the composition and concentration of strong and weak acids.
12. Refractometry:
    a. Determination of the molar refraction of a solid substance by dissolving it in a solvent.
    b. Determination of the composition of an unknown mixture of two given liquids by refractive index measurements.

Books Recommended:

1. Practical Physical Chemistry by A. M. James and F. E. Prichard, Longmans, London, 1923.
2. Experiments in Physical Chemistry by Shoemaker and Garland, McGraw Hill, New York, 1964.
3. Experiments in Physical Chemistry by Daniels, Alberty and Willams, McGraw Hill, New York, 1970.

4. Experimental Physical Chemistry by W. G. Palmer, Cambridge University Press, London, 1946.
5. Advanced Physico-Chemical experiments by J. Rose, 1965.
6. Text Book of Physical Chemistry by S. Glasstone, McGraw Hill, London, 1969.
7. Text Book of Quantitative Chemical Analysis by A. I. Vogel, ELBS, Harlow, 1996.
8. Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publishing House, 1999.
9. Experimental Physical Chemistry by V. D. Athawale and Parul Mathur, New Age International Publishers, 2001.
10. Advanced Physical Chemistry Experiments by Gurtu and Gurtu, Pragati Prakashan Education Publishers, 3rd Edition 2007.

Formative Assessment for Practical		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
	Total	10 Marks
Formative Assessment as per the guidelines		

M.Sc. Semester – I
Analytical Chemistry (Theory)

Course Title: Analytical Chemistry -I
Course Code: A1CHE004GT

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 04	**Theory**	**04**	**04**	**60 Hrs.**	**3 Hrs.**	**20**	**80**	**100**

Course outcomes:

1. Students will have the knowledge to select an analytical method to achieve accuracy, precision and also have an understanding about statistical treatment of results.
2. Students will understand the basic principles of titrimetric analysis with emphasis on the understanding of complexometric, redox and precipitation titrations.
3. The students will learn the fundamentals of chromatography and classification of chromatographic techniques like column, TLC and HPLC besides methodologies and applications.
4. Students will get the knowledge about gas chromatography, ion exchange chromatography and solvent extraction.

Analytical Chemistry -I : A1CHE004GT	**60 Hrs.**
UNIT-I: Language of Analytical Chemistry, Data Treatment and Gravimetric Analysis	**15 Hrs.**
Language of analytical chemistry: Definition of analysis, determination, measurement, techniques and methods. Classification of analytical techniques. Selection of an analytical method: Accuracy, precision, sensitivity, selectivity, robustness and ruggedness. Figures of merit of analytical methods: Sensitivity, detection limit and linear dynamic range. Errors and Treatment of analytical Data: Limitations of analytical methods–Errors: determinate and indeterminate errors, minimization of errors. Significant figures. Statistical treatment of finite samples, mean, median, range, standard deviation, % RSD and variance. Student's t-test, analysis of variance (ANOVA) confidence interval of mean. Testing for significance and comparison of two means and two standard deviations. Comparison of an experimental mean and a true mean. Criteria for the rejection of an observation, Q-test. Standard/calibration graph/curve, the least squares methods, regression equation and correlation coefficient. Gravimetric analysis: Stages involved in gravimetric analysis. Mechanism of precipitation, factors influencing precipitation, co-precipitation, post-precipitation and organic reagents used in gravimetry (oxine, salicylaldoxime and cupferron). Numerical problems.	
UNIT-II: Volumetric Methods	**15 Hrs.**
Titrimetric Analysis: Principles of titrimetric analysis. Classification of reactions in titrimetry. Titrations based on acid-base reactions: Titration curves for strong acid and	

strong base, weak acid and strong base and weak base and strong acid titrations. Quantitative applications (alkalinity, acidity, ammonium salts, free carbon dioxide in water samples), selecting and standardizing a titrant. Complexometric titrations: Indicators for EDTA titrations, theory of common indicators, titration methods employing EDTA, direct, back and displacement titrations, indirect determinations, conditions for selectivity in EDTA titrations, titration of mixtures using masking and demasking agents. Redox Titrations: Balancing redox equations, calculation of the equilibrium constant of redox reactions, titration curves, theory of redox indicators, calculation of standard potentials, and determination of chemical oxygen demand (COD) and biological oxygen demand (BOD) in natural and waste waters. Precipitation titrations: Titration curves, titrants and standards, indicators for precipitation titrations involving silver nitrate, the Volhard, the Mohr's and the Fajan's methods. Numerical problems.	
UNIT-III: Separation Methods I	**15 Hrs.**
Fundamentals of chromatography: General description, definition, terms and parameters used in chromatography, classification of chromatographic methods, criteria for selection of stationary and mobile phase and nature of adsorbents. Column chromatography: Theories, plate theory, rate theory, band broadening-eddy diffusion, longitudinal diffusion and resistance to mass transfer, column efficiency, van Deemter's equation and its modern version, interrelationships, capacity factor, selectivity factor, column resolution, distribution constant and applications of conventional column chromatography, advantages and limitations. Affinity chromatography: Principle and applications. Thin layer chromatography (TLC): Definition, mechanism, efficiency of TLC plates, methodology, selection of stationary and mobile phases, development, spray reagents, identification and detection, reproducibility of R_f values, qualitative and quantitative analysis (organic and inorganic compounds). High performance liquid chromatography (HPLC): Instrumentation, methodology, isocratic and gradient elution, pumps, column packing, characteristics of liquid chromatographic detectors, UV and fluorescence detectors, advantages and applications. Stability indicating studies. Basics of preparative HPLC. Numerical problems.	
UNIT-IV: Separation methods-II	**15 Hrs.**
Gas chromatography (GC): Principle, instrumentation, columns, study of detectors, thermal conductivity, flame ionization and mass spectrometry, factors affecting separation, retention volume, retention time and applications. GCMS: Principle, instrumentation and applications. Ion exchange chromatography (IEC): Definition, principle, requirements for ion-exchange resin, types of ion-exchange resins, resin properties-ion-exchange capacity and its determination, resin selectivity and factors affecting the selectivity, applications of IEC in purification and recovery processes. Solvent extraction: Nernst partition law, efficiency and selectivity of extraction. Extraction systems: Extraction of covalent neutral molecules, extraction of uncharged metal chelates and synergic extraction, extraction of ion-association complexes-non chelated complexes and chelated complexes. Use of salting out agents. Methods of	

extraction: batch and continuous extractions. Applications (special emphasis on extraction of iron and copper). Numerical problems.	

Recommended Books:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D. M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York, (2005).
2. Analytical Chemistry, G. D. Christian, 6th Ed, Wiley, India (2007).
3. Quantitative Analysis, R. A. Day and A. L. Underwood, 6th Ed, PHI Learning Pvt. Ltd. New Delhi, (2009).
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, 5th Ed, (1989)
5. J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, Pearson Education Pvt. Ltd. (2007).
6. Analytical Chemistry Principles, John H. Kennedy, 2nd Ed, Saunders College (2018).

Formative Assessment for Theory		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
02	Internal Assessment test 2	10
	Total	20 Marks
Formative Assessment as per the guidelines		

M.Sc. Semester – I
Analytical Chemistry (Practical)

Course Title: Lab Course in Analytical Chemistry
Course Code: A1CHE008GP

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 08	**Practical**	**02**	**04**	**60 Hrs.**	**4 Hrs.**	**10**	**40**	**50**

Course outcomes:

After the completion of the course,

1. Students get hands on experience in the use of various instruments to understand the instrumentation.
2. Students will gain the in-depth knowledge and skill in organic separations, purification and qualitative analysis.
3. Students will be able to understand the concepts of electrochemistry, Thermodynamics and surface chemistry.

Lab Course in Analytical Chemistry: A1CHE008GP	**60 Hrs.**
Experiments **I. Organic Chemistry Practical** **Quantitative analysis** 1. Titrimetric Estimation of amino acids. 2. Estimation of glucose by Bertrand's method. 3. Estimation of keto-group. 4. Iodine value of oil (Chloramine-T method) 5. Estimation of Nitro group by reduction using $SnCl_2$. **Qualitative Analysis** Separation of binary mixture of organic compounds using ether and identification of separated compounds by systematic qualitative organic analysis. Please Note: 1) Individual organic compounds are to be given after the candidate reports the nature of the mixture. 2) Ether insoluble acids and ether insoluble neutral organic compounds may be given. 3) Low boiling liquids and amino acids need not be given. The following mixtures may be given: 1. Acid + Base 2. Acid + Neutral 3. Base + Neutral 4. Phenol + Acid 5. Base + Phenol	

II. Physical Chemistry practicals 1. Determination of molecular radius of glycerol molecule by viscosity method. 2. Determination of metal ions of ferric-thiocyanate and copper-ammonia complexes by spectrophotometrically. 3. Determination of relative strength of acids (HCl and H_2SO_4) by studying the hydrolysis of methyl actetate. 4. Determination of dissociation constants of weak monobasic acids potentiometrically by titrating against NaOH. 5. Comparison of strengths of chloroacetic acid and acetic acid using Conductometric method. 6. Determine the dissociation constant of acetic acid pH-metrically by titrating against NaOH.	

Recommended Books:

1. Practical Physical Chemistry by A. M. James and F. E. Prichard, Longmans, London (1974).
2. Experiments in Physical Chemistry by Shoemaker and Garland, McGraw Hill, New York (2011).
3. Experiments in Physical Chemistry by Daniels, Alberty and Willams, McGraw Hill, New York (2006).
4. Experimental Physical Chemistry by W. G. Palmer, Cambridge University Press, London (1949).
5. Advanced Physico-Chemical experiments by J. Rose. 6. Text Book of Physical Chemistry by S (1964).
6. Physical Chemistry, S. Glasstone, , McGraw Hill, London.
7. Text book of Quantitative Analysis by A. I. Vogel, ELBS, Harlow (2021).
8. Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publishing House.
9. Experimental Physical Chemistry by V. D. Athawale and Parul Mathur, New Age International Publishers (2001).
10. Advanced Physical Chemistry Experiments by Gurtu and Gurtu, Pragati Prakashan Educational Publishers, 3rd Edition (2007).

Formative Assessment for Practical		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
	Total	10 Marks
Formative Assessment as per the guidelines		

SECOND SEMESTER

Program learning outcomes:

After completion of the program, Students will

1. Learn basic chemistry of some selected group elements.
2. Understand the properties and structures of metal carbonyls, nitrosyls and clusters
3. learn the application of symmetry and group theory in molecules and spectroscopy
4. Have the skill for the qualitative analysis of various mixtures containing 5 radicals.
5. Have idea about the Reaction mechanism and its conditions helps to students for understanding the type of the reaction, major minor products formation, sterochemical changes in the products.
6. Understand carbohydrates and its biopolymers properties as well as synthesis, reactions and biological importance of heterocycles.
7. Understand and identify the functional groups by performing experiments and importance of the functional groups in various useful transformations as well as reagents properties, functions and its MSDS.
8. Have the basic knowledge of quantum mechanics and properties of hydrogen atoms in terms of wave function.
9. Gain the fundamental knowledge solution kinetics of fast reactions and also effect of solvent and ionic strength on the concentration of the reactions and also, electrochemistry of Metal-Water interaction.
10. Understand the fundamental concept in polymers and types of polymers, polymerization, classification, solubility, chemical reaction of polymers.
11. Study the effect of added salt, heat of solution of a solute, viscosity average molecular weight of a polymer, enthalpy of neutralization of weak acid.
12. Understand the importance of formal redox potential of ferrous-ferric system, limiting equivalent conductance of a weak electrolyte, Ostwald's dilution law and dissociation constant of a weak acid.

M.Sc. Semester – II
Inorganic Chemistry (Theory)

Course Title: Inorganic Chemistry-II
Course Code: A2CHE001GT

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 09	**Theory**	**04**	**04**	**60 Hrs.**	**3 Hrs.**	**20**	**80**	**100**

Course outcomes:

After the completion of the course,

1. Students will understand the chemistry of p-block elements, inorganic polymers, metal carbonyls, nitrosyls and clusters.
2. Students will understand preparation and chemistry of various binary compounds including hydrides, chlorides, oxides and oxoacids.
3. Students will understand the interhalogen compounds and noble gas compounds.
4. Students will understand the symmetry and group theory of various molecules and its applications.

