P. D. E. A's
Prof. Ramkrishna More Arts, Commerce and Science
College Akurdi Pune-411044
(Autonomous)

Affiliated to

Savitribai Phule Pune University [SPPU]

B. Sc. With Major Chemistry

(Three years B. Sc. in Chemistry / Four Years Honors in Chemistry)

Choice Based Credit System-2023 Pattern

Under

Autonomy and NEP-2020

From Academic Year
2024-2025

Syllabus

S. Y. B. Sc. With Major Chemistry

Board of Studies in Chemistry

Department of Chemistry
Prof. Ramkrishna More Arts, Commerce and Science
College Akurdi Pune-411044

Rules and Regulations

1. **National Credit Framework (NCrF):** For creditisation and integration of all higher education qualifications leading to a certificate/ diploma/ degree with multiple entry and exit options, college will refer to National Credit Framework (NCrF) which encompasses the qualification frameworks for higher education, vocational and skill education and school education, namely National Higher Education Qualification Framework (NHEQF), National Skills Qualification Framework (NSQF) and National School Education Qualification Framework (NSEQF) respectively.

2. **Structure of Four years multidisciplinary UG Programme and Five Years Integrated Multidisciplinary Master's Degree Programmes with Multiple Entry and Exit Options at Different Levels:**

   (i) Students will have the flexibility to enter four years multidisciplinary Under Graduate Programme in odd semesters and exit a programme after the successful completion of even semesters as per their future career needs.

   (ii) Students will get a Certificate after a One year programme (minimum 40 Credits), a Diploma after two years (minimum 80 Credits), a Bachelor's degree after three years (minimum 120 Credits), and a Bachelor's degree with Research or Honours after Four years (minimum 160 Credits).

3. **Qualification Type and Credit Requirements of Four Years Multidisciplinary Degree Programme with Multiple Entry and Exit Options**

   (i) Details of qualifications, minimum credit requirements, exit credit courses, year and semester are as under:

Levels	Qualification Title	Credit Requirements		Semester	Year
		Minimum	Maximum		
4.5	UG Certificate	40	44	2	1
5.0	UG Diploma	80	88	4	2
5.5	Three Years Bachelor's degree	120	132	6	3
6.0	Bachelor's degree Honour's with Major	160	176	8	4
	Bachelor's degree Honour's with Major	160	176	8	4
7.0	Master's Degree	200	220	10	5
8.0	Ph. D.	----	-----	-----	----

   (ii) An exit 6-credit bridge course(s) lasting two months, including at least 6-credit job specific internship/apprenticeship that will help the graduates acquire job-ready competencies required to enter the workforce will be an additional requirement for the award of the undergraduate Certificate/ Diploma/ three year Bachelor's Degree.

   (iii) On exit, the students will have the option to re-enter the programme in the college, or in a different higher education institution. Re-entry at various levels for lateral entrants in academic programmes should be based on the earned and valid credits as deposited and accumulated in the Academic Bank of Credits (ABC) through Registered Higher Education Institutions (RHEI) and proficiency test records.

   (iv) Eligibility for admission to the fourth year of four-year **Honours with Research Degree Programmes** as per UGC guidelines: Minimum CGPA of 7.5 or minimum 75% at three-year degree.

(v) PG curriculum, as illustrated below, have flexibility a) One-year Post-Graduate Diploma (PGD), b) Two year Post-graduate Programme and c) 5 Years Master's degree programmes with multiple Entry and Exit options at different levels.

(a) Post-Graduate Diploma (PGD): Programme duration- One year (2 semesters) after any bachelor's degree, min. 40 credits

(i) UGC: 1-Year (2 semesters) Post-Graduate Diploma (PGD) after 3-years Bachelor's degree: Level 6.0

(ii) UGC: 1-Year (2 semesters) PGD after 4 years Bachelor's degree (Honors/ Research): Level 6.5

(b) Master's Degree:

(i) UGC: 2-Years (four semesters) Master's Degree after obtaining a 3-years Bachelor's degree, Minimum 40 credits/year, second year devoted entirely to research, PG – 2nd year: Level 6.5

OR

(i) 1-Year (two semesters) Master's Degree after obtaining a 4-year Bachelor's degree (Honours/Research): Minimum 40 credits: Level 6.5

(c) Level 8 represents Ph. D. Research Degree.

(d) A 5-year Integrated Bachelor's and Master's programme shall have a minimum of 220 credits.

(e) Master's and doctoral programmes, while providing rigorous research-based specialization, should also provide opportunities for multidisciplinary work, in academia, government, research institutions, and industry.

4. Lateral Entry/ Re-entry at higher Levels after exit from lower levels of four years multidisciplinary UG degree programme:

(i) The credit points earned and accumulated shall be used to determine the eligibility for taking admission to various programs at multiple levels, subject to fulfilment of the broad principles laid down under NCrF. Students who leave with a Certification, Diploma, or a Basic Bachelor's Degree will be eligible to re-enter the programme at the exit level to complete or progress to the next level through lateral entry mode. Depending upon the academic and physical facilities available, the State Universities/ Autonomous Colleges (Higher Education Institutions or HEI) may earmark specific seats/ intake for lateral entry into the second year/ third year/ fourth year of a four years multidisciplinary UG degree programme as approved by Professional Standard Setting Bodies (PSSB/Govt. of Maharashtra/ statutory council of affiliating University plus any consequential vacancies caused by exits to an ongoing programme (four-year Degree Programme and Integrated Master's or second year Master's). Lateral entry or Re-entry is open to those students if he/she has either –

(a) successfully completed the first year/second year/third year of the particular four years multidisciplinary degree programme in any ABC registered HEI with valid credits in ABC and re-entering into the second year/third year/fourth year, respectively of the same four years degree programme of any ABC registered HEI, within stipulated/ permissible period of years as decided by Statutory Councils of that HEI

OR

(b) Already successfully completed a multidisciplinary four-year first-degree programme and is desirous of and academically capable of pursuing another multidisciplinary four years first-degree programme in an allied subject.

(ii) A student will be allowed to enter/re-enter only at the odd semester. Re-entry at various levels for lateral entrants in academic programmes should be based on the earned and valid credits as deposited and accumulated in Academic Bank of Credits (ABC) through Registered Higher Education Institutions (RHEI) and proficiency test records. However, in terms of the admission eligibility requirements, the student shall belong to the same faculty/ discipline in terms of Major Subject i.e., the Major subject of his earlier Programme and the Major subject of the new Programme for which he is seeking admission must be from the same faculty/discipline. Reservation for lateral entry will be executed as per the Government of Maharashtra norms.

5. Distribution of Credits across Multidisciplinary Four Years Degree Programme:

(i) Four-year multidisciplinary degree programme with Honours/ Specialization Degree will have Internship and Core /Major Courses with a minimum of 22 credits per sem. in the Fourth Year.

(ii) Four-year multidisciplinary degree programme with Research will have Research Projects, Seminars, Dissertations and Internships with a minimum of 22 credits per Sem. in the Fourth Year.