Inorganic Chemistry-II : A2CHE001GT	**60 Hrs.**
UNIT I: Chemistry of non-transition elements	**15 Hrs.**
Alkali and alkaline earth metal complexes of crown ethers, cryptands and calixarenes and their biological importance. Hydrogen bonding and its influence on properties. Synthesis, properties, reactivity and structures of boron, carbon and silicon compounds: Trihalides of Al, Ga, In and Tl. Chalcogenides, Chemistry of higher boranes, classification, structures and M.O. description of bonding, framework electron counting, Wade's rules, chemistry of B_5H_9, $B_{10}H_{14}$ and $B_nH_n^{2-}$, metalloboranes,boron nitride, borazines, carboranes, metallocarboranes; silicate minerals, aluminosilicates, zeolites- preparation and applications, silicones, Allotropes of carbon (graphite, diamond, C_{60} fullerene, graphene, carbon nanotubes).	
UNIT II: Chemistry of main group elements	**15 Hrs.**
Preparation, reactivity and structures of nitrogen, phosphorous and sulphur compounds: Hydrides, oxides and oxo acids of Nitrogen, Phosphorous, Sulphur and halogens; phosphazines, phosphazene polymers, P-O and P-S cage compounds, Chain polyphosphates. Sulphur-nitrogen compounds: binary sulphur nitrides- S_4N_4, S_2N_2 and $(SN)_x$. Chemistry of halogens and Xenon: Interhalogens, psuedohalogens, polyhalogen cations, polyhalide anions, oxyhalogen species. Aqueous chemistry of group 17 elements. Xenon oxides,	

fluorides, chlorides, oxofluorides and oxochlorides. Compounds of Ar, Kr & Rn. Clathrates of noble gas compounds.	
UNIT III: Symmetry and group theory	**15 Hrs.**
Molecular symmetry, representation of symmetry operation as matrices. Definition of groups, set of symmetry operations of molecules satisfying the condition of point groups. Representation, basis of representation, reducible and irreducible representation. The great orthogonality theorem and its consequences, character tables. The direct product. Applications of group theory - Molecular vibrations, group theoretical selection rules for electronic transitions, for IR and Raman spectra, Hybridization.Molecular transforming properties of atomic orbitals.	
UNIT IV: Metal carbonyls, nitrosyls and clusters	**15 Hrs.**
Metal carbonyls– Binding modes of carbon monoxides, pi (π) acidity of CO, back bonding, Synergic effect, 18-electron rule, mononuclear carbonyls, low nuclear carbonyl clusters, high nuclear carbonyl clusters and calculation of number of M-M bonds. Prediction of nature of metal framework using polyhedral skeletal electron pair theory (PSEPT) in high nuclear clusters. Preparative methods, structure and bonding, IR spectroscopy of metal carbonyls, magnetic properties and reactions of metal carbonyls.Metal carbonylates and carbonyl halides – preparation and important reactions. Metal nitrosyls: Binding modes of NO, factors favoring linear and bent M-N-O linkage, synthesis of heteroleptic nitrosyl complexes, relative instability of homoleptic nitrosyl complexes and structural aspects of some nitrosyl complexes (Roussin's salts, nitroprusside and brown ring complexes). Bimetallic clusters: Quadruple bonding in dinuclear clusters containing halide, acetate, phosphine and mixed ligands and calculation of M-M bond order.	

Recommended Books:

1. Inorganic Chemistry-Principles of Structure and Reactivity, 4thEd - J. E. Huheey, E. A. Keiter, R. L. Keiter and O.K. Medhi. Pearson Education, 2009.
2. Inorganic Chemistry, 5th Edn. Catherine E. Housecroft and A.G. Sharpe, Pearson Prentice Hall, 2018.
3. Chemical Applications of Group Theory -F. A. Cotton, 2nd Ed. Wiley Eastern Ltd, 2005.
4. Symmetry and Spectroscopy of Molecules-K. Veera Reddy, New Age International, 2011.
5. Group Theory in Chemistry - M. S. Gopinathanan and V. Ramakrishnan, Vishal Publishing Co., 2007.
6. Organometallic Chemistry - A unified Approach, R.C. Mehrotra and A. Singh, 2nd Ed. New Age International, 2011.
7. Chemistry of the elements, N.N. Greenwood and A. Earnshaw, 2nd Ed., Butterworth & Heinemann publishers, 1997.

8. Basic Organometallic Chemistry – B D Gupta and A J Elias, 2nd Ed., Universities Press, 2013.
9. Inorganic Chemistry- Gary L. Miessler and Donald A. Tarr, 3rd Ed, Pearson, 2016.
10. Fundamental Concepts of Inorganic Chemistry – A. K. Das, Vol 2, 2nd Ed, CBS publishers, New Delhi, 2010.
11. Fundamental Concepts of Inorganic Chemistry – A. K. Das and Mahua Das, Vol 6, CBS publishers, New Delhi, 2014.
12. Cluster Chemistry- Guillermo Gonzalez-Moraga, Springer-Verlag Berlin Heidelberg, New York, 1993.
13. Multiple bonds between metal atoms – F. A. Cotton, C. A. Murillo and R. A. Walton, 3rd Edn, Springer Science and Business Media, Inc. 2005.

Formative Assessment for Theory		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
02	Internal Assessment test 2	10
	Total	20 Marks
Formative Assessment as per the guidelines		

M.Sc. Semester – II
Inorganic Chemistry (Practical)

Course Title: Lab Course in Inorganic Chemistry
Course Code: A2CHE005GP

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC - 12	**Practical**	**02**	**04**	**60 Hrs.**	**4 Hrs.**	**10**	**40**	**50**

Course outcomes:

After the completion of the course,

1. Students will understand the principles involved in the semi-microanalysis of inorganic salt mixtures.
2. Students will understand the chemistry involved in each semi-micro test of acid and basic radicals.

Lab Course in Inorganic Chemistry : A2CHE005GP	**60 Hrs.**
Experiments 1. Semi-micro qualitative inorganic analysis of a mixture containing three cations (including one less common cation such as W, Mo, Ti, Zr, Ce, and Li) and two anions (one of them may or may not be interfering anion such as PO_4^{3-}, BO_3^{3-}, $C_2O_4^{2-}$, F^- and CH_3COO^-). 2. Demonstration experiment: Solvent extractionof iron using 8-hydroxyquinoline.	

Recommended Books:

1. Vogel's Text Book of Quantitative Chemical Analysis (5th Ed), G. H. Jeffrey, J. Bassette, J.Mendham and R. C.Denny, Longman, 1999.
2. Vogel's Qualitative Inorganic Analysis (7th Ed), G.Svehla, Longman, 2001.

Formative Assessment for Practical		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
	Total	10 Marks
Formative Assessment as per the guidelines		

M.Sc. Semester – II
Organic Chemistry (Theory)

Course Title: Organic Chemistry-II
Course Code: A2CHE002GT

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 10	**Theory**	**04**	**04**	**60 Hrs.**	**3 Hrs.**	**20**	**80**	**100**

Course Outcomes (COs)

After completion of this course successfully, the student will be able to

1. Understand the insights of the reaction mechanism (Both aliphatic and aromatic).
2. Provide the insights on the factors responsible for prochirality and optical activity.
3. Write the stereochemical structures of the substituted cyclohexanes.
4. Appreciate the structures and properties of mono and disaccharides etc.
5. Understand systematic names and synthetic methods of the five member and benzfused heterocycles.

Organic Chemistry-I (Theory) : A2CHE002GT	**60 Hrs.**
UNIT-I: Reaction Mechanism	**15 Hrs.**
Aliphatic electrophilic substitutions: Bimolecular pathways. S_E2, S_E1 and S_Ei mechanisms. Reactions involving double bond shifts, α-halogenation of aldehydes, Ketones, aliphatic diazonium coupling, nitrosation at carbon bearing active hydrogen, mercury exchange reactions. **Aromatic electrophilic substitutions:** Mechanisms of aromatic, nitration, sulphonation, halogenation, isotope effects, energy profile diagrams. Kinetic and thermodynamic control, amination and sulphonation, Hammond's Postulate, o/p ratio, ipso–substitution, Vilsmeir Haack, Pechmann condensation, Fischer-Hepp rearrangement and Fries rearrangement. **Aromatic nucleophilic substitutions:** S_NAr, S_N1 and aryne pathways. Meisenheimer complexes, mechanism and synthetic applications of Vicarious Nucleophilic Substitution (VNS), Von-Richter, Goldberg, Bucherer, Shiemann reactions and Smiles rearrangement.	
UNIT-II: Advanced Stereochemistry	**15 Hrs.**
Prochirality: Homotopic, enantiotopic and diastereotopic atoms, groups and faces. **Stereochemical descriptors:** Application to reduction of carbonyl compounds, cyanohydrin formation, addition of water to alkenes. **Optical activity due to molecular dissymmetry:** Allenes, spiranes, biphenyls-atropisomerism, molecular crowding.	

Conformational analysis of cyclohexane, mono substituted and disubstituted (1,2, 1,3, 1,4) cyclohexanes, di– & tri–substituted cyclohexanones, *cis*- and *trans*–decalins. Chirality of cyclohexanes.	
UNIT–III: Carbohydrates	**15 Hrs.**
Monosaccharides: Conformational representation of monosaccharides and their transformations. Determination of configuration of the monosaccharides, mechanism of mutarotation–base catalyzed isomerisation of aldoses and ketoses. Epimerisation, anomeric effect, glycosides, ether and ester derivatives of carbohydrates. Amino sugars (β-D-glucosamine, galactosamine, N-acetylmuramic acid (NAMA), N-acetyl neuraminic acid (NANA) and deoxysugars. Oxidation and reduction reactions of carbohydrates. **Disaccharides:** Structure elucidation of maltose, lactose, sucrose, gentiobiose and meliobiose. **Trisaccharides:** Raffinose and melezitose. **Polysaccharides:** Structure and degradation of starch, cellulose and glycogen.	
UNIT–IV: Chemistry of heterocycles	**15 Hrs.**
Nomenclature of heterocyclic compounds: (i) Hantzhsch-Widmann (ii) Replacement Nomenclature. Structure, synthesis, reactivity and chemical reactions of indole, benzofuran, quinoline, isoquinoline, thiazole, imidazole, benzimidazole, coumarin, chromones, flavones and isoflavones.	

Recommended Books:

1. Advanced Organic Chemistry, Part A and B - F. A. Carey and R. J. Sundberg, 4th Ed, Plenum Publishers (2000).
2. Advanced Organic Chemistry, Reactions, Mechanism and Structure – J. March, 3rd Ed, Wiley Eastern Ltd. (2004).
3. Guide Book to Mechanism in Organic chemistry - Peter Sykes Oriant- Longman (1985).
4. Stereochemistry of Carbon Compounds–Eliel, Tata McGraw Hill, New Delhi (1976).
5. Stereochemistry of Organic Compounds, Principles and Applications – D. Nasipuri, Wiley Eastern Ltd (1992).
6. Organic Chemistry Vol-I, II, III–S. M. Mukherji, S. P. Singh and R. P. Kapoor, New Age International Ltd, New Delhi (2000).
7. Organic Chemistry Volume–I, II– I. L. Finar, 6th Ed, ELBS London (2004).
8. Chemistry of Carbohydrates–G. C. Percival.
9. Carbohydrates –Chemistry and Biochemistry –Pigman and Harton.
10. Heterocyclic Chemistry–T. L. Gilchrist, 3rd Edition, Pearson Education Delhi, (2005).
11. Heterocyclic Chemistry –J.A. Joule and G.F. Smith, 2nd Ed, Van Nostrand London (1978).
12. Heterocyclic Chemistry–R. K. Bansal, 3rd Ed, New Age Interantional, New Delhi, 2004.

13. https://profiles.uonbi.ac.ke/sderese/files/upc_213nomenclature_of_heterocyclic_compounds_0.pdf

Formative Assessment for Theory		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
02	Internal Assessment test 2	10
	Total	20 Marks
Formative Assessment as per the guidelines		

M.Sc Semester – II
Organic Chemistry (Practical)

Course Title: Lab Course in Organic Chemistry
Course Code: A2CHE006GP

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 13	**Practical**	**02**	**04**	**60 Hrs.**	**4 Hrs.**	**10**	**40**	**50**

Course outcomes (COs)

After completion of this course successfully, the students will be able to….

1. Determine the amount of acid and ester/amides present in the mixture.
2. Determine the molecular weight.
3. Get hands on experience to synthesize the heterocyles.
4. Utilize the functional groups in the organic synthesis.

Lab Course in Organic Chemistry: A2CHE006GP	**60 Hrs.**
Experiments 1. Quantitative Estimation of the following Organic compounds: (i) Acid (ii) Acid + Amide (iii) Acid + Ester (iv) Molecular weight determination by base hydrochloride method (v) Phenol (Bromometric method). 2. Preparations of derivatives of heterocycles like coumarins, quinolines, benzimidazoles, benzoxazines, pyrazoles. 3. Preparations based on functional group reactions of organic compounds like aldehydes, ketones, esters, phenols etc. Note: Any two of the above experiments will be prescribed for the examination.	

Recommended Books:

1. Vogel's Textbook of Practical Organic Chemistry Revised–B. S. Furniss, A.J. Hannaford, P.W.G. Smith, A.R. Tatchell, 5th Edition, Addison Wesley Longman Limited, UK, 1997.
2. A Hand book of Organic Chemistry– H.T. Clarke.
3. A Laboratory Manual of Organic Chemistry–B. B. Dey and M. V. Govindachari.
4. Lab Experiments in Organic Chemistry - Arun Sethi, New Age International Ltd. New Delhi. 2006.
5. Experimental Organic Chemistry- L. M. Harwood, and C. J. Moody, Blackwell Scientific, London, 1989.
6. Practical Organic Chemistry - W. Kemp, McGraw Hill, London, 1967.