(iii) Students shall select a 'Major or Core Subject/ Discipline' and a '**Minor Subject/Discipline' from the lists of various Subject Combinations and Options provided the Colleges.** In general, for the four years multidisciplinary bachelor's degree programme, the distribution of credits will be as follows:

(a) Disciplinary/interdisciplinary Major/ Core Subject (minimum of 68 credits)- Mandatory and Elective Courses

(b) Disciplinary/interdisciplinary Minor Subject (maximum of 22 credits)

(c) Skill based/Vocational studies corresponding to the Major/ Core Subject (8 credits)

(d) Field projects/internship/apprenticeship/community engagement and service corresponding to the Major/ Core Subject (14-22 credits) with a maximum of six credits per Semester

(e) Generic/ Open Electives through Baskets of Elective Courses (12 credits),

(f) Ability Enhancement Courses including Languages, Literature and Environmental Studies (12 credits),

(g) In-built modules on the Indian Knowledge System (IKS) in Major/ Core Subject at Level 4.5 – 2 credits

(h) Value-based Education, Life Skills and Professional Ethics: Co-curricular Courses such as Sports and Culture, NSS/NCC and Fine/ Applied/Visual Arts (8 credits).

Student can earn some credits (SEC/VSC/GE/OE) in the form of online from-

(i) The National Skills Qualifications Framework (NSQF) organizes qualifications for Vocational and Skill Courses in a series of 8 levels based on professional knowledge, professional skills, core skills and responsibilities, in the increasing order of complexity and competency.

(ii) University Grants Commission (Credit Framework For Online Learning Courses through Study Webs of Active-Learning for Young Aspiring Minds) Regulations, 2021, **permits up to 40 per cent of the total courses being offered in a particular programme in a semester through the Online Learning Courses offered through the Study Webs of Active-Learning for Young Aspiring Minds (SWAYAM) platform**.

6. Examination and Assessment Process:

(i) The basic principle of the credit framework is that credits are a function of the successful completion of a program of study/ vocational education/ training and assessment. No credit can be earned by the student unless the student is assessed for the achievement of the desired competencies and outcome of a program.

(ii) Exit options are provided with certification, diploma and basic Bachelor's degrees to the students at the end of the second, fourth and sixth semesters of a four years multidisciplinary degree programme. Students will receive a Bachelor's degree with Honours/ Research on successfully completing of all eight semesters of the UG Program either at a stretch or with opted exits and re-entries.

(iii) For the smooth success of four-year multidisciplinary degree programme with multiple entry and exit systems, the examination mode will be based on the combination of innovative trends in formative (informal and formal tests administered during the learning process) and summative (evaluation of students learning at the end of an instructional unit) examination modes. This is in line with the UGC Report on 'Evaluation Reforms in Higher Educational Institutions (2019)'.

(iv) Evaluation of each students in each course will be done as follows

a. Each theory or practical course will be of 2 credits = 50 marks

b. Internal evaluation 30% weightage (15 marks)

c. External evaluation 70% weightage (35 marks)

d. Students should secure 40% marks in each type of evaluation for successful completion of a course (student should secure at least 6 marks in internal and 14 marks in external evaluation).

(v) Evaluation Pattern.

a. Internal evaluation - Two written test, each of 20 marks will be conducted i. e. two tests on two modules. 1st assignment after completing 6 weeks of teaching and 2nd on completion of 13th week of teaching. 5 marks out of 15 will be assigned from these written tests. Remaining 10 marks will be assigned from other types of evaluation such as seminars, orals, poster presentation, open book challenging tests, surprise test, objective test etc. Examination (Internal and external) will conducted so that CO, PO, PSO can be evaluated.

b. External Evaluation - External evaluation will be done at the end of each semester.

i. For theory, 35 marks written examination will be conducted and time of examination will be 2-hours.

ii. For practical, 35 marks practical examination will be conducted and time of examination will be 4-hours.

iii. For project / field project, 35 marks evaluation will done on the basis of viva-voce and examination of thesis by the examiners.

iv. For OJT 35 marks evaluation will be done on the basis of report of industrial mentor / supervisor / industry and viva-voce. However, student has to produce and submit OJT certificate from competent authority of industry.

7. Attendance: The student must have at least 70% attendance, to appear any type of examination.

8. Declaration of Results:

(i) Declaration of result is based on the Semester Grade Point Average (SGPA) earned towards the end of each semester or the Cumulative Grade Point Average (CGPA) earned at the completion of all eight semesters of the programme and the corresponding overall alpha-sign or letter grades as given in Table 2. If some candidates exit at the completion of the first, second or third year of the four years Undergraduate Programmes, with Certificate, Diploma or Basic Degree, respectively, then the results of successful candidates at the end of the second, fourth or sixth semesters shall also be classified on the basis of the CGPA obtained in the two, four, six or eight semesters, respectively. Successful candidates at the end of the tenth semester of the integrated Master's Degree Programmes shall also be classified on the basis of CGPA obtained in the ten semesters of the Programmes. Likewise, the successful candidates of one year or two semesters Master's Degree Programme are also classified on the basis of the CGPA of two semesters of the Master's Degree Programme.

Table-2: Grades on degree certificate/mark sheet will be assigned to the students as per the following table

Semester GPA/ Program CGPA Semester/Program	**% of Marks**	**Alpha-Sign / Letter Grade Result**
9.00-10.00	90-100	O (outstanding)
8.00 - <9.00	80.00 – <90.00	A+ (Excellent)
7.00 - <8.00	70.00-<80.00	A (Very Good)
6.00 - <7.00	60.00-<70.00	B+ (Good)
5.50 - <6.00	55.00-<60.00	B (Above Average)
5.00 - <5.50	50.00-<55.00	C (Average)
4.00 - <5.00	40.00-<50.00	P (Pass)
Below 4.00	< 40	F (Fail)
Ab	----------	Absent

(ii) A student obtaining Grade F shall be considered failed and will be required to reappear in the examination. For non-credit courses 'Satisfactory' or "Unsatisfactory' shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA.

9. Award of Major and Minor Degree:

(i) A student pursuing four-year multidisciplinary UG programme will be awarded an appropriate Honours/ Research degree in Major/ Core Subject on completion of VIII Semester with the minimum of 176 credits if he secures in that Subject at least 50% of the total credits for that programme. He shall thus study the specific number of Mandatory Core Courses, Core

Electives, Vocational and Skill Courses and Field projects/ Internships connected to Core Subjects in eight semesters so as to cover at least 50% of the total credits.

(ii) In case of Research Degree, a student shall pursue research project and write dissertation in that Major in the VII and VIII semesters.

On the basis of above rules and regulations under NEP-2020 following course frame work is adopted by the Prof. Ramkrishna More Arts, Commerce and Science College, Akurdi, Pune-411044 for the completing of four years honours degree in Major and Minor subjects.

10. Distribution of Credits across Four Years Degree Programmes:

In general, for the four years' bachelor's degree programme, the distribution of credits will be as follows:

(a) Major (Core) Subject comprising Mandatory and Elective Courses:

i. Minimum 50% of total credits corresponding to Three/Four - year UG Degree- Mandatory Courses offered in all Four years;

ii. 2 credit course on Major Specific IKS shall be included under Major;

iii. Elective courses of Major will be offered in the third and/or final year.

iv. Vocational Skill Courses, Internship/ Apprenticeship, Field Projects, Research Projects connected to Major first to fourth year.

(b) Minor Subject: 18-20 Credits

i. The Minor subjects may be from the different disciplines of the same faculty of DSC Major (Core) or they can be from different faculty altogether.

ii. The credits of Minor subjects shall be completed in the first three years of UG Programme.

(c) Generic/ Open Elective Courses (OE): 10-12 credits

i. It is to be offered in I and/or II year

ii. Faculty-wise baskets of OE shall be prepared by University/ Autonomous Colleges.

iii. OE is to be chosen compulsorily from faculty other than that of the Major.

(d) Vocational and Skill Enhancement Courses (VSEC): 14-16 credits

Vocational Skill Courses (VSC): 8-10 credits, including Hands on Training corresponding to the Major and/or Minor Subject:

i. To be offered in first to three years;

ii. Wherever applicable vocational courses will include skills based on advanced laboratory practicals of Major

 # Skill Enhancement Courses (SEC): 06 credits

i. To be offered in I and II year;

ii. To be selected from the basket of Skill Courses approved by University/ Autonomous Colleges

(e) Ability Enhancement Courses (AEC), Indian Knowledge System (IKS) and Value Education Courses (VEC): 14 Credits

- **AEC: 08 credits**

i. To be offered in I and II year

ii. English: 04 Credits

iii. Modern Indian Language: 04 credits

iv. To be offered from the Basket approved by the College;

The focus for both languages should be on linguistic and communication skills.

o IKS: 2 Credits

i. To be offered in I Year

ii. Courses on IKS to be selected from the basket of IKS courses approved by the Colleges

o VEC: 04 Credits

i. To be offered in I year

ii. Value Education Courses (VEC) Environmental Science Education (Compulsory), Understanding India, and Digital and Technological Solutions.

(f) Field Projects/ Internship/ Apprenticeship/ Community Engagement and Service corresponding to the Major (Core) Subject, Co-curricular Courses (CC) and Research Project

o Internship/Apprenticeship corresponding to the Major (Core) Subject: 8 Credits

o Field Projects/Community Engagement and Service corresponding to the Major (Core) Subject: minimum 4-6 credits

To be offered in II, and III years of UG Degree Programmes.

- **Co-curricular Courses (CC) such as Health and Wellness, Yoga education sports, and fitness, Cultural Activities, NSS/NCC and Fine/ Applied/ Visual/ Performing Arts: 8 credits.** To be offered in I and/or II year
- **Research Projects: 12 credits**

To be offered in the final year for 4-year Honours with Research UG Degree

The UGC Regulations, 2021 permit up to 40% of the total courses being offered in a particular programme in a semester through the Online Learning Courses offered through the SWAYAM platform and/or other State Level Common Platforms which can be developed in due course with the participation of different Universities/ HEIs.

Abbreviations: Generic/ Open Electives: **GE**/**OE**; Vocational Skill and Skill Enhancement Courses: **VSEC**; Vocational Skill Courses: **VSC**; Skill Enhancement Courses**: SEC**; Ability Enhancement Courses: **AEC**; Indian Knowledge System: **IKS**; Value Education Courses: **VEC; OJT**: On Job Training: Internship/ Apprenticeship; Field projects: **FP**; Community engagement and service: **CEP**; Co-curricular Courses: **CC**; Research Methodology**-RM**; Research Project: **RP** Note: The Credit Distribution Table given above is illustrative only. The Universities/ Autonomous Colleges may suitably modify within the broader framework of credit distribution across six verticals.

11. Definitions:

i. One semester = 15 weeks

ii. 1-credit theory = 15 hours i.e. for 1 credit, 1 hour per week teaching is to be performed.

15 hours of 1-credit are splinted as 12 hours actual teaching + 3 hours Tutorial (Numerical problem solving sessions, revision on difficult topics, dialog on student's difficulties, and internal evaluation)

iii. 1-credit practical = 30 hours. Thus, 1 credit practical = 2 contact hours in laboratory per week. 30 hours splinted as 24 hours actual table work and 6 hours for journal competition, oral on each practical and other internal evaluation.

iv. Each theory course of any type (major, minor, VSC, VEC, OE/GE, VEC, SEC, CC, etc.) **is of 2 credits**.

v. Theory per semester: Each theory course is of 2 credits. Thus, for each theory course contact hours = 24 teaching + 6 tutorials

vi. Each practical course is of 2 credits = 60 hours per semester

a. Minimum 12 laboratory sessions will be conducted in one semester.

b. Each laboratory sessions will be of 4 hour.

P. D. E. A's.

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Graduate and Honors Degree Course Framework under Autonomy as per NEP-2020; With Major Chemistry

Sem.	Major Courses	Major Elective Curses	Minor Curses	VSC	IKS	FP/OJT/CEP	GE/OE	SEC	AEC	VEC	CC	Total Credits
First Year Certificate Course												
I	CHMAT-111 CHMAT-112 CHMAP-113	0	0	CHVST-111	CHIKT-111	0	1 theory + 1 Practical From Basket	1 theory/ practical From Basket	1 theory Marathi /Hindi	Environment Awareness VEAET-111	1 theory CCHWT-11	22
II	CHMAT-121 CHMAT-122 CHMAP-123	0	1 Theory Other than chemistry	CHVSP-121	0	0	1 theory + 1 Practical From Basket	1 theory/ practical From Basket	1 theory Marathi /Hindi	1 theory From Basket VECOT-111	1 theory CCPEP-111	22
Second Year Graduate Diploma												
III	CHMAT-231 CHMAT-232 CHMAT-233 CHMAP-234	0	1 Theory + 1 Practical Other than chemistry	CHVST-231	0	Field Project (2 Credit) CHFPP-231	1 Practical From Basket	0	ENAET-231: English Communication-I	0	CCHRT-231 Human Rights	22
IV	CHMAT-241 CHMAT-242 CHMAT-243 CHMAP-244	0	1 Theory + 1 Practical Other than chemistry	0	0	Community Engagement and Service (2 Credit) CHCEP-241	1 theory From Basket	CHSEP-241 Chemo-Informatics and Organic synthesis	ENAET-241: English Communication-II	0	CCCRT-241 Cyber Security	22
Third Year Graduate Degree												
V	CHMAT-351 CHMAT-352 CHMAT-353 CHMAP-354 CHMAP-355	CHMET-356-A CHMEP-357-A Or CHMET-356-B CHMEP-357-B	1 Theory + 1 Practical Other than chemistry	CHVST-351	0	Research project (2 Credit) CHRPP-351	0	0	0	0	0	22
VI	CHMAT-361 CHMAT-362 CHMAT-363 CHMAP-364 CHMAP-365	CHMET-366A CHMEP-367A Or CHMET-366B CHMEP-367B	1 Theory + 1 Practical Other than chemistry	0	0	OJT (4 Credit) CHOJT-361	0	0	0	0	0	22