Formative Assessment for Practical		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
	Total	10 Marks
Formative Assessment as per the guidelines		

M.Sc. Semester – II
PHYSICAL CHEMISTRY (Theory)

Course Title: PHYSICAL CHEMISTRY-II
Course Code: A2CHE003GT

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 11	**Theory**	**04**	**04**	**60 Hrs.**	**3 Hrs.**	**20**	**80**	**100**

Course outcomes

The completion of this course will enable students to understand

1. The interpretation of quantum systems and its application to simple molecular models, factors influencing the reaction dynamics in solutions and techniques to follow fast reactions, electrochemical models and electrochemistry occurring at interfaces and about polymers: their types, synthesis, stereochemistry, thermal and various other properties that can be fined tuned for practical application as per the needs.
2. Application of these theoretical concepts in various practical problems and gaps that still exists in different areas of science and technology.

PHYSICAL CHEMISTRY-II (Theory): A2CHE003GT	**60 Hrs.**
UNIT–I: Quantum Mechanics-II	**15 Hrs.**
Interpretation of quantum mechanics: Copenhagen interpretation and Bohr's interpretation, Quantum superimposition and Schrodinger's cat thought experiment. Rigid rotator, derivation of selection rules for transitions in rotating molecule, linear harmonic oscillator, Hermite polynomials. Equation for hydrogen atom and its solutions, separation of variables, the phi, theta and radial equations, the problems of spherical symmetry, the quantum numbers and their significance**.** Hydrogen-like atoms, properties of the H–atom wave functions. Electronic energy states of H–atom. Many electron systems and the self-consistent field method. Spectroscopic term symbols.	
UNIT–II: Solution Kinetics	**15 Hrs.**
Kinetics in Solution:Effect of solvent, pressure and ionic strength for ion–ion, ion–neutral molecule type reactions and cage effects. Potential energy surfaces, features and construction of potential energy surfaces, theoretical calculation of energy of activation Fast Reactions: Techniques for fast reactions, flow methods, stopped flow technique, relaxation methods, flash photolysis and pulse radiolysis. Kinetics of oscillation reactions and isokinetic temperature	
UNIT–III: Electrochemistry-II	**15 Hrs.**
Electrification of interface, the basis of electrodics, thermodynamics at electrified interfaces: electrocapilarity, Lippmann equation. Structure of electrified interface: theories of electrical double layer: Helmholtz–Perrin, Gouy–Chapman and Stern	

theories. Orientation of solvent at interface: Metal–water interactions, Three state water model, The enthalpy and entropy of adsorption. Mobile electrified interface: electrokinetic phenomena, streaming current, streaming potentials, zeta potential, Electrophoresis. Electrodics: Equilibrium and the exchange current density, out of equilibrium and over potentials, Tafel equation, Butler-volmer equation.	
UNIT–IV: Polymer Chemistry-I	**15 Hrs.**
Introduction and History of polymers, industrial scenario, monomers, types of monomers, functionality, polymerization and degree of polymerization. Initiators. Classification of polymers with examples - Based on the origin, composition, the method of preparation, thermal behavior, structure, magnitude of intermolecular forces. Plasticizers. Plasticizers in plastic industry – Introduction, types, basic properties, bioplasticizers and applications of plasticizers. Solubility, crystallization and Glass transition temperature of polymers, factors influencing the solubility, crystallization and glass transition temperature of polymers. Determination of glass transition temperature, significance of glass transition temperature. Reactions of vinyl polymers: Functional group reactions, ring-forming reactions and block & graft copolymer formation. Crosslinking reactions: peroxide crosslinking, sulphur vulcanization, radiation crosslinking, photo crosslinking, electron beam crosslinking and miscellaneous crosslinking reactions. Polymer degradation: Chemical, thermal and radiation degradations.Polymer molecular weight: Number average and weight average molecular weights, polydispersity and molecular weight distribution in polymers. Fibers: Silk, Cellulose acetate fibres, Polyester fibres, Nylon fibres, Rayon. Adhesives: Natural and synthetic adhesives. Ion exchange resin.	

Books Recommended

1. Atkins' Physical chemistry, Peter Atkins and Julio De Paula, Oxford University Press, Oxford, 2010 (9 and 10th ed.,).
2. Introduction to Quantum Chemistry by A. K. Chandra, Ed. 3, Tata McGraw Hill, New Delhi, 1988.
3. Quantum Chemistry by R. K. Prasad, New Age International Publications, New Delhi, 1997.
4. Quantum Chemistry by Eyring, Walter and Kimball, John-Wiley, New York, 1961.
5. Physical Chemistry by G. M. Barrow, McGraw Hill, New York, 1996.
6. Fundamentals of Physical Chemistry by Maron and Lando, 1974.
7. Physical Chemistry by P. W. Atkins, ELBS, London, 1990 (Ed. 4).
8. Physical Chemistry by K. Vamulapalli, Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
9. Physical Chemistry by Daniels and Alberty, Wiley, New York, 1961.
10. Physical Chemistry through Problems by S. K. Dogra and S Dogra, Wiley Eastern, New Delhi, 1984.
11. A Text Book of Physical Chemistry by Samuel Glasstone, McMillan, London, 1943.
12. Atomic Structure and Chemical Bonding by ManasChanda, Tata McGraw Hill, Publishing Co., New Delhi, 2019.

13. Chemical Kinetics by K. J. Laidler, Tata McGraw Hill Publishing Co., New Delhi, 1965.
14. Kinetics and Reaction Mechanisms by Frost and Pearson, Wiley, New York, 1961.
15. Polymer Chemistry: An Introduction, Malcolm P. Stevens, Oxford University Press, 1999.
16. An Introduction to Electrochemistry by S. Glasstone, Van Nostrand, London, 1942.
17. A Text book of Electrochemistry by G.F.A. Kortum and J.O.M. Bockris, Elsevier, New York, 1951.
18. Modern Electrochemistry by J.O.M. Bockris and A.K.N. Reddy Vol. I and Vol. II, Butterworths, London, 1971.
19. Contemporary Polymer Chemistry, Harry R. Allcock and Frederick W. Lampe, Printice-Hall, 1981.
20. Principles of Polymer Chemistry, P. Bahadur and N. V. Shastri, Narosa Publisher, 2002
21. Polymer Chemistry: Properties and Applications, Andrew Peacock and Allison Calhoun, Hanser Publisher, 2006.
22. Text Book of Polymer Chemistry, Fred W. Billmeyer, Jr., Wiley Publisher, 1984.
23. Polymer Science, V. R. Gowariker, N. V. Viswanathan and Jayadev Sreedhar, New Age International Publisher, 2001.

Formative Assessment for Theory		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
02	Internal Assessment test 2	10
	Total	20 Marks
Formative Assessment as per the guidelines		

M.Sc Semester – II
Physical Chemistry (Practical)

Course Title: Lab Course in Physical Chemistry
Course Code: A2CHE007GP

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 14	**Practical**	**02**	**04**	**60 Hrs.**	**4 Hrs.**	**10**	**40**	**50**

Course Outcomes

After completion of the practical's students will be able

1. comprehend the practical aspects of reaction kinetics, solubility, viscosity and cryoscopy techniques and apply theoretical knowledge of thermodynamics and chemical reactions to real world laboratory experiments like determining various effects on reactions, use of calorimeters for studying neutralization reactions, use of Beckman thermometer for determining the freezing point depression and its relation to molecular weight, determining various physical and chemical parameters of chemical compounds and their solutions like viscosity using Ostwald viscometer, heat evolved during solubility of a solute in solvent, partial molar volumes etc.
2. get insight into the experiments related to finding important physical properties and parameters such as the determination of stability constant of complex formation using spectrophotometer,redox potential using potentiometer, equivalent conductance using conductimetry and dissociation constants of weak acids using pH meters allow students to acquire practical proficiency with instruments. These skills help students develop a strong foundation in physicals chemistry, preparing them for advanced research or professional role in the field.

Lab Course in Physical Chemistry: A2CHE007GP	60 Hrs.

Experiments

Non-Instrumental

1. Chemical Kinetics: Study the effect of added salt on the persulphate oxidation of iodide ions.
2. Solubility: Determination of the heat of solution of a solute (oxalic acid, benzoic acid etc.) by solubility method
3. Viscosity: Determination of viscosity average molecular weight of a given polymer (polyvinyl alcohol, polyethylene glycol etc.) by viscosity measurements using Mark-Howink equation.
4. Thermochemistry: Determination of enthalpy of neutralization of weak acid (CH_3COOH) with a weak base (NH_4OH)
5. Cryoscopy: Determination of molecular weight of non-volatile substance (glucose, urea etc.) cryoscopically using water as the solvent.
6. Self-generated experiment.

Instrumental

7. Spectrophotometry: Investigation of the complex formation between Fe^{3+} and salicylic acid and find the formula, stability constant and free energy change of the reaction
8. Potentiometry: Determination of the formal redox potential of ferrous-ferric system by titrating with dichromate solution and estimation of amount of Fe2+/FeSO4 present in given solution
9. Conductometry:
    a. Determination of the limiting equivalent conductance of a weak electrolyte (acetic acid, formic acidetc) at infinite dilution following the Kohlrausch law.
    b. Verification of Ostwald's dilution law and determination of dissociation constant of the weak acid
10. pH-metry: Determination of dissociation constant of a weak acid (acetic acid, formic acid, etc.) pH metrically
11. Self-generated experiments

Recommended Books

1. Practical Physical Chemistry by A. M. James and F. E. Prichard, Longmans, London, 1974.
2. Experiments in Physical Chemistry by Shoemaker and Garland, McGraw Hill, New York, 1964.
3. Experiments in Physical Chemistry by Daniels, Alberty and Willams, McGraw Hill, New York, 1970.

4. Experimental Physical Chemistry by W. G. Palmer, Cambridge University Press, London, 1946.
5. Advanced Physico-Chemical experiments by J. Rose.
6. Text book of Quantitative Analysis by A. I. Vogel, ELBS, Harlow, 1978.
7. Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publishing House, 1981.
8. Experimental Physical Chemistry by V. D. Athawale and Parul Mathur, New Age International Publishers, 2017.
9. Advanced Physical Chemistry Experiments by Gurtu and Gurtu, Pragati Prakashan Educational Publishers, 3rd Edition 2007.

Formative Assessment for Practical		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
	Total	10 Marks
Formative Assessment as per the guidelines		

M.Sc. Semester – II
Applied Inorganic Chemistry (Elective)

Course Title: Applied Inorganic Chemistry (Elective)
Course Code: A2CHE204GT

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
OEC – 01	**Theory**	**04**	**04**	**60 Hrs.**	**3 Hrs.**	**20**	**80**	**100**

Program outcomes:

1. To understand the concepts of statistical data treatment, thermal methods of analysis and chromatographic methods.
2. To study about metallobiomolecules and their biological roles.

Course outcomes:

1. Students will be able to subject the results to statistical analysis.
2. Students will understand the chemistry of thermal methods and inorganic polymers and their applications.
3. Students will realize the importance of essential elements and proteins and their functions.
4. Students will understand the principle, instrumentation and applications of gas chromatography.

Applied Inorganic Chemistry (Elective): A2CHE204GT	**60 Hrs.**
UNIT–I: Data analysis	**15 Hrs.**
Types of errors, accuracy and precision, methods of minimization of systematic errors, mean and standard deviation, distribution of random errors, reliability of results, comparison of results-Student t-test, F-test and chi–square test, significant figures, confidence intervals, method of least squares, calibration curve and standard addition method.	
UNIT–II: Thermal methods of analysis and inorganic polymers	**15 Hrs.**
Thermal methods of analysis: Thermobalance, factors influencing thermogravimetric results, differntial thermal analysis: Instrumentation for differential thermal analysis (DTA) and differential scanning calorimetry (DSC). Applications of TG, DTA and DSC. Inorganic Polymers:Silicones, polyphosphazenes, synthesis, structure and applications.	
UNIT–III: Bioinorganic Chemistry	**15 Hrs.**
Metal ions in biological systems, deficiency of trace metal ions (Fe, Zn, Cu and Mn), metal ions and chelating agents in medicine: Treatment of toxicity due to inorganics (chelation therapy) and metal complexes as therapeutic agents.	

Proteins and their functions: Heme proteins, oxygen uptake proteins-hemoglobin and myoglobin.	
UNIT–IV: Chromatography	
Gas chromatography**:** Principles, instrumentation, stationary phases and types of carrier gases used in GC. Methods of sample injection, types of detectors, programmed temperature GC, plate and plate height theory in GC. Applications of GC and use of GC-MS in detection of samples.	

Recommended Books:

1. Vogel's Texbook of Quantitative Analysis. 6th Edition–J. Mendham, R. C. Denney, J. D. Branes and MJK Thomas, Pearson Education, 2007.
2. Contemporary polymer Chemistry, 3rd Ed, H. R. Allcock, F. W. Campe and J. E. Mark, Publisher: Pearson Education.
3. Inorganic Chemistry, 4th Ed, J. E Huheey, R. L. Keiter and A. L. Keiter, Addison Wesley, 2000.
4. Inorganic Chemistry of Biological Processes, 2nd Ed. –M. N. Hughes, Wiley, 1988.
5. Bioinorganic Chemistry – I. Bertini. H. B. Gray, S. J. Lippard and J. S. Valentine, Viva Books, 1998.
6. Bioinorganic Chemistry - A.K. Das, Books and Allied (P) Ltd, 2007.
7. Principles of Instrumental Analysis-Skoog, Holler and Nieman, Harcourt Afca, 2001.
8. Vogel's Text Book of Quantitative Inorganic Analysis., 4th Edn. J. Bessett, R. C. Denney, G. H. Jeffery and J. Mendham, Longman Green and Company Ltd.
9. Quantitative Chemical Analysis, 6th Ed-D. C. Harris, W. H. Freeman and Company, New York, 2003.