VII and VIII Semester Honours Degree with Major												
Sem.	**Major Courses**	**Major Elective Curses**	**Minor Curses**	**VSC**	**IKS**	**FP/OJT/CEP**	**GE/OE**	**SEC**	**AEC**	**VEC**	**CC**	**Total Credits**
VII	CHMAT-471 CHMAT-472 CHMAT-473 CHMAT-474 CHMAT-475 CHMAP-476 CHMAP-477	CHMET-478-A CHMEP-479-A Or CHMET-478-B CHMEP-479-B	Research methodology (4 Credits) CHRMT-471	0	0	0		0	0	0	0	22
VIII	CHMAT-481 CHMAT-482 CHMAT-483 CHMAT-484 CHMAT-485 CHMAP-486 CHMAP-487	CHMET-488-A CHMEP-489-A Or CHMET-488-B CHMEP-489-B	0	0	0	On Job Training (4 Credit) CHOJT-481	0	0	0	0	0	22
VII and VIII Semester Honours Degree with Research												
VII	CHMAT-471 CHMAT-472 CHMAT-473 CHMAT-474 CHMAP-476	CHMET-478-A CHMEP-479-A Or CHMET-478-B CHMEP-479-B	RM 4 Credits	0	0	Research Project (4 Credit) CHPRP-471	0	0	0	0	0	22
VIII	CHMAT-481 CHMAT-482 CHMAT-483 CHMAT-484 CHMAT-485 CHMAP-486	CHMET-487-A CHMEP-488-A Or CHMET-487-B CHMEP-488-B	0	0	0	Research Project (6 Credit) CHPRP-481	0	0	0	0	0	22

Courses for S. Y. B. Sc. [2023 Pattern]

Paper Code	Generic Name	Title	Credits
Major Semester-III			
CHMAT-231	Chemistry Paper-V	Physical Chemistry-II	2
CHMAT-232	Chemistry Paper-VI	Organic Chemistry-II	2
CHMAT-233	Chemistry Paper-VII	Industrial Chemistry-I	
CHMAP-234	Chemistry practical-III	Chemistry Practical-III	2
Major Semester-IV			
CHMAT-241	Chemistry Paper-VIII	Inorganic Chemistry-II	2
CHMAT-242	Chemistry Paper-IX	Analytical Chemistry-II	2
CHMAT 243	Chemistry Paper-X	Chemistry of Biomolecules-I	2
CHMAP-244	Chemistry practical-IV	Chemistry Practical-IV	2
Minor SEM-III			
CHMIT-231	Chemistry Minor-II	Fundamentals of Analytical Chemistry	2
CHMIP-232	Chemistry Minor-III	Analytical Chemistry Practical	2
Minor SEM-IV			
CHMIT-241	Chemistry Minor-IV	Material Science-I	2
CHMIP-242	Chemistry Minor-V	Practical on Material Science	2
Vocational Skill Course (VSC), SEM-III			
CHVST-231	Vocational Chemistry-III	Pharmaceutical Analysis-III	2
Skill Enhancement Course (SEC), SEM-IV			
CHSET-241	Skill Chemistry-III	Chemo-Informatics and Organic Synthesis	2
Field Project in Chemistry (FP), SEM-III			
CHFPP-231	Chemistry Project-I	Field Project in Chemistry	2
Community Engagement Project (CEP), SEM-IV			
CHFPP-241	Chemistry Project-II	Community Engagement Project in Chemistry	2
GE/OE Course for SEM-III (For Arts and Commerce Students)			
CHGET-231	GE-Chemistry Theory-III	Agriculture and Dairy Chemistry	2
GE/OE Course for SEM-IV (For Arts and Commerce Students)			
CHGET-241	GE-Practical-III	Food and Water quality analysis	2
Ability Enhancement Courses Sem-III			
ENAET-231	AEC English-I	English Communication and Soft Skill-I	2
Ability Enhancement Courses Sem-IV			
ENAET-241	AEC English-II	English Communication and Soft Skill-II	2
Co-Curricular Courses-III			
CCHRT-231	Co-Curricular Course-III	Human Rights: An Introduction	2
Co-Curricular Courses-IV			
CCCST-241	Co-Curricular Course-IV	Cyber Security	2

Program: B.Sc. [Chemistry], 2024-25

Program Outcomes (POs):

PO-1: **Disciplinary knowledge and skill:** A graduate student is expected to be capable of demonstrating comprehensive knowledge and understanding both theoretical and practical fundamental concepts in all disciplines of Chemistry. Further, the student will be capable of applying technologies, handling instruments and Chemistry related soft-wares for chemical analysis, characterization of materials and in separation technology.

PO-2: **Skilled communicator:** The course curriculum incorporates basics and advanced training in order to make a graduate student capable of expressing the subject through technical writing as well as through oral presentation.

PO-3: **Critical thinker and problem solver:** The course curriculum also includes components that can be helpful to graduate students to develop critical thinking and to design, carry out, record and analyze the results of chemical reactions. Students will be able to think and apply evidence based comparative chemistry approach to explain chemical synthesis and analysis.

PO-4: **Sense of Inquiry:** It is expected that the course curriculum will develop an inquisitive characteristic among the students through appropriate questions, planning and reporting experimental investigation.

PO-5: **Team player:** The course curriculum has been designed to provide opportunity to act as team player by contributing in laboratory, field-based situation and industry.

PO-6: **Skilled project manager:** The course curriculum has been designed in such a manner as to enabling a graduate student to become a skilled project manager by acquiring knowledge about chemistry project management, writing, planning, study of ethical standards and rules and regulations pertaining to scientific project operation.

PO-7: **Digitally literate:** The course curriculum has been so designed to impart a good working knowledge in understanding and carrying out data analysis, use of library search tools, use of chemical simulation software and related computational work.

PO-8: **Ethical awareness:** A graduate student requires understanding and developing ethical awareness or reasoning which is adequately provided through the course curriculum. To know how to handle the technical devices for presenting research works.

PO-9: **Environmental Awareness:** The course curriculum is designed to teach a Chemistry graduate student to follow the green routes for the synthesis of chemical compounds and also find out new greener routes for sustainable development. The course also helps them to understand the causes of environmental pollution and thereby applying environmentally friendly policies instead of environmentally hazard ones in every aspect.

PO-10: **Analytical skill development and job opportunity:** The course curriculum is designed in such a way that Chemistry graduate students can handle many Chemistries based software, modern instruments and advanced technologies to synthesize, characterize and analyze the chemical compounds very skillfully. Such a wonderful practice in the graduate level will bring a good opportunity to the students for getting job in industries besides academic and administrative works.