Formative Assessment for Theory		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
02	Internal Assessment test 2	10
	Total	20 Marks
Formative Assessment as per the guidelines		

THIRD SEMESTER (GENERAL CHEMISTRY)

Program learning outcomes:

1. The students will learn spectral properties of complexes, interpretation of spectra, Magnetic behavior of metal complexes, Spectral applications of coordination compounds.
2. Students will appreciate the spectral studies for the interpretation of the structure of the inorganic and organic molecules.
3. The students will have hands on training for the preparation of inorganic complex molecules.
4. Analyse and interpret the spectral properties of simple atoms like hydrogen & hydrogen like atoms, alkali & alkali like atoms to understand the atomic structure.
5. The students will understand the organic reaction mechanism in detail.
6. Design the stereoselective and stereospecific reactions.
7. Students will understand the extraction and structure elucidation of naturally occuring compounds of biological importance.

M.Sc Semester – III

INORGANIC CHEMISTRY (Theory)

Course Title: INORGANIC CHEMISTRY –III
Course Code: A3CHE001GT

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC - 15	**Theory**	**04**	**04**	**60 Hrs.**	**3 Hrs.**	**20**	**80**	**100**

Course outcomes:

After completion of this course the students will

1. understand reactions mechanisms in Transition metal complexes, Electron transfer reactions.
2. understand the importance and functions of enzymes and coenzymes in biological systems.
3. understand the basic principles and theory of Infra Red, Electron Paramagnetic Resonance, M**ö**ssbauer and Nuclear Quadrupole Resonance spectroscopy of metal complexes.
4. enable the students to study the utility of these techniques in structure elucidation of metal complexes.

INORGANIC CHEMISTRY –III : A3CHE001GT	**60 Hrs.**
UNIT-I: Spectral and Magnetic properties of complexes:	**15 Hrs.**
Term symbols for d^n ions, spectroscopic ground states, selection rules, nature of spectral bands, band shapes, band intensities, band widths, effect of spin-orbit coupling, Orgel diagrams, Tanabe-Sugano diagrams, Racah parameters, interpretation of spectra of octahedral, distorted octahedral, tetrahedral and square planar complexes, calculation of nephelauxetic parameter, charge transfer bands, intervalence charge-transfer bands. Type of magnetic behaviour, classical magnetism, orbital contribution, orbital contribution reduction factor, spin orbit coupling, measurement of magnetic susceptibility–Gouy and Faraday methods, diamagnetic corrections, magnetically non-dilute compounds- ferro, antiferro and ferrimagnetic, spin cross-over systems, correlation of magnetic and structural properties	
UNIT-II: Reaction Mechanisms in Transition Metal Complexes and Bioinorganic Chemistry	**15 Hrs.**
Kinetics of octahedral substitution and mechanistic aspects. Acid hydrolysis, base hydrolysis, Substitution reactions in square planar complexes, trans effect, Electron transfer reactions-inner sphere and outer sphere reactions.	

Bioinorganic Chemistry: Transport and storage of dioxygen-haemoglobin, myoglobin, hemerythrin and hemocyanins, Electron transfer proteins- iron-sulphur proteins. Metalloproteins as enzymes–carboxy peptidase, cytochrome P-450, superoxide dismutase, vitamin B12 coenzyme, chlorophyll and its role in photosynthesis.	
UNIT–III: IR spectroscopy	**15 Hrs.**
Introduction and Experimental methods. Units, Notation and Regions. Fundamental vibrations, overtones, Group frequencies, factors affecting group frequencies. Mechanical coupling, Fermi resonance, Applications of IR in the study of H– bonding, Alkanes, Alkenes, Alkynes, Aromatic compounds, Aldehydes, Ketones, Alcohols, Thiols, Acids, Acid chlorides, Amides, Amines, Esters, halides, nitro compounds, etc. Infrared spectra of simple molecules and coordination compounds, changes in infrared spectra of donor molecules upon coordination (N,N-dimethylacetamide, urea, DMSO, pyridine-N-oxide, ammine, cyano, cyanato and thiocyanato complexes), mono and multinuclear carbonyl complexes, nitosyls, phosphine and arsine complexes. Change in spectra accompanying change in symmetry upon coordination (NO_3^-, SO_4^{2-}, NO_2^- and ClO_4^-) hydrogen bonding, instrumentation including FTIR.	
UNIT-IV: Electron Paramagnetic Resonance (EPR) Spectroscopy	**15 Hrs.**
Basic principles, Selection rules, intensity, width, position of spectral line, multiplet structure of EPR spectra, hyperfine interaction, spin-orbit coupling, zerofield splitting and Kramer's degeneracy, rules for interpreting spectra, factros affecting the magnitude of values. Instrumentation. Applications to the study of free radicals, Coordination compounds, biological studies, rate of electron exchange reactions. **Mössbauer Spectroscopy:** Introduction, Principles, conditions for Mössbauer spectroscopy, parameters from Mossbauer spectra, isomer shifts, electric quadrupole interaction, magnetic interactions, Mossbauer spectrometer, applications, $Fe_3(CO)_{12}$, Prussion blue, oxyhemerythrin, hexacyanoferrates, nitropruside, tin halides. **Nuclear Quadrupole Resonance (NQR) Spectroscopy**-Quadrupole nuclei, quadrapole movement, electric field gradient, the NQR experiment, structural information from NQR spectra. **Photoelctron spectroscopy:** Basic princilples , Photo-electric effect, ionization process, Koopman`s theorem, Photoelectro spectra of simple molecules, XPX, ESCA, Chemical information from ESCA. Instrumentation. Auger electron spectroscopy, basic ideas.	

Books Recommended:

1. Electronic absorption Spectroscopy and Related Techniques, D. N. Satyanarayana, OUP, 2001.
2. Inorganic Reaction Mechanisms, F. Basolo and R. G. Pearson, Wiley Eastern, 1979.
3. Inorganic chemistry–A Unified Approach, W. W. Porterfield, Elsevier, 2005.
4. Elements of Magnetochemistry, R. L. Dutta and A Syamal : Affiliated East-West, 1993.
5. Inorganic Chemistry, 4th Ed, J. E Huheey, R. L. Keiter and A. L. Keiter, Addison Wesley, 2000.
6. Inorganic Chemistry of Biological Processes, 2nd Ed. M. N. Hughes, Wiley, 1988.
7. Bioinorganic Chemistry–I. Bertini. H. B. Gray, S. J. Lippard and J. S. Valentine:, Viva Books, 1998.
8. Bioinorganic Chemistry–A.K. Das, Books and Allied (P) Ltd, 2007
9. Principles of Bioniorganic Chemistry–S. J. Lippard and J. M. Berga. Panima Publishing Corporation.
10. Fundamentals of Molecular Spectroscopy –C. N. Banwell.
11. Physical Methods in Chemistry–R .S. Drago, Saunder college.
12. Structural Methods in Inorganic Chemistry–E. A. Ebsworth, D. W. H. Ranbin and S. Cradock, ELBS.
13. An introduction to Molecular Spectroscopy by G. M. Barrow, McGraw Hill, New York.
14. Molecular Spectra and Molecular Structure: I Spectra of Diatomic Molecules by G. Herzberg, Van Nostrand, Princeton.
15. Introduction to Spectroscopy, Donald L. Pavia, Gary M. Lampman, and George S. Kriz, Cenage Learning, USA, (2015).
16. Infrared Spectra of Inorganic and Coordination Compounds, K. Nakamoto.
17. Infrared Spectroscopy–C.N.R. Rao.
18. Electron Absorption Spectroscopy and Selected Techniques–D. N. Satyanarayana, University Prof. India Ltd. Hyderabad.
19. Introduction to Spectroscopy- Pavia, Lampman and Kriz.

Formative Assessment for Theory		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
02	Internal Assessment test 2	10
	Total	20 Marks
Formative Assessment as per the guidelines		

M.Sc Semester – III
Inorganic Chemistry (Practical)

Course Title: Lab Course in Inorganic Chemistry
Course Code: A3CHE006GP

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC - 18	**Practical**	**02**	**04**	**60 Hrs.**	**4 Hrs.**	**10**	**40**	**50**

Course outcomes:

The students will have practical experience in the preparation and analysis of the following complexes, structural study of the prepared complexes by cation/ anion determination, by recording the electronic, infrared and nuclear magnetic spectra.

Lab Course in Inorganic Chemistry: A3CHE006GP	**60 Hrs.**
Experiments **I. Preparation of the following complexes:** 1. Copper-glycine complex : cis-and trans forms. 2. $Co(DMG)_2$ model for Vit-B_{12} and reaction 3. Potassium trisoxalatoferrate(III) 4. Tris(acetylacetonate)manganese(III) 5. Hexaammine & pentaammine chlorido cobalt (III) chloride. 6. Nitro- and nitrito-complexes.(examples for linkage isomers) 7. Tris(thiourea) copper(I) sulphate monohydrate 8. Seperation of optical isomers of cis$[Co(en)_2Cl_2]Cl$. **II. Characterization** 1. Metal ion/anion determination in the above complexes 2. Interpretation of electronic, IR and NMR spectra of Ligands and their complexes	

***Books recommended**:*

1. Vogel's Text Book of Quantitative Inorganic Analysis–J. Basett, R. C. Denney, H.
2. Jeffery and J. Mendham, Longmans, Green and company Ltd.
3. Practical Inorganic Chemistry–G. Pass and H. Sutcliff, Chapman and Hall Ltd.(1968)
4. General Chemistry Experiments-A. J. Elias, University Press.
5. Computers and their applications to Chemistry, Ramesh Kumari, Narosa

Formative Assessment for Practical		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
	Total	10 Marks
Formative Assessment as per the guidelines		

M.Sc. Semester – III
Organic Chemistry (Theory)

Course Title: Organic Chemistry-III
Course Code: A3CHE002GT

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC - 16	**Theory**	**04**	**04**	**60 Hrs.**	**3 Hrs.**	**20**	**80**	**100**

Course Outcomes:

After completion of this course,

1. Student will be enlightened about two different aspects: Nucleophilic substitution at sp^2 carbon and NGP, both induce rate enhancement one through bond delocalization another through space.
2. Stereoselectivity in addition and substitution reactions and changes after the use of chiral auxiliaries emphasize the necessity of stereochemistry for synthetic chemists.
3. Enable the students to understand absorption spectroscopic techniques: UV-Vis, IR, NMR (1H and 13C) and also Mass spectrometry though their principle, instrumentation and application s to organic molecules.
4. Enable the students to analyze the spectra and arrive at the correct structure.

Organic Chemistry-III: A3CHE002GT	**60 Hrs.**
UNIT–I: Reaction Mechanism	**15 Hrs.**
Nucleophilic substitution at allylic and trigonal carbon atom, Neighbouring group participation (NGP), participation of σ, π, cyclopropane and aromatic rings in nucleophilic substitution reaction. Addition reactions: electrophilic addition across alkenes, *cis- trans* alkenes, dienes. **Stereochemistry:** Stereoselectivity in organic synthesis, stereospecific and stereoselective reaction, principle of stereoselectivity, stereoselectivity in addition, elimination, substitution reaction. Asymmetric synthesis, enantioselective and diastereoselectivity in acyclic system, addition of nucleohphiles to carbonyl group, correlation of configuration, Crams rule and Prelogs rule for diastereselection.	
UNIT–II: UV-Vis, IR Spectroscopy and Mass Spectrometry	
Electronic Spectroscopy: Introduction. Beer- Lambert law. UV spectral study of unsaturated carbonyl and aromatic compounds. Woodward Fieser rules and related examples, Steric effects, charge transfer bands.	