Paper Wise Detailed Syllabus of S. Y. B. Sc. (2024-25)

Semester-III, Major Theory Paper-1

CHMAT-231: Physical Chemistry-II

[Theory, 2 Credits Paper, 30 L]

Module	Chapter No	*No. of lecture*
I	Chemical Kinetics	9
	The Phase Rule	6
II	Adsorption	5
	Solutions	10

Module-1; 15 L

1. Chemical Kinetics [9L]

Reaction Rate, Units of Rate, Rate Laws, Order of a Reaction, Zero Order Reaction, Molecularity of a Reaction, Molecularity *Versus* Order of Reaction, Pseudo–Order Reactions, Rate Constants of – a) Zero Order Reactions, b) First Order Reactions, c) Second Order Reactions; d) Third Order Reactions; Half–Life of A Reaction, How to Determine The Order Of A Reaction, Collision Theory of Reaction Rates; Effect of Increase of Temperature on Reaction Rate; Transition State Theory; Lindeman's Theory of Uni-molecular Reactions (**Ref-1**: 731 -768)

2. The Phase Rule [6L]

The Statement; What is Meant by a 'Phase'?; What is Meant by 'Components'?; Degrees of Freedom; Derivation of the Phase Rule; One–Component System; Phase Diagrams; Polymorphism; Experimental Determination of Transition Point; The Water System; The Sulphur System; Two–Component Systems; The Silver–Lead System; The Zinc–Cadmium System**;** (**Ref-1**: 697-715)

Module-1; 15 L

3. Adsorption [5L]

Mechanism of Adsorption; Types of Adsorption; Adsorption of Gases by Solids; Adsorption Isotherms- a) Freundlich Adsorption Isotherm b) Langmuir Adsorption Isotherm; Derivation of Langmuir Isotherm; Adsorption of Solutes from Solutions; Applications of Adsorption. (**Ref-1**: 843-851)

4. Solutions [10 L]

Concentration Of A Solution; Ways Of Expressing; Types Of Solutions; Concentration; Solutions Of Gases In Gases; Henry's Law; Solutions Of Liquids In Liquids; Solubility Of Completely Miscible Liquids; Solubility Of Partially Miscible Liquids; Phenol–Water System; Triethylamine–Water System; Nicotine–Water System; Vapour Pressures Of Liquid–Liquid Solutions; Theory Of Fractional Distillation; Vapour Pressure Of Mixtures Of Non–Miscible Liquids; Steam Distillation;

Solutions Of Solids In Liquids; Solubility–Its Equilibrium Concept; Determination Of Solubility; Solubility Curves; Solubility of Solids in Solids

(**Ref-1**: 528-551)

Reference-1: Essential of Physical Chemistry, Bahl, Bahl and Tuli; S. Chand publication, 4th colour Ed.

Reference-2: Atkins' Physical Chemistry by Peter Atkins, Julio de Paula, James Keeler -11th edition

Reference-3: Principles of Physical Chemistry, Fourth Edition by S.H. Marron and C. F. Pruton

Reference-4: Principles of Chemical Kinetics- James E. House. 2nd Edition, Elsevier Publication

Course Outcomes (CO): CHMAT-231: Physical Chemistry-II

CO1: Define rates, rate laws and rate constants, reaction order and Molecularity, adsorption, Adsorbate, adsorbent, desorption, absorption**.**

CO-2: Explain first order, second order chemical reaction, factors affecting rate of chemical reaction, half -life period, adsorption process and factors affecting adsorption process.

CO-3: Recognize order and Molecularity of chemical reaction, Physisorption or chemisorption,

CO-4: Apply knowledge of adsorption to purify water.

CO-5: Write various types of adsorption isotherms, types Of Solutions

CO-6: Draw isotherm diagram, rate la Steam Distillation, critical solution temperature of phenol-water system.

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Major Theory Paper-2, SEM-III

CHMAT-232: Organic Chemistry -II

[Theory, 2 Credits Paper, 30 L]

Module	Chapter No.	Title of Topic/Chapter	No. of lecture
I	1	Alkyl and Aryl Halides	07
	2	Alcohols, Phenols and Ether	05
	3	Aldehydes and Ketones-I	03
II	4	Aldehydes and Ketones-II	03
	5	Carboxylic acids and their derivatives	06
	6	Amines and Diazonium Salts	06

Module-1; 15 L

Chapter-1: Alkyl and Aryl Halides: [8 L]

Alkyl Halides (up to 5 Carbons): Introduction and IUPAC nomenclature, Types of Nucleophilic Substitution (SN^1, SN^2 and SNi) reactions. *Preparation:* from alkenes *and* alcohols. *Reactions:* hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs. substitution.

Aryl Halides: Introduction and IUPAC nomenclature, *Preparation:* (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer and Gattermann reactions. *Reactions (Chlorobenzene):* Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$). Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides**.** ***(Ref.-1:*** *165-211 and 943-967)*

Chapter-2: Alcohols, Phenols and Ethers (Up to 5 Carbons): [5 L]

Alcohols: Introduction and IUPAC nomenclature, *Preparation:* Preparation of 1o, 2o and 3o alcohols: using Grignard reagent, ester hydrolysis, reduction of aldehydes, ketones, carboxylic acid and esters. *Reactions:* with sodium, HX (Lucas test), esterification, oxidation (with PCC, alc. KMnO4, acidic dichromate, conc. HNO_3). Oppeneauer oxidation *Diols:* (Up to 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols (Phenol case): Introduction and IUPAC nomenclature, *Preparation:* Cumene hydroperoxide method, from diazonium salts. *Reactions:* Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer- Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction. **Ethers (aliphatic and aromatic):** Cleavage of ethers with HI. (***Ref-1:*** *213-244 and 889-912)*

Chapter-3: Aldehydes and ketones (aliphatic and aromatic)-I [2 L]

(Formaldehyde, acetaldehyde, acetone and benzaldehyde)

Introduction and IUPAC nomenclature, *Preparation:* from acid chlorides and from nitriles.

Module-2; 15 L

Chapter-3: Aldehydes and ketones (aliphatic and aromatic)-I [2 L]

Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemenson reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction. (***Ref-1:*** *657-700 and 797-816*)

Chapter-4: Carboxylic acids and their derivatives [6 L]

Carboxylic acids (aliphatic and aromatic): Introduction and IUPAC nomenclature, *Preparation:* Acidic and Alkaline hydrolysis of esters. *Reactions:* Hell – Vohlard - Zelinsky Reaction. **Carboxylic acid derivatives (aliphatic):** (up o 5 carbons) *Preparation:* Acid chlorides, Anhydrides, Esters and Amides from acids and their inter conversion. Reaction: Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation. *(**Ref-1:** 713-745 and 753-785).*

Chapter-5: Amines and Diazonium Salts: [6 L]

Amines (Aliphatic and Aromatic): Introduction and IUPAC nomenclature, *Preparation* from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction. *Reactions:* Hofmann

vs. Saytzeff elimination, Electrophilic substitution (Case Aniline): nitration, bromination, sulphonation. **Diazonium salts:** Preparation from aromatic amines. (***Ref-1:*** *821-877)*

References

1.Morrison, R.T. & Boyd, R.N. Organic Chemistry, Prentice Hall of India, Sixth Edition, 2002.

2. Jonathan Clayden, Nick Greeves, Stuart Warren, Peter Wothers Organic Chemistry - Oxford University Press, USA, 2nd Ed.

3. Bahl, A. and Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.

4. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley and Sons (2014). 5. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013. 6. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).

7. Finar, I. L. Organic Chemistry (Vol. I and II), E.L.B.S.

Course Outcomes (CO) for Organic Chemistry-II

CO-1: Identify and draw the structures alkyl / aryl halides, Alcohols, Phenols ethers, Aldehydes, ketones, Carboxylic acids and Amines from their names or from structure name can be assigned.

CO-2: Explain synthesis alkyl / aryl halides, Alcohols, Phenols ethers, Aldehydes, ketones, Carboxylic acids and Amines.

CO-3: Write the mechanism of various reactions involved.

CO-4: Discuss the role of reagents involved in various organic reactions.

CO-5: Correlate reagent and reactions.

CO-6: Differentiate between alcohols and phenols

CO-7: Perform inter conversion of functional groups.

CO-8: Give synthesis diazonium salt from amines and reactions of diazonium salt.

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Major Theory Paper-3, SEM-III

CHMAT-233: Industrial Chemistry-I

[Theory, 2 Credits Paper, 30 L]

Module	Chapt. No.	Title of Topic/Chapter	No. of lecture
I	1	Modern Approach to Chemical Industry	05
	2	Manufacture of Basic Chemicals	06
	3	Sugar Industry	04
II	4	Dyes and Pigments Industry	07
	5	Chemistry of pharmaceutical industries	08

Module-1; 15 L

Chapter-1: Modern Approach to Chemical Industry (5 L)

Introduction, basic requirements of chemical industries, chemical production, unit process and unit operations, Quality control and quality assurance, process control, research and development, human resource, safety measures, batch and continuous process, Conversion, selectivity and yield, copy-right act, patent act, trademarks.

Reference No.-4: Page No- 6 to 18**, Reference No.-2:** Relent pages

Reference -10: www.wikipedia.org/wiki/copyright_act_of1976/patent act/ trademark

Chapter-2: Manufacture of Basic Chemicals (NH_3, HNO_3 and H_2SO_4) (6 L)

a) Ammonia: Manufacture of ammonia by modified Haber-Bosch process, Physicochemical principles involved and uses of ammonia.

b) Nitric acid: Manufacture of nitric acid by Ostwald's process, Physicochemical principles involved and uses of nitric acid.

c) Sulphuric acid: Manufacture of sulphuric acid by contact process, physicochemical principles involved and uses of sulphuric acid.

Reference No.-1: Page No. 731 to 761, 809 to 844, **Reference-2:** Page No.- 466 t0 477

Chapter-3: Sugar Industry (4 L)

a. Sugar Industry: Introduction, occurrence, manufacture of cane sugar from sugar cane: extraction of juice, purification of juice: lime defecation, sulphitation and carbonation, concentration or evaporation of juice, crystallization, separations of crystals, drying, refining, by-product of sugar industry and their uses, testing or estimation of sugar.

Reference No.-1: Page No.-1208 to 1214; **Reference-3**: Page No.- 337 to 347

Module-2; 15 L

Chaptrr-4: Dyes and Pigments Industry (7 L)

(a) Dyes: Introduction, qualities of good dye, Colour constituents (Chromophore, auxochrome), classification of dyes according to their application, Synthesis and uses of following dyes: Nitroso dye-martius yellow, Azo Dyes-Methyl orange and aniline yellow, Triphenylmethane dye-Crystal violet, Phthalein dye - Phenolphthalein, Xanthane-Fluorescein, Antha-quinnoe-Alizarin and Indigo dyes - Indigo.

Reference -1: Page No.- 1545 to 1595 **; Reference -2**: Page No.- 863 to 911

(b) Pigments: Introduction, classification and general properties of pigments of Inorganic pigments**:**

i) Zinc oxide pigments (Fundamentals and properties, Raw materials, Direct process (American process), Precipitation process)

Iron oxide pigments (Fundamentals and properties, Production of iron oxide pigment by precipitation process), **Reference-6:** Page No.- 80-87, and 97 to 109.

Chapter-5: Chemistry of pharmaceutical industries (8 L)

a. Introduction, classification, nomenclature, structure-activity relationship, action of drugs, factors affecting drug action, metabolism of drugs.

b. Meaning of the terms: Prescriptions, doses, analgesic, antipyretic, diuretic, anesthetics, antibiotics, anti-inflammatory, anti-viral, tranquilizer, antiulcer, antialargic and

bronchodilators, cardiovascular, cold preparations, anti-hypertensive, cough preparation, anti-neoplastic, sedative and hypnotics, steroidal, contraceptive, histamine and antihistamine.

c. Synthesis and uses: Paracetamol, Aspirin, Sulphanilamide, Benzocaine and penicillin-G.

Reference-2: Page No. 987 o 1011 **Reference-5**: Page No.- 531 to 579

References:

1. Industrial Chemistry, B. K. Sharma, Goel publishing House, 18th Ed. (2014)
2. Riegeal's Hand book of industrial chemistry, James A. kent. 9th Ed. CBS publishers
3. Industrial Chemistry, Part-II, R. K. Das, Kalyani Publisher, Second Ed.
4. Shreve's Chemical Process Industries, Georce Austin, 5th Edition, Tata McGraw Hill Education,
5. Advanced Inorganic Chemistry, Satyaprakash, Tuli, Basu pages 458-463.
6. Inorganic Pigments by Gerhard Pfaff, Publisher-De Gruyter, 1st Ed.
7. www.wikipedia.org/wiki/copyright_act_of1976 , www.wikipedia.org/wiki/patentact and www.wikipedia.org/wiki/trademark

Course Outcomes (CO): CHMAT-233: Industrial Chemistry-I

CO-1: Define the terms unit process and unit operations, Quality control and quality assurance, process control, Conversion, selectivity, yield, copy-right and patent act, trademarks, dyes, drugs, antipyretic, antibiotics, anti-viral, tranquilizer, antiulcer, antialargic and bronchodilators etc.

CO-2: Describe manufacture of ammonia, sulphuric acid, nitric acid, sugar, factors affecting drug action, structure-activity relationship, and general properties of pigments.

CO-3: Explain the terms safety measure, research and development, human resource, soap Extraction, Centrifugation, Neutralization, drugs, pigments, dyes, etc.

CO-4: Classify the industrial processes, dyes, pigments, and drugs

CO-5: Illustrate various physicochemical parameters involved in manufacture of ammonia, sulphuric acid, nitric acid, manufacture of dyes and pigments, synthesis of drugs.

CO-6: Distinguish between batch and continuous process, Platinum and vanadium catalyst used in manufacture of sulphur trioxide, dyes and pigments, etc.