Mass Spectrometry: Instrumentation and theoretical principles, determination of empirical formula. Fragmentation: Principles, odd and EE ions, molecular ion and base peak, nitrogen rule, metastable ions. Isotope effects in chloro and bromo compounds. Stevenson rule. Fragmentation of: i) normal and branched alkanes. ii) alkenes. iii) benzene and its derivatives. iv) alcohols. v) aldehydes. vi) ketones. vii) acids. viii) esters. ix) ethers. x) amines. xi) nitro compounds. McLafferty rearrangement.	
UNIT III: Nuclear Magnetic Resonance:	
^{1}H NMR: Magnetic properties of nuclei, shifts of different types of organic compounds empirical rules, spin-spin coupling, geminal–vicinal coupling–relative intensities, Long range coupling–spin decoupling, equivalence of protons–chemical and magnetic equivalence, spin– systems Karplus equation–curve, first order and second order patterns, exchange phenomena, NOE. **^{13}C NMR:** Broad band and off resonance coupling methods of detection. ^{13}C Chemical shifts of different classes of organic compounds–alkanes, alkyl halides, alkenes, alcohols, ethers, carbonyl compounds and aromatic compounds. Composite problems**: Applications of UV, IR, NMR and Mass methods and chemical reactions in structure elucidation of organic compounds.**	
UNIT–IV: Natural Products and Lipids	
Structure, synthesis and stereochemistry of the following: **Steroids**: Cholesterol **Alkaloids**: Papaverine, reserpine and morphine. **Terpenoids**: α–Cadeine, zingiberene, α–Pinene and camphor. **Lipids:** Sphingolipids, phospholipids, cyanolipids and glycolipids, naturally occurring fatty acids and their triglycerides, essential fatty acids, unusual fatty acids. Reactions of fatty acids: Fischer– and trans–esterification, oxidation, hydrogenation and acyl group transfer reactions. Analytical values: Cetane number and Iodine value. Emulsions and biodiesel**.**	

Books Recommended:

1. Stereochemistry of Organic compounds –Eliel, Tata McGraw Hill (2000).
2. Stereochemistry, Conformation and Mechanism –P.S. Kalsi, 6th Edition, New Age International Ltd. (2006).
3. Stereochemistry of Organic Compounds, Principles and Applications – D. Nasipuri, Wiley Eastern Ltd. (1992).
4. Advanced Organic Chemistry part A and B –F.A. Carey and R.J. Sundberg, 4th Edition, Plenum Publishers, (2000).
5. Advanced Organic Chemistry, Reactions, Mechanism and Structure – J March, 6th Edition, Wiley Eastern Ltd. (2007).
6. Mechanism and Theory in Organic Chemistry –T.A.Lowry and K.S. Richardson, 3rd

Edition, Addison-Wesley, UK (1998).
7. Organic Chemistry Volume-I, II and III –S.M.Mukherji, S.P.Singh and R.P. Kapoor, New Age International Ltd (2000).
8. Organic Reaction Mechanism – by R. K. Bansal, 3rd Edition, Tata McGraw Hill (2006).
9. Mechanism and Theory in Organic Chemicals –T.H. Lowry and K.S. Richardson, AWL, UK, 1998.
10. Advanced Organic Chemistry–R. Buckner, HAP Publishers, Sandiego, USA (2002).
11. Reactive Intermediates in Organic Chemistry – N. S. Isaacs, John Wiley and Sons, 1974.
12. Fundamentals of Molecular Spectroscopy by C. N. Banwell, Tata McGraw Hill Publishing Co., New Delhi. 4th Edition (2013)
13. An introduction to Molecular Spectroscopy by G. M. Barrow, McGraw Hill, New York. (1962)
14. Molecualr Spectra and Molecular Structure:I Spectra of Diatomic Molecules by G. Herzberg, Van Nostrand, Princeton. Vol-1(1950)
15. Introduction to Spectroscopy, Donald L. Pavia, Gary M. Lampman, and George S. Kriz, Cenage Learning, USA, (2015).
16. Organic Chemistry Volume-I, II – I. L. Finar, 6th Edition, ELBS London (2004).
17. The Alkaloids Volume II, IV– K. W. Bentley. Interscience Publishers(1966)
18. The Chemistry of Alkaloids –S. W. Pelletier. Van Nostrand Reinhold (1970)
19. Terpenoids Volume I and II – P. De Mayo. Interscience Publishers(1959)
20. Industrial Oil and Products Volume I–A. Baileys, wiley (2005)
21. Introduction to the Chemistry and Biochemistry of fatty acids and their Glycerides–F.D. Gunstone, Chapman and Hall, London (1980).

Formative Assessment for Theory		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
02	Internal Assessment test 2	10
	Total	20 Marks
Formative Assessment as per the guidelines		

M.Sc. Semester – III
Organic Chemistry (Practical)

Course Title: Lab Course in Organic Chemistry
Course Code: A3CHE007GP

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 19	**Practical**	**02**	**04**	**60 Hrs.**	**4 Hrs.**	**10**	**40**	**50**

Course Outcomes (COs)

1. Enable the students to understand isolation techniques, structural elucidation methods and synthetic routes for various plant natural products.
2. Qualitative analysis in practicals enables students to separate binary mixtures of various combinations of acid, base, phenol and neutrals and analyse to identify their structures.

Lab Course in Organic Chemistry: A3CHE007GP	**60 Hrs.**
Experiments Identification of the Nature, Bulk separation, Purification and Qualitative analysis (using ether) of the Binary mixture of the following classes: Acids, Bases, Phenols and Neutral compounds (without derivatives).	

Books Recommended:

1. Vogel's Textbook of Practical Organic Chemistry Revised by B.S. Furniss, A. J. 5th Ed, 1989.
2. Hannaford, P.W.G. Smith, A.R. Tatchell, 5th Edition, Addison Wesley Longman. Limited, UK (1997).
3. A Hand book of Organic Chemistry–by H. T. Clarke. Edward Ernnold publishers (1957).
4. A Laboratory Manual of Organic Chemistry by B. B. Dey and M.V. Govindachari. 3rd Ed, (1957).
5. Lab Experiments in Organic Chemistry–by Arun Sethi, New Age International Ltd. New Delhi (2006).

Formative Assessment for Practical		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
	Total	10 Marks
Formative Assessment as per the guidelines		

M.Sc. Semester – III
PHYSICAL CHEMISTRY (Theory)

Course Title: PHYSICAL CHEMISTRY-III
Course Code: A3CHE003GT

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 17	**Theory**	**04**	**04**	**60 Hrs.**	**3 Hrs.**	**20**	**80**	**100**

Course Outcomes:

After completion of course Quantum mechanics, Molecular symmetry &Diffraction studies (Theory) students will be able to

1. handle the complex quantum mechanical models like the interacting electrons within the atoms or molecules and approximate the solutions where exact solutions are not feasible.
2. understand the role of symmetry in determine the molecular properties like the orientation in 3-dimension, optical activity, dipole moments and also the symmetry influence of molecules on vibrational spectroscopy.
3. understand different diffraction methods to gain proficiency in interpreting diffraction patterns and apply them in material analysis.

PHYSICAL CHEMISTRY-III: A3CHE003GT	**60 Hrs.**
UNIT–I: Quantum Mechanics III	**15 Hrs.**
Approximate methods in quantum mechanics: variation method (time dependent and time independent), variation theorem, linear variation functions, secular equations and secular determinants. Application of variation method to hydrogen molecule ion, hydrogen molecule and normal helium atom. Perturbation theory (non-degenerate and degenerate), application of perturbation theory to the helium atom ground state and first excited state, perturbation theory for a degenerate energy level. Comparison of the variation and perturbation methods.	
UNIT–II: Atomic Structure and Atomic Spectra	**15 Hrs.**
A summary of the hydrogen spectrum. Alkali spectra and alkali like spectra, spark spectra and arc spectra. Moseley lines. Helium and alkaline earth spectra. Multiplet structure of line spectra. Doublet structure of alkali spectra and compound doublets, triplets and singlets of alkaline earths and helium, prohibition of intercombinations. Multiplicities and term symbols. Space Quantization: Zeeman effect, normal and anomalous Zeeman effects, Paschen–Back effect and Stark effect.	

UNIT–III: Molecular Symmetry	**15 Hrs.**
Introduction to symmetry, molecular symmetry, symmetry elements and operations, consequences of symmetry in molecules: polarity and optical isomerism, symmetry point groups, classification of molecular point groups, properties of a group, group multiplication table, some examples of group, subgroups and classes. Matrix methods in symmetry: Representation of the Symmetry elements and point groups, Equivalent, Reducible and Irreducible Representations. The great orthogonality theorem and its corollaries, Irreducible Representations using the great orthogonality theorem, Character tables and its construction, Mulliken Symbols for Irreducible Representations, Representations of a Cyclic Group. Application of Group Theory to Quantum Mechanics, Degenerate eigen functions, Direct product of irreducible representations. Application of Symmetry in hybridization: Molecular orbitals and hybrid orbitals, criteria for overlap in LCAO approximation, Designation of symmetry of molecular orbitals, Modes of overlap, application to Symmetry Adapted Linear Combinations, SALCs (Construction of SALC for sigma bonding for molecules belonging point groups: D_{2h}, D_{3h}, D_{4h}, C_{4v}, T_d, O_h. Application of symmetry to Vibrational Spectroscopy: Introduction, selection rules, Transition moment integrals, Dipole moments in vibrating molecules, selection rule for spectral transitions, polyatomic molecules, possible vibrations in a linear molecule, bending modes, symmetry of vibrations and their IR activity, Group vibration concept and its limitations, IR and Raman spectra related to symmetry of some compounds and rule of mutual exclusion.	
UNIT–IV: Diffraction Studies	**15 Hrs.**
X-ray diffraction: Origin and production of X-rays, interaction of X–rays with matter: Absorption, scattering and diffraction. Crystal structure: Unit cell, lattices, planes and miller indices, Reciprocal lattice: Bragg's law, powder diffraction and single crystal rotation photographs. Determination of molecular parameters, the structure factor calculations, Fourier series and phase problems, Refinements of Fourier procedures and general concept of solution of structures. Neutron diffraction: Neutron diffraction and differences from X-ray diffraction. Electron diffraction: Theoretical principles, structure analysis: visual comparison of intensities, radial distribution function and its refinements,the rotating sector method and applications.	

Recommended Books:

1. Quantum Mechaincs–L.T.Schiff, Prentice - Hall, 1968
2. Quantum Chemistry–H. Eyring, J. Walter and G. E. Kimball, John Wiley, 1957

3. Quantum Mechanics–An Introduction–H. L. Strauss, Prentice Hall of India, 2003
4. Quantum Mechanics–L. Pauling and E. B. Wilson, McGraw Hill, 1972.
5. Contemporary Quantum Chemistry–J. Goodisman, Plenum/Rosetta, 2012.
6. Quantum Chemistry–K. S. Pitzer, Prentice-Hall, 2009
7. Introductory Quantum Mechanics-Valdimir Rojanstry, 1956.
8. Quantum Chemistry–John P.Lowe, 2005.
9. Quantum Chemistry –Ira N. Levine, Prentice Hall of India Pvt. Ltd., 2013.
10. Quantum Chemistry–Donald A. McQuarrie, Viva Book Pvt. Ltd., 2007.
11. Physical Chemistry–P.W. Atkins, Clarendon Press, Oxford, 1970.
12. Molecular Quantum Mechanics–P. W. Atkins, Clarendon Press, Oxford, 1970.
13. Introduction to Quantum Chemistry–J. M. Anderson, 1969.
14. Introduction to Quantum Mechanics–R. H. Dicke, J. P. Wittke, 2011.
15. Indroductory Quantum Chemistry–A. K. Chandra, Tata McGraw Hill, New Delhi, 1994.
16. Quantum Mechanics in Chemistry-M.W. Hanna, 2010.
17. Quantum Chemistry–R .K. Prasad, New Age International Publishers, New Delhi, 2022.
18. Atomic Spectra and Atomic structure–G. Herzberg, Van Nostrand, 2017.
19. Chemical Applications of Group Theory–F. A. Cotton, Wiley Eastern, New Delhi, 1971.
20. Molecular Symmetry–D. S. Schonlnd, Van Nostrand Comp.London,1965
21. Symmetry in Chemistry-Jeffe and Orchin, Wiley Inter Science, NewYork, 1977.
22. Symmetry, Orbitals and Spectra–Jeffe and Orchin, -Jeffe and Orchin, Wiley InterScience, New York, 1971.
23. Electron Diffraction–T. B. Rymer, Methuen, London,1970
24. Neutron Diffraction–G. E. Becon, 1962.
25. Symmetry in Molecules–J. M. Hollar, 2022.
26. X-Ray Crystallography–Buerger, 2017.
27. Diffraction Methods–Wernard, 1973.
28. Chemical Crystallography–L. W. Bunn. N. Y. and Oxford, 1945.
29. Crystals and X–Rays K. Landsdale, N.Y.,1945
30. Crystal Structure Analysis–M. J. Berger, John Wiley and Sons, N.Y.,1960
31. The Determination of Molecular Structure–P. J. Wheatley, Clarendon, Oxford,1960
32. Physical Chemistry–G. M. Barrow, McGraw Hill, New York, 1991
33. X-ray Diffraction–D. B. Cullity, Mass Addison, Wesley, 1978.

Formative Assessment for Theory		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
02	Internal Assessment test 2	10
	Total	20 Marks
Formative Assessment as per the guidelines		

M.Sc. Semester – III
Physical Chemistry (Practical)

Course Title: Lab Course in Physical Chemistry
Course Code: A3CHE008GP

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 20	**Practical**	**02**	**04**	**60 Hrs.**	**4 Hrs.**	**10**	**40**	**50**

Course outcomes:

After completion of course Lab Course in Physical Chemistry students will be able to

1. understand the practical aspects of the concepts like surface tension, thermodynamics, reaction kinetics and cryoscopy
2. determine the order, rate constants of a reaction etc.; construct phase diagrams; orrelate the observed freezing point depression by croscopic methods to molecular weight; and characteristics associated with surface tension, etc
3. determine the isoelectric point of amino acids using pH meters, the estimate metal ion concentration using spectrophotometers, estimation halide mixture concentration using potentiometry, verify the Debye-Hückel-Onsagar law using conductometry allowing students to acquire practical proficiency with instruments.
4. build a solid foundation in laboratory techniques enabling students to pursue research or careers in the subject

Lab Course in Physical Chemistry : A3CHE008GP	**60 Hrs.**
Experiments **Non-Instrumental** 1. Chemical Kinetics: a. Determination of degree of hydrolysis of urea hydrochloride by studying kinetics of hydrolysis of methyl acetate using HCl and equinormal urea hydrochloride solutions. b. Determination of relative strength of two acids (HCl and H_2SO_4) by studying the acid catalysed hydrolysis of methyl acetate 2. Phase Equilibria: Determinization of the equilibrium constant of the reaction $KI + I_2 \rightleftharpoons KI_3$ 3. Thermochemistry: a. Determination of heat of ionization of weak base (NH_4OH) calorimetrically b. Heat of precipitation of $BaSO_4$. 4. Cryoscopy: Determination of apparent molecular weight of a uni-	

univalent electrolyte (KCl, NaCl etc.) and the degree of dissociation.