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Major Practical Paper-4, SEM-III

CHMAP: 234: Major Practical Chemistry-III

[Practical, 2 Credits Paper, 60 L]

Part-I: Physical Chemistry practical (Any Six Experiments)

1. Kinetics of reaction: Determination of rate constant of acid catalyzed hydrolysis of methyl acetate.
2. Kinetics of reaction: Determination of rate constant of base catalyzed hydrolysis of methyl acetate.
3. Determination of energy of activation of the reaction between $K_2S_2O_8$ and KI by initial rate method.
4. **Phase Equilibria: Phenol water system (compulsory)**: To study of the variation of mutual solubility temperature with concentration for the phenol - water system and determination of

the critical solubility temperature and to study of effect of added electrolyte on CST of phenol water system.

5. Study of phase diagram of two component system
6. Adsorption (**Compulsory**): To verify the Freundlich and Langmuir adsorption isotherm for adsorption of acetic acid on activated charcoal.
7. Adsorptive removal of Phenol / colours by using activated charcoal.

Part-II: Organic Chemistry practical (any Six Experiments)

1. Identification tests of sugars (Molish test of sugars, Benedict's and Fehling's test for reducing sugar) and preparation Osazon derivative of glucose.
2. Biuret assay of protein by colorimetric method.
3. Isolation of Lactose from milk and its identification by Fehling solution
4. Paper chromatographic separation of glucose and fructose from fruit extract.
5. Determination of isoelectric point of glycine
6. Isolation protein: Isolation of Casein from milk
7. Estimation of amino acids (glycine) by formal titration / titration curve for amino acids.
8. Determination oil/fat content in oil seeds / food samples.
9. Determination of acid value and peroxide value of fat/oil.

References:

1. Iron Analysis by Redox Titration A General Chemistry Experiment, Journal of Chemical Education, Volume 65, Number 2, February 1988.183.
2. A Precise Method for Determining the CO2 Content of Carbonate Materials, Journal of Chemical Education, Vol. 75, No. 12, December 1998.
3. Vogel's Textbook Quantitative Chemical Analysis, 3rd and 6th Ed.
4. Advanced Practical Chemistry, Jagdamba Sing et al, Pragati Prakashan, Merrut.
5. Practical Chemistry, Panday, Bajpai, Giri, S.Chand and Co.
6. McNeese, T.J.; Wierda, D.A. Synthesis of Potassium Tris(oxalato)aluminate(III) Trihydrate. Journal of Chemical Education,1983, 60(11), 1001.
7. An Introduction to Practical Biochemistry, David Plummer, 3rd Edition.
8. Biochemical Methods 3rd Edition, by S. Sadasivam, A. Manickam

Course Outcomes (CO): CHMAP: 233: Major Practical Chemistry-III

CO-1: Determine the rate of reaction experimentally, activation energy, critical solution temperature, hardness of water, pH range of methyl orange indicator, calcium content.

CO-2: Analysis of water, calcium carbonate, strong acid – weak base; Strong acid – strong base volumetrically, pH range of methyl orange indicator

CO-3 Design to make solutions of different concentrations

CO-4: Uses of pH metery, Conductometry, Calorimetry for sample analysis.

CO-5:. Categorized chemical reactions according order of chemical reactions

CO-6: Demonstrate Volumetric analysis, Beers law and determination of linearity range, Conductometry titration, phase diagram of two component system.

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Semester-IV, Major Theory Paper-1

CHMAT-241: Inorganic Chemistry-II

[Theory, 2 Credits Paper, 30 L]

Module-1; 15 L

Chapter-1. Introduction to Coordination Compounds [6 L]

Double salt and coordination compound, basic definitions: *coordinate bond, ligand, types of ligands, chelate, central metal ion, charge on complex ion, calculation of oxidation state of central metal ion, metal ligand ratio*; Werner's work and theory, Effective atomic number, equilibrium constant of coordination compounds ***(Ref-4: 138-140)****, chelate effect,* ***IUPAC nomenclature according to 2018 rules****. (****Ref.-1:*** *194-200, 222-224;* ***Ref-4:*** *483-492)*

Chapter-2: Valance Bond Theory of Coordination Compounds [6 L]

What is para and diamagnetism, unpaired electron and para-magnetism in coordination complexes (spin only formula), Valence Bond Theory (VBT): on the basis of hybridization and observed magnetic moment explain the structure and bonding in $[Ag(NH_3)_2]^{1+}$, $[Cr(H_2O_6)]^{3+}$ (Inner orbital complex), $[FeF_6]^{3-}$(outer orbital complex), use of observed magnetic moment to decide square planar and Td geometry in four ligand complex-$[Ni(Cl_4)]^{2-}$, $[Ni(CN)_4]^{2-}$, case of $Fe(CN)_6]^{3-}$ complex ion and limitations of VBT (**Ref-2:** 592-597, **Ref-3:**350-351).

Chapter-4: Isomerism in coordination complexes [3 L]

Introduction, polymerization isomerism, ionization isomerism, hydrates isomerism, linkage isomerism, coordination isomerism, coordination position isomerism, geometric isomerism, optical isomerism. ***(Ref-1:*** *232-236)*

Module-2; 15 L

Chapter-3. Crystal Field Theory [15 L]

Shapes of d-orbitals, Crystal field theory: Assumptions, Application to **i) Octahedral complexes should be explained with respect to**: splitting of 'd' orbitals in Oh ligand field, effect of weak and strong ligand fields, magnetic moments in weak and strong ligand fields in d^1 to d^{10} configuration, colour absorbed and spectrochemical series, crystal splitting energy, Crystal field stabilization energy and factors affecting it, Jahn-Teller Distortion-tetragonal distortion in Cu(II) complexes **ii) Square planar complexes** - splitting of 'd' orbitals, calculation of magnetic moment

iii) Tetrahedral complexes, splitting of 'd' orbitals in Td crystal field, spin only magnetic moment of Td complexes. Numerical, Extension of CFT to allow some covalency ***(Ref-1:****194-225).*

References:

1. Concise inorganic chemistry, J. D. Lee, 5th Ed (1996), Blackwell Science
2. Inorganic Chemistry, James E. House, Academic Press (Elsevier), 2008
3. Inorganic Chemistry by Miessler and Tarr, Third Ed. (2010), Pearson.
4. Basic Inorganic Chemistry, F. A. Cotton, Wiley

Course Outcomes (CO): CHMAT-242: Inorganic Chemistry-II

CO-1: Define terms related to: molecular orbital theory, basics of coordination compounds, Werner theory of coordination compounds, Write formulas of organic and inorganic compounds. Write elementary reactions in organic chemistry related to syllabus. IUPAC names of organic and coordination compounds.

CO-2: Explain the terms and facts related to: substitution reaction, molecular orbital theory, basics of coordination compounds, Werner theory of coordination compounds.

CO-3: Write applications of coordination complexes

CO-4: Apply knowledge of molecular orbital theory and Werner theory to explain respectively properties, structures of diatomic molecules and coordination compounds

CO-5. Draw MO energy level diagrams of homo and hetero diatomic molecules. On the basis of MO energy level diagram student can explain the magnetic properties and bond order of a particular molecule.