5. Surface tension: Study the variation of surface tension of aqueous solutions of a liquid (n–propyl alcohol) with concentration and determination of limiting cross sectional area of the alcohol molecule
6. Self-generated experiment

Instrumental

1. Spectrophotometry:
   a. Individual estimation of amount of Cu(II) and Fe(III) present in given solution spectrophotmetrically
   b. Simultaneous estimation of amount of Cu(II) and Fe(III) present in given solution spectrophotmetrically
2. Conductometry: Verification of the Debye-Huckel Onsagar conductance equation and determination of equivalent conductance at infinite dilution
3. Potentiometry: Potentiometric estimation of a mixture of halides (KCl, KBr and KI) by titrating against $AgNO_3$
4. pH-metry: Determination of the acid and base dissociation constant of an amino acid (Glycine, Alaline etc.) and its isoelectric point.
5. Self-generated experiments.

Books Recommended:

1. Findlay`s Practical Physical Chemistry, 9th edition, revised by B. P. Levitt, 2012.
2. Practical Physical Chemistry by A. M. James and F. E. Prichard, 1974.
3. Experiments in Physical Chemistry by Shoemaker and Garland, 1964.
4. Experiments in Physical Chemistry by Daniels, Alberty and Williams, 1956.
5. Laboratory Physical Chemistry by Oelke/ M.A.C.T.L.A.C., 1969.
6. Experimental Physical Chemistry by W.G. Palamer, 2020.
7. Advanced Physico-chemical experiments by J.Rose, 2023.
8. Experimental Physical Chemistry by V.D.Athwale and Paul Mathur, New Age International Publishers, 2001.
9. Text book of Physical Chemistry by S.Glasstone, 2009.
10. Text book of quantitative analysis by A. I. Vogel, 1989.
11. Advanced Practical Physical Chemistry by J. B. Yadhav, Goel Publishing house, Meerut, 2014

Formative Assessment for Practical		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
	Total	10 Marks
Formative Assessment as per the guidelines		

M.Sc Semester – III
Applied Organic Chemistry (ELECTIVE)

Course Title: Applied Organic Chemistry (ELECTIVE)
Course Code: A3CHE204BT

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
OEC - 02	**Theory**	**04**	**04**	**60 Hrs.**	**3 Hrs.**	**20**	**80**	**100**

Course outcomes (COs)

After completion of this course successfully, the students will be able to…

1) understand the fundamental properties such as orientation and optical activity of the organic molecules.
2) predict the physical and chemical methods reaction mechanism and learn about few mechanisms of organic reactions.
3) understand the heterocycles structural feature and synthesis and its reactions as well as biological and material science importance.
4) learn about functional groups importance in organic synthesis and its internal transformations.

Applied Organic Chemistry (ELECTIVE) : A3CHE204BT	**60 Hrs.**
UNIT–I: Molecular Parameters, Isomerism and Prochirality	**15 Hrs.**
Molecular Parameters: bond lengths, bond angles, bond energies, bond polarity and dipole moment. Geometrical and optical isomerism: E/Z, R/S nomenclature, Fischer, Sawhorse, Newmann projections. Enantiomers, diastereomers and epimers, Prochirality: Homotopic, enantiotopic, diastereotopic groups & faces and their reactivity.	
UNIT–II: Organic Reactions	**15 Hrs.**
Classification of organic reactions, Methods of identification, kinetic, non–kinetic methods, isotopic labeling techniques, intermediates, cross over products and product proportions in different types of reactions. Named Reactions: Classification, aldol, Dieckmann, Claisen–Schmidt and similar carbanion addition reactions.	
UNIT–III: Chemistry of Heterocycles	**15 Hrs.**
Structure, synthesis, reactivity of the following heterocycles and their	

biologically important derivatives: (i) indole (ii) thiazole (iii) pyrimidine (iv) quinoline (v) furan (vi) thiophene and (vii) pyrrole.	
UNIT–IV: Functional group Transformations	**15 Hrs.**
Multi step organic functional group interconversions involving substitution, addition, eliminations, oxidation, reduction, etherification, hydrolysis and diazocoupling reactions.	

Recommended Books:

1. Organic Chemistry – P.Y. Bruice, Pearson Education Pvt. Ltd., New Delhi (2002).
2. Organic Chemistry–S. H. Pine, McGraw-Hill, London (1987).
3. Organic Chemistry–R.T. Morrison and R.T. Boyd, Prentice Hall New Delhi (1994).
4. Organic Chemistry–T.W. Graham Solomons, 4th Ed, John Wiley and Sons, (1988).
5. Organic Chemistry volume I, II-I. L. Finar, 6th Ed, ELBS London (2004).
6. Organic Chemistry–F.A. Carey, 4th Ed, McGraw Hill, (2000).
7. Advanced Organic Chemistry, Reactions, Mechanism and Structure–J. March, 4th Ed, Wiley Eastern Ltd (2004).
8. Stereochemistry–Conformation and Mechanism P. S. Kalsi, Wiley- Eastern Ltd, New Delhi (1992).
9. Heterocyclic Chemistry–T. L. Gilchrist, Butterworths (London), 1985.
10. Heterocyclic Chemistry – J. A. Joule and G. F. Smith, 2nd Ed, Van Nostrand (London), 1978.

Formative Assessment for Theory		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
02	Internal Assessment test 2	10
	Total	20 Marks
Formative Assessment as per the guidelines		

M.Sc. Semester – III
Applied Physical Chemistry (ELECTIVE)

Course Title: Applied Physical Chemistry (ELECTIVE)
Course Code: A3CHE205CT

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
OEC – 02	**Theory**	**04**	**04**	**60 Hrs.**	**3 Hrs.**	**20**	**80**	**100**

Course outcomes

After completion of this course the students will be able to
1. understand and apply the principles of thermodynamics in daily life situations.
2. predict possible mechanisms of various reactions
3. understand the various concepts of electrochemistry of electrolytes.
4. appreciate the applications of polymers in day-to-day situations.

Applied Physical Chemistry (ELECTIVE): A3CHE205CT	**60 Hrs.**
UNIT-I: Reaction Kinetics	**15 Hrs.**
A critical account of collision and transition state theories. **Kinetics and Mechanism**: Steady state approximation and simple examples relating kinetics to mechanism. Theories of unimolecualr reactions: RRKM theory. Isomerisation of methyl isocyanide. General features of fast reactions, study of fast reactions by flow method, relaxation method, Flash photolysis and the nuclear magnetic resonance method.	
UNIT-II: Thermodynamics	**15 Hrs.**
Thermodynamic criteria for spontaneous chemical changes. Standard free energies and their determination. Relation between free energy change and equilibrium constant. The pressure dependence of free energy of non-ideal gases; fugacity. Standard state for non-ideal gas. Equilibrium constants in non-ideal systems. Temperature dependence of free energy and equilibrium constants.	
UNIT-III: Electrochemistry	**15 Hrs.**
Electrical double layer: Lippman equation, theories of electrical double layer-Helmholtz-Perrin, Gouy-Chapman and Stern theories. Effect of ions on zeta potential. Activity of ions in solution: ion-solvent interactions, ion-ion interactions and free energy of ions in solution. Born model and modifications, solvation number and their determination. triple ion formation and conductance minima.	
UNIT-IV: Introduction to Polymers	**15 Hrs.**
Basic Concepts: Monomers, repeat units, polymers and degree of polymerization. General classification of polymers, homopolymers, copolymers, terpolymers, additon polymers and condensation polymers with examples, tacticity, comparison between thermoplastics and thermosetting polymers. **Methods of Polymer Fabrications:** Fabrication of polymer films: solution casting, melt pressing, melt extrusion and bubble blown. Fabrication of shaped polymer	

objects: compression molding, injection molding, reaction injection molding, blow molding extrusion molding and calendaring. Spinning industrial polymers: solution spinning and melt spinning. Preparation, properties and commercial importance: Vinyl polymers: polyethylene, polypropylene, polystyrene, polymethylmethacralate, polyvinyl chloride, polytetrafluoroethylene. Polyesters: poly (ethylene terephthalate). Polyamides: aramides (Kevlar and Nomex). Polyimides. Polysulphone. Polyurethanes. Polyureas. **Natural polymers:** polyisoprenes, chitosan,	

Books Recommended:

1. Physical Chemistry-G. M. Barrow, McGraw Hill, 1996.
2. Physical Chemistry-R.A. Alberty, Wiley Eastern Ltd, 1961.
3. Elements of Physical Chemistry-P. W. Atkins, Oxford, 2009.
4. Physical Chemistry - P.W. Atkins, ELBS, 1990.
5. Modern Electrochemistry Vol.I and II-J.O.M, Bokris and A.K.N.Reddy, Plenum, 2006.
6. An Introduction to Electrochemistry-S.Glasstone, Van Norstrand, 1942.
7. A Text Book of Electrochemistry-G.F.A.Kortum and J.O.M. Bokris, Elsevier, 1951.
8. Electrolyte Solutions-R.A.Robinson and R. H. Stokes, Acedemic Press, 1959.
9. Chemical Kinetics-K.J.Laidler, Pearson Education 2004
10. Kinetics and mechanism of chemical transformations-J.Rajaraman and J. Kuriacose, McMillan.
11. Theory of rate processes-S. Glasstone, K. J. Laidler and H.Eyring, McGraw-Hill, 1941.
12. Thoeries of chemical reaction rates-K.J.Laidler, MacGraw-Hill, 1969.
13. Fast Reactionss-D.N. Hague, Wiley-Interscience, New York, 1971.
14. Techniques of Oraganic Chemistry- Weissberger(ed.), Interscience, 1963, Vol.VIII
15. Kinetics of Chemical Changes in Solution-E.S.Amis, McMillan, 1948
16. The Foundations of Chemical Kinetics-S.W. Benson, McGraw-Hill, 1960.
17. Polymer Chemistry An Introduction, Malcolm P. Stevens, Oxford University Press, 1999.
18. Contemporary Polymer Chemistry, Harry R. Allcock and Frederick W. Lampe, Printice-Hall, 1981.
19. Principles of Polymer Chemistry, P. Bahadur and N. V. Shastri, Narosa Publisher, 2002
20. Polymer Chemistry Properties and Applications, Andrew Peacock and Allison Calhoun, Hanser Publisher, 2006.
21. Text Book of Polymer Chemistry, Fred W. Billmeyer, Jr., Wiley Publisher, 1984.
22. Polymer Science, V.R. Gowariker, N. V. Viswanathan and Jayadev Sreedhar, New Age International Publisher, 2001
23. Principles of Polymer Chemistry, A. Ravve, Plenum Press, New York, 1998.

Formative Assessment for Theory		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
02	Internal Assessment test 2	10
	Total	20 Marks
Formative Assessment as per the guidelines		

FOURTH SEMESTER

Program learning outcomes:

After completion of this program the students will

1. be able to classify Transition metal to carbon multiple bonded compounds, Transition metal- carbon pi complexes.
2. have deep knowledge of organometallics and able to use as catalyst in different reaction
3. be able to suggest route of synthesis for given molecule.
4. have clear idea about light mediated reactions.
5. be able to predict structural variations on medicinal property of molecules.
6. understand the microscopic basis of thermodynamic properties which helps in predicting and relating the microscopic particle behavior to macroscopic thermodynamic properties.

M.Sc. Semester – IV
Inorganic Chemistry (Theory)

Course Title: Inorganic Chemistry – IV
Course Code: A4CHE001GT

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 21	**Theory**	**04**	**04**	**60 Hrs.**	**3 Hrs.**	**20**	**80**	**100**

Course Outcomes:

1. Enables the students to acquire the knowledge of organometallic compounds.
2. Students will learn the Classification, Nomenclature, Transition metal to carbon multiple bonded compounds, Transition metal- carbon pi complexes,
3. Catalysis by organometallic compounds, Homogeneous and Heterogeneous catalysis by organometallics
4. Hydrocarbonylation, hydrogenation, hydroformylation, oxidative addition reactions.
5. Ziegler-Natta catalyst and Water Gas Shift reactions.
6. Students will be familiarizing with Thermogravimetric Analysis, DTA, DSC, Atomic absorption Spectroscopy, Molecular Luminescence Spectroscopy, Cyclic Voltammetry.
7. It is an interdisciplinary course falling at the boundary of physics and chemistry.
8. It is aimed at understanding the properties of solids and their possible applications in materials science as superconductors, semiconductors, liquid crystal materials and as magnetic materials.
9. Importance has been given to the methods of preparation of solids, understanding the structure-property relationships and their possible applications.

Inorganic Chemistry – IV: A4CHE001GT	**60 Hrs.**
UNIT-I: Organometallic Chemistry	**15 Hrs.**
Chemistry of organometallic compounds with π-bonding ligands: 18 and 16 electron rules, electron counting schemes. Synthesis, structure, spectroscopy, reactions, bonding and fluxinol behaviour in metal–carbon π-bonded systems involving dihapto to hexahapto ligands *viz*, olefins, acetylenes, allylic moieties, butadienes, cyclobutadienes, cyclopentadienes and arenes.	
UNIT-II: Organometallic compounds as Catalysts	
Homogeneous and heterogeneous catalysis involving metal complexes and organometallic complexes, oxidative additions, reductive elimination, insertion and de-insertion reactions, hydrogenation, hydroformylation, isomerisation, carboxylation, and polymerisation, Water-gas shift reactions. Carbene (Fischer and Schrock type) complexes: Preparation, structure and bonding. The isolobal principles.	

UNIT-III: Instrumental Methods	
Thermogravimetric analysis (TGA): Factors affecting the results**,** Instrumentation and applications. Differential thermal analysis (DTA): Theory Instrumentation and applications. Differential scanning calorimetry (DSC): Theory instrumentation and applications Voltammetry: Fundamentals of voltammetry. Cyclic voltammetry: Principle and applications. Stripping voltammetry basic principle and applications, Atomic absorption spectrometry: Theory, instrumentation, different types of nebulizers, electrothermal vaporizer, cold vapour AAS determination of mercury, interferences, analytical applications of AAS. Molecular luminescence spectroscopy: Theory, instrumentation, factors affecting fluorescence and its applications	
UNIT-IV: Solid State Chemistry	
Introduction **Electrical properties:** survey of electrical properties and materials. Super conductivity: Nature and properties of super conductivity material, Meissner effect, Type I and II super conductors, Theories, high temperature oxide super conductors, applications. **Ionic conductivity**: Alkali halides: Vacancy conduction. Silver chloride: interstitial conduction. **Solid electrolytes:** β-Alumina, AgI and Ag^+ ion solid electrolytes. Anion conductors, requirements for conductivity and Applications. **Magnetic properties:** Mechanism of ferro and antiferro magnetic ordering, selected examples of magnetic materials, their structure and properties; metals and alloys, transition metal oxides, spinels, garnets, ilemenites, perovskites, magneto plumbites, applications. **Optical properties:** Luminescence and phosphorus, configurational coordinate model, some phosphor material, antistokes, phophores, lasers.	

Recommended Books:

1. Vogel's Text Book of Quantitative Inorganic Analysis -J. Bassett, R. C. Denney, G. H. Jaffery and J. Mandham, Longmans, Green and Company Ltd.
2. Chemical analysis of foods and food products-Morris B. Jacobs (3rd Ed.), D. Van Nostrand Company Inc.
3. Standard methods of chemical analysis, F. J. Welcher (6th Ed., Vol. 3 Part-B), D. Van Nostrand Company, Inc. Indian, United States and European Pharmacopea.
4. General Chemistry Experiments, A. J. Elias, University Press.

5. Solid State Chemistry and Its Applications - Anthony R. West (2nd Ed,).

6. The Organometallic Chemistry of the Transition Metals - Robert H. Crabtree (4th Ed.)

Formative Assessment for Theory		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
02	Internal Assessment test 2	10
	Total	20 Marks
Formative Assessment as per the guidelines		

M.Sc. Semester – IV
Inorganic Chemistry (Practical)

Course Title: Lab Course in Inorganic Chemistry
Course Code: A4CHE005GP

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 25	**Practical**	**02**	**04**	**60 Hrs.**	**4 Hrs.**	**10**	**40**	**50**

Course outcomes:

Students gain training and skills to use cation and anion resins and in colorimetric analysis

Lab Course in Inorganic Chemistry: A4CHE005GP	**60 Hrs.**
EXPERIMENTS: 1. Determination of composition of complexes of iron(II)-1,10-phenanthroline complex by Job's method and Mole ratio method. 2. Colorimetric determination of Ti(IV) using H_2O_2 and iron(II) using 1,10-phenanthroline 3. Separation and estimation of i) Al + Mg and (ii) Cu + Ni using oxine and salicylaldoxime by volumetric/ gravimetric method 4. Use of cation resin 5. Use of anion resin 6. Determination of iron(II) using 1,10-phenanthroline by colorimetry 7. Determination of composition of iron(II)-1,10-phenanthroline complex by Job's and Mole ratio methods 8. Determination of titanium (IV) using H_2O_2 by colorimetry 9. Use of oxine and salicylaldoxime in the separation and estimation using volumetric/ gravimetric method Al + Mg and (ii) Cu + Ni	

Books recommended:

1. A text Book of Quantitative Inorganic Analysis – A.I Vogel
2. Vogel's Text Book of Quantitative inorganic Analysis, Basset, Denney, Jeffery & Mendham
3. Colorimetric Determination of Traces of Metals – E. B Sandell.
4. Analytical Chemistry, G.D. Christian, 5th edition, 2001 John Wiley & Sons, Inc. India

Formative Assessment for Practical		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
	Total	10 Marks
Formative Assessment as per the guidelines		

M.Sc. Semester – IV
Organic Chemistry (Theory)

Course Title: Organic Chemistry IV
Course Code: A4CHE002GT

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 22	**Theory**	**04**	**04**	**60 Hrs.**	**3 Hrs.**	**20**	**80**	**100**

Course Outcomes:

After completion of this course successfully, the students will be able to..

1. propose synthetic routes for given organic molecules through their retrosynthetic approach. Also understand the uses of newer reagents in synthesis process.
2. understand uniqueness of light mediated reactions of alkenes and carbonyl compounds and stereoselectivity of photo and thermal reactions depends on symmetry of π electrons molecular orbitals.
3. learn preparations, properties, reactions and uses of various oxidizing and reducing agents and understand various metal catalyzed reactions and their applications.
4. get knowledge about structure, synthesis and reactions of nitrogen, oxygen and sulfur containing three and four membered heterocycles.
5. get knowledge about theories of drugs and importance SAR studies in development of drugs. And learn various types of drugs through their mode of actions.
6. Multistep preparations and the spectral analyses, enable the students to arrive at the structure of synthesized compounds.

Organic Chemistry IV: A4CHE002GT	**60 Hrs.**
UNIT–I: Retrosynthetic analysis and Newer Reagents	**15 Hrs.**
Retrosynthesis: Retrosynthetic analysis: Terminology, synthon, synthetic equivalent, functional group interconversion and disconnection approach, one group C–X and two group disconnections. Applications of C–C disconnection in the synthesis of substituted 1,1–, 1,2– 1,3– and 1,4– bifunctional compounds. Retrosynthetic analysis and forward synthesis for alcohols, benzocaine, acetone cyanohydrin, *p*–methoxy acetophenone, 6–methyl quinoline, pirindol, 6–methoxy indole–3–acetic acid. **Newer Reagents:** Methods of preparations, mechanism of action and application of the following reagents in Organic synthesis: DCC, 1, 3 Dithiane, LDA, DDQ, tributyl tinhydride (TBTH), Wilkinson Catalyst, Gilman reagent.	

UNIT–II: Organic Photochemistry and Pericyclic Reactions:	15 Hrs.
Organic Photochemistry: Principles of photochemistry, photochemical processes, energy transfer and photosensitization. Photochemical reactions: Photoreduction, Norrish type–I and II cleavages. Di-pi methane rearrangement, optical pumping. Photochemistry of cyclohexadienones, photo Fries rearrangement. **Pericyclic Reactions:** Classification and features, Molecular orbital symmetry. Frontier orbitals of ethylene, 1,3–butadiene, 1,3,5–hexatriene and allyl systems. Electrocyclic processes**:** Woodward Hoffmann rules for 4n and (4n + 2)π systems. Cycloaddition reactions: Diels–Alder reaction, [2+2] and [4+2] cycloaddition reactions, Supra facial and Antra facial addition. Significance of Reactions**:** Sigmatropic rearrangement, supra and antra facial hydrogen shifts. Claisen, Cope, oxy Cope and aza Cope Rearrangements. Vitamin – D group isomerisations.	
UNIT – III: Oxidations, Reductions and Newer Reactions	**15 Hrs.**
Oxidations: Oxidation of organic compounds using $KMnO_4$, CrO_3, $K_2Cr_2O_7$, PCC, SeO_2, $Pb(OAc)_4$, HIO_4, Oxygen, Oppenauer oxidation, Swern oxidation. Hydroboraton – Isomerisation and oxidation. **Reductions:** Reduction of organic compounds using the following reagents: $LiAlH_4$, $NaBH_4$, DIBAL-H, Birch Reduction, Wolf-Kishner Reduction. **Newer Reactions:** Mechanism and Synthetic applications of the following Named reactions: Mitsunobu reaction, Pauson-Khand reaction, Simon-Smith reaction, Robinson annulation, Suzuki coupling, Heck arylation and Sonogashira reaction.	
UNIT–IV: Heterocyclic and Medicinal Chemistry	**15 Hrs.**
Heterocyclic Chemistry: Synthesis, reaction and applications of three, four, and seven membered heterocycles with one Heteroatom **Three membered**: Oxiranes, aziridines and thiranes. **Four membered**: Oxetanes, azetidines and thietanes. **Medicinal Chemistry**: Modern theories of drug action, concept of receptors, computer aided drug design, qualitative and quantitative SAR. **Sulfa Drugs**: Sulfadiazines, sulfamethazines, sulfaguanidines. **Analgesics**: Classification of narcotic and non-narcotic analgesics. **Narcotic**: Opium alkaloids, morphine and metopon**.** **Non-narcotic**: 4**-**Phenylpiperidines–Pethidine, methadone, pyrazolones.	

Books Recommended:

1. Organic Synthesis–The Disconnection Approach - Stuart Warren, Wiley 2nd Ed (2008)
2. Designing Organic Synthesis–Stuart Warren. Wiley publication (1991)
3. Modern Synthetic Organic Chemistry–H. O. House, W. A. Benjamin INC, New York (1969).
4. An Introduction of the Chemistry of Heterocyclic Compounds - R. M. Acheson, 4th Ed, John Wiley and Sons. (1960)
5. Heterocyclic Chemistry –A.R. Katritzky and J. J. Logowskii. Wiley publication (1960)
6. Heterocyclic Chemistry –T. L. Gilchrist, 3rd Edition, Pearson Education Delhi (2005).
7. Modern Heterocyclic Chemistry –Joules and Smith. Wiley publication 5th Ed, (2004)
8. Heterocyclic Chemistry –R. K. Bansal, 3rd Ed, New Age International Publishers, (2002).
9. Medicinal Chemistry Volume I and II–A. Burger, Wiley- Interscience, New York (1988).
10. Progress in Medicinal Chemistry Volumes 1–8. Edited – G.P. Ellis and G. B. West. North Holland New York (1974).
11. Organic Chemistry volume I and II –I. L. Finar, 6th Ed, ELBS London (2004)
12. Principles of Organic Synthesis–R. O. C. Norman and J. M. Coxon, 3rd Ed, Nelson, Thrones, UK (2003).
13. Organic Reaction Mechanism –R. K. Bansal, 3rd Edition, Tata McGraw Hill (2006).
14. Molecular rearrangements–I and II–P.de. Mayo. Wiley publication (1963)
15. Mechanisms of Molecular Migrations. Volume I and II–B. S. Thyagarajan, 1st Ed, Wiley Interscience, London (1979).
16. Molecular Transformations in Organic Chemistry – D. Ranganathan and S. Ranganathan, 1st Ed, McMillan India, New Delhi (1975).
17. Biotransformations in Organic Chemistry–K. Faber, 4th Ed, Springer, Asian Books Ltd, (2002).

Formative Assessment for Theory		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
02	Internal Assessment test 2	10
	Total	20 Marks
Formative Assessment as per the guidelines		

M.Sc. Semester – IV
Organic Chemistry (Practical)

Course Title: Lab Course in Organic Chemistry
Course Code: A4CHE006GP

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 26	**Practical**	**02**	**04**	**60 Hrs.**	**4 Hrs.**	**10**	**40**	**50**

Course outcomes:

After completion of course for students

1. Multistep preparations enable to design and synthesis desired molecules using different reagents and reaction.
2. The spectral analyses, enable to arrive at exact the structure of synthesized compounds.

Lab Course in Organic Chemistry: A4CHE006GP	**60 Hrs.**
Experiments 1. Multi-step preparation of organic compounds involving various reactions like addition, elimination, oxidation, hydrolysis etc. and purification methods like distillation and crystallization. 2. Identification of structure of the organic molecules based on spectra.	

Books Recommended:

1. Vogel's Textbook of Practical Organic Chemistry Revised - B.S. Furniss, A. J. Hannaford, P.W.G. Smith, A. R. Tatchell, 5th Edition, Addison Wesley Longman Limited, UK (1997).
2. A Hand book of Organic Chemistry–by H. T. Clarke. Edward Ernnold publishers (1957).
3. A Laboratory Manual of Organic Chemistry by B. B. Dey and M. V. Govindachari, 3rd Edition (1957).
4. Lab Experiments in Organic Chemistry –Arun Sethi, New Age International Ltd. New Delhi (2006).

Formative Assessment for Practical		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
	Total	10 Marks
Formative Assessment as per the guidelines		

M.Sc Semester – IV
PHYSICAL CHEMISTRY (Theory)

Course Title: PHYSICAL CHEMISTRY - IV
Course Code: A4CHE003GT

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 23	**Theory**	**04**	**04**	**60 Hrs.**	**3 Hrs.**	**20**	**80**	**100**

Course Outcomes

After completion of course the students will be able to

1. understand the quantum mechanical basis of chemical bonding like LCAO and Molecular orbital approach
2. obtain the knowledge of catalysis, types, their mechanistic pathways and their influence on reaction rates, efficiency, selectivity and sustainability
3. understand the microscopic basis of thermodynamic properties which helps in predicting and relating the microscopic particle behavior to macroscopic thermodynamic properties
4. Interpret the spectra obtained from above mentioned spectroscopic techniques and get an understanding to relate them with molecular structure, molecular dynamics and various interaction occurring at molecular levels.

PHYSICAL CHEMISTRY – IV: A4CHE003GT	**60 Hrs.**
UNIT–I: Chemical Bonding	
Electronic structure of diatomic molecules. The Born–Oppenheimer approximation. Linear combination of atomic orbitals (LCAO) approximation, molecular orbital (MO) theory, comparison of the two theories. Applications of LCAO and MO theories to hydrogen molecule and hydrogen molecule ion. Shortcomings of MO treatment Bonding and antibonding molecular orbitals. Molecular orbital theory applied to homonuclear and heteronuclear diatomic molecules, molecular electron configuration and calculation of bond order. Valence bond theory: Hitler–London treatment of H_2 molecule Slater orbitals, Hartee–Fock self-consistent field method for many electron atoms. Configuration interaction and Roothaam equations.	
UNIT–II: Homogeneous Catalysis	**15 Hrs.**
Homogeneous Catalysis: Introduction, general catalytic mechanism: equilibrium treatment and steady-state treatment, activation energies for catalyzed reactions.	

Acid-Base catalysis: General acid–base catalysis, mechanism of acid-base catalysis, catalytic activity and acid-base strength, salt effects in acid-base catalysis and specific acid-base catalysis: Bronsted relation and linear free energy changes. Acidity functions: Zucker–Hammett hypothesis and Bunnett hypothesis. Enzyme Catalysis: Single and multi-substrate mechanisms, Influence of substrate concentration, pH, temperature and inhibitors, transient-phase kinetics. Mechanism of enzyme catalysis: Michaelis–Menten mechanism and Lineweaver–Burk plot.	
UNIT–III: Statistical Thermodynamics	**15 Hrs.**
Microscopic and macroscopic systems. Microstates and macrostates. Assemblies of independent localised and non-localised systems. Phase space or γ-space and μ-space. Ensembles. Classical statistics: Maxwell–Boltzmann distribution for ideal gases and mixture of gases. Determination of Lagrangian multipliers, alpha and beta. Principle of equipartition energy. Heat capacities of solids: Einstein's theory of heat capacity of solids, Debye's theory, characteristic temperature and use of Debye equation for the determination of heat capacity at low temperature. Sackur-Tetrode equation: Entropies and heat capacities of *ortho*-, *para*-hydrogen systems, comparison of third law entropies with statistical entropies	
UNIT–IV: Rotational and Vibrational Spectroscopy	**15 Hrs.**
Rotation of polyatomic molecules: classification of molecules, momental ellipsoid, energy levels of linear, symmetric, spherical and asymmetric top molecules and their symmetry properties, selection rules, thermal distribution of rotational energy levels, infrared rotational spectra and non–rigid rotor treatment and applications. Vibration of molecules: molecule as harmonic oscillator, vibrational eigen functions and eigen values, hermite polynomials, calculation of transition of probabilities and selection rules, the anharmonic oscillator, vibrational energy levels, infrared spectra of diatomic and polyatomic molecules, normal modes of vibration, force constant, selection rules, anharmonicityand Morse equations, Rotation-vibration spectra of polyatomic molecules: Rotation-vibration spectra, shapes of absorption bands in case of linear, symmetric top, spherical top and asymmetric top, molecules, isotopic effects, infrared spectra of simple molecules, applications of IR spectroscopy and numerical problems.	

Recommended Books:

1. Quantum Mechaincs–L. T. Schiff, Prentice–Hall, 1968.
2. Quantum Chemistry–H. Eyring, J. Walter and G. E. Kimball, John Wiley, 1957.

3. Quantum Mechanics– An Introduction- H. L. Strauss, Prentice Hall of India, 2003.
4. Contemporary Quantum Chemistry–J. Goodisman, Plenum/Rosetta, 2012.
5. Quantum Chemistry–K. S. Pitzer, Prentice–Hall,2009
6. Introductory Quantum Mechanics–Valdimir Rojanstry, 1956.
7. Quantum Chemistry– John P. Lowe, 1977.
8. Quantum Chemistry–Ira N. Levine, Prentice Hall of India Pvt. Ltd., 2013.
9. Quantum Chemistry–Donald A. McQuarrie, Viva Book Pvt. Ltd., 2007.
10. Physical Chemistry–P.W. Atkins, Clarendon Press, Oxford, 1970.
11. Molecular Quantum Mechanics–P. W. Atkins, Clarendon Press, Oxford, 1970.
12. Introduction to Quantum Chemistry–J. M. Anderson, 1995.
13. Introductory Quantum Chemistry–A. K. Chandra, Tata McGraw Hill, New Delhi, 1994.
14. Quantum Chemistry–R. K. Prasad, New Age International Publishers, New Delhi, 2022.
15. Chemical Kinetics by K. J. Laidler, Tata McGraw Hill Publishing Co., New Delhi, 1985.
16. Kinetics and Reaction Mechanisms by Frost and Pearson, Wiley, New York, 1981.
17. Chemical Kinetics, K. J. Laidler, McGraw–Hill, 1950.
18. Theory of rate processes, S. Glasstone, K. J. Laidler and H. Eyring Mcgraw-Hill, 1941.
19. Kinetics and Mechanism, A Frost and R. G. Pearson, John Wiley, 1953.
20. The foundations of Chemical Kinetics, S. W. Benson, McGraw-Hill, 1960.
21. Kinetics of Chemical Changes in Solution, E. S. Amis, McMillan, 1948.
22. The Kinetics of Chemical Change, C. N. Hinshelwood, Oxford, 1942.
23. Theories of Chemical Reactions Rates, K. J. Laidler, McGraw-Hill, 1969.
24. Statistical Mechanics–N. Davidson, McGraw–Hill, 1962
25. Introduction to Statistical Thermodynamics–M. Dole, Prentice Hill. 1954
26. Statistical Thermodynamics–R. H. Fowler and E. A. Guggenheim, Cambridge University Press, 1939.
27. An Introduction to Statistical Mechanics–T. L. Hall, Addison Wesley, 1960.
28. Introduction to Statistical Mechanics–G. S. Rushbrook, Oxford University Press, 1949.
29. Statistical Mechanics–J. E. Mayer and M. G. Mayer, John Willey, 1940.
30. Introduction to Molecular Spectroscopy–G. M. Barrow, McGraw Hill,1962.
31. Physical Methods in Inorganic Chemistry-R. S. Drago East-West Press, New Delhi,2012.
32. Molecular Spectroscopy–J .D. Graybeal. McGraw Hill,2022.

33. Spectroscopy, Volumes I-III Ed–B. P. Straughan and S. Walker Chapman Gall, 1976.
34. Molecular Magnetic Resonance Spectroscopy–R. M. L. Bell and R.K. Harris, 2012.
35. Spectra of Diatomic Molecules, G. Hertzberg-D. Van Norstrand Co. Inc. Prenceton N.J., 1950
36. Infrared and Raman Spectra of Polyatomic molecules–G. Hertzberg, D. Van Norstrand Co.Inc. Prenceton N.J., 1950
37. Absorption Spectroscopy–R.P.Bauman,1962.
38. Molecular' Structure: A Physical Approach–J. C. D. Brand and J. C. Speakaman, Edward Arnold Ltd., London,1975.
39. Molecular Vibrations–E. B. Wilson, J. C. Decius and P. G. Cross,1955

Formative Assessment for Theory		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
02	Internal Assessment test 2	10
	Total	20 Marks
Formative Assessment as per the guidelines		

M.Sc. Semester – IV
Physical Chemistry (Practical)

Course Title: Lab Course in Physical Chemistry
Course Code: A4CHE007GP

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC – 27	**Practical**	**02**	**04**	**60 Hrs.**	**4 Hrs.**	**10**	**40**	**50**

Course outcomes:

After completion of course the students will be able to

1. understand the practical aspects of chemical kinetics, solubility, cryoscopy, thermochemistry etc
2. apply this theoretical knowledge to laboratory experiments like determining the order of the reaction, variation of solubility in the presence of common ion, calorimetrical determination of heat of neutralization, surface tension determination of liquids etc.
3. gain practical instrument proficiency through carefully planned instrumental experiments that involve determination of composition in a binary mixture using spectrophotometer, redox potential by potentiometer, hydrolysis constant and critical micelle concentration using conductometers, and hydrolytic constants using pH meters etc.
4. build a solid foundation in physical chemistry and equip them in making careers in the discipline

Lab Course in Physical Chemistry: A4CHE007GP	**60 Hrs.**
Experiments **Non-Instrumental** 1. Chemical Kinetics: (i) Investigation of autocatalytic reaction between potassium permanganate and oxalic acid in the presence of H_2SO_4 (ii) Investigating the acid catalysed kinetics of oxidation of glycine by chloramine-(CAT) and hence determine the order w.r.t. CAT and glycine 2. Cryoscopy: Determination of activities of electrolytes and non-electrolytes using cryoscopy method 3. Solubility: To study the variation of solubility of $Ca(OH)_2$ in NaOH solution and hence determine the solubility product. 4. Thermochemistry: Determine the heat of neutralization of acetic acid and chloroacetic acid and their relative strength 5. Surface Tension: Determination of the surface tension of a given liquid	

(methyl acetate, ethylacetate, benzene, nitrobenzene, toluene etc) by a. Drop weight method or b. Drop number method 6. Self-generated experiments. **Instrumental** 1. Spectrophotometry: To determine the composition of binary mixture containing $K_2Cr_2O_7$ and $KMnO_4$. 2. Potentiometry: Titration of ferrous ammonium sulphate against ceric sulphate and hence to determine the formal redox potential of Fe^{2+}/Fe^{3+} and Ce^{3+}/Ce^{4+} systems. 3. Conductometry: a. Determination of hydrolysis constant of aniline hydrochloride b. Titration of a moderately strong acid (Salicylic acid etc.) by salt line and double alkali method. c. To determine the critical micelle concentration of a surfactant. 4. pH-metry: Determination of hydrolytic constant of ammonium chloride 5. Self-generated experiments	

Recommended Books*:*

1. Findlay's Practical Physical chemistry, 9th edition, revised by B. P. Levitt, 2012.
2. Practical Physical Chemistry by A. M. James and F. E. Prichard, 1974.
3. Experiments in Physical Chemistry by Shoemaker and Garland , 1964.
4. Experiments in Physical Chemistry by Daniels, Alberty and Williams, 1956.
5. Laboratory Physical Chemistry by Oelke / M.A.C.T.L.A.C., 1969.
6. Experiments in Physical Chemistry by W. G. Palmer, 2020.
7. Advanced Physico–Chemical experiments by J. Rose, 2023.
8. Experimental Physical Chemistry by V. D. Athwale and Paul Mathur, New Age International Publishers, 2001.
9. Text Book of Physical Chemistry by S. Glasstone, 2009.
10. Text Books of quantitative analysis by A. I. Vogel, 1989.
11. Advanced Practical Physical Chemistry by J. B. Yadhav, Goel Publishing House, Meerut, 2014.

Formative Assessment for Practical		
Sl. No	Assessment Occasion / type	Marks
01	Internal Assessment test 1	10
	Total	10 Marks
Formative Assessment as per the guidelines		

M.Sc. Semester – IV
General Chemistry (Project Work)

Course Title: Project Work
Course Code: A4CHE004GP

Type of Course	Theory/ Practical	Credits	Instruction Hour per week	Total No. of Lectures / Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC - 24	**Practical**	**06**	**04**	**60 Hrs.**	**8 Hrs.**	**30**	**120**	**150**

Course Outcomes (COs)

After completion of this course successfully, the students will be able to……

1. identify the research problem.
2. carry out literature search on a research topic.
3. design new experiments to address research problems.
4. conduct experiments in a scientific way.
5. analyze and interpret the results.
6. write the research articles.

The project work may include in–plant training in industries/short term work in the Department/other educational institutions/R&D organizations/data mining/review of current literature/theoretical methods/computer applications. Experimental work may involve studies on synthesis/measurements/study of properties/characterization by physical methods/activities for reported/unreported research or any suitable combination thereof. In case of the students who would work outside the campus, the supervising staff member may visit to the work place at least once during the period and may be eligible for TA–DA as per the University rules.

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