CO-6: Reasoning for appropriate facts and properties related to aromatic hydrocarbons, alcohols and phenols, aryl and alkyl halides, Werner's theory and basics of coordination compounds.

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Major Theory Paper-2, SEM-IV

CHMAT-242: Analytical Chemistry-II

[Theory, 2 Credits Paper, 30 L]

Module	Chapter No	No. of lecture
I	Conductometry	8
	Analytical Electrochemistry-Potentiometry	7
II	Colorimetry	8
	Column Chromatography with Ion-Exchange Resins	7

Module-1; 15 L

1. Conductometry [8 L]

General Considerations, the Measurement of Conductivity, Conductimetry as an Analytical Tool, Applications of Direct Conductimetric Measurements, the Basis of Conductimetric Titrations, Apparatus and Measurements, Applications of Conductimetric Titrations. ***Ref-1***

2. Analytical Electrochemistry-Potentiometry [7 L]

Introduction (Electrochemical cell, Nernst Equation, Electrode potential and Standard Electrode Potential), Reference Electrodes, the Hydrogen Electrode, the Calomel Electrode, the Silver-Silver Chloride Electrode, Indicator Electrodes, General Discussion, The Glass Electrode, Instrumentation and Measurement of Cell e.m.f.; Poggendorff's Compensation Principle, Principles of Potentiometric Titrations, Location of End Points, Some General Considerations, Some Experimental Details For Potentiometric Titrations (with respect to working electrode, reference electrode, titration curve, chemical reaction and change in potential): Experiment-1: Neutralisation Reactions, Experiment-2: Oxidation-Reduction Reaction, Experiment-3: Precipitation Reactions. ***Ref-1***

Module-2; 15 L

3. Colorimetry [8 L]

General Discussion (transmittance, absorbance, molar absorptivity); Theory of Spectrophotometry and Colorimetry; Lambert's Law; Beer's Law, Application of Beer's Law, Deviation from Beer's Law, Photoelectric Colorimeter: Layout of Instruments, Source of radiation, Wavelength Selection, Optical Parts, Detector, Some General Remarks upon Colorimetric Determinations, Calibration curve, standard addition method, Determination of Al(III) by Eriochrome cyanine R solution, Fe(III) by thiocyanate method, phosphate by Molybdenum blue method. ***Ref-1***

4. Column Chromatography with Ion-Exchange Resins [7 L]

General discussion (definition, types of ion exchange resins, structure, etc); Action Of Ion Exchange Resins (Ion exchange equilibria, Exchange of organic ions, Ion exchange capacity, Changing the ionic form, Strongly acidic cation exchangers, Weakly acidic cation exchangers, Strongly basic anion exchangers, Ion Exchange Chromatography; Applications In Analytical Chemistry -Experimental Techniques, Determination Of The Capacity Of An Ion Exchange Resin, Separation Of Zinc And Magnesium On An Anion Exchanger, Separation Of Chloride And Bromide On An Anion Exchanger, deionization water using ion exchange resins. ***Ref-1***

Refence-1: Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R. C. Denney, J. D. Barnes, J. K. Thomas, 6th Ed. Pearson Education.
Refence-2: Basics Concepts of Analytical Chemistry, S. M. Khopkar, Narosa.
Reference-3: Fundamentals of Analytical Chemistry, Ninth Edition Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, 9th Ed., Brooks/Cole, Cengage Learning.
Reference-4: Analytical Chemistry, G. D. Chirstian, P. K. Dasgupta, K. A. Schug, 7th Ed. Wiley.

Course Outcomes (CO): Biomolecules and Analytical Chemistry

CO-1: Define the terms Conductance, Absorbance, Cell Constant, Chromatography.
CO-2: Describe Lamberts-Beers law, Nernst's Equation, separation of anions
CO-3: Explain the terms potentiometric titrations, Calibration curve, standard addition method
CO-4: Classify types of Chromatography, potentiometric electrodes, deionizer for purification of water
CO-5: Illustrate Neutralisation Reactions, Oxidation-Reduction Reaction, Precipitation Reactions, Action of Ion Exchange Resins, Fe(III) by thiocyanate method.
CO-6: Predict applications of Carbohydrates, Amino Acids, proteins, Lipids, Chromatography Calorimetry and resins,

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CHMAT-242: Chemistry of Biomolecules-I

[Theory, 2 Credits Paper, 30 L]

Module	Chapter No	No. of lecture
I	Introduction to Biomolecules	2
	Carbohydrates	6
	Amino acids and Proteins	7
II	Lipids	5
	Enzymes	5
	Hormones	5

Module I **15 L**

1. Carbohydrates **(7 L)**

Introduction to biomolecules, Carbohydrate classification of carbohydrates, their structures and biological significance. Concept of anomers, epimers, reducing and non-reducing sugars, mutarotation, inversion. Reactions of glucose with acid, base, phenyl hydrazine, oxidizing agents, reducing agents and its significance, Glycosidic bonds.

2. Amino acids and Proteins **(8 L)**

Amino acids: classification of amino acids. Cocept of ampholytes, isoelectric pH, zwitter ions, titration curve of glycine. Reactions of amino acid with Ninhydrin, Sanger's, Dansyl chloride, Dabsyl chloride and Edmann's reagents and their significance. Peptide bond and its features. **Proteins:** Classification based on function, nutrition and composition. Structural organization of proteins- primary, secondary, tertiary and quaternary structures.

Module II **15 L**

3. Lipids **(5 L)**

Introduction, classification of lipids, their structures and biological significance. Reactions of Lipids- Saponification Hydrolysis, emulsification, oxidation. Concept of saponification number, acid number, iodine number and their significance. Rancidity. Types of Lipoproteins and their significance. Blood group substances.

5. Enzymes **(5 L)**

Classification of enzymes. Features of active site. ES complex formation, Enzyme specificity, Factors affecting enzyme activity. Basics of Enzyme kinetics. MM and LB equation and Significance of Km. Types of Enzyme inhibitions. Concept of Conjugated enzymes- Holoenzyme, Apoenzyme, prosthetic groups. Coenzymes of vitamins. Industrial applications of enzymes.

6. Nucleic Acids and Nucleotides **(5 L)**

Nucleic Acids, Components and functions of nucleic acids. Nucleotides, Structure of Nucleotides, Purines and Pyrimidines, Structure of DNA, Structure of RNA, mRNA, tRNA, rRNA, Catalytic RNAs.

References

1. Lehninger's Principles of Biochemistry, by Nelson and Cox Macmillan Publisher 4th Edn.
2. Biochemistry by U. Satyanarayana
3. Harper's Illustrated Biochemistry, 26th Edition

4. Biophysical techniques by Upadhyay and Nath, 3rd revised edition.

5. Biochemistry by B. D. Hames & N. M. Hooper second Edition, BIOS Scientifi Publishers Ltd.

Course Outcomes (CO): Chemistry of Biomolecules- I

CO-1: Define the terms Biomolecules, Amino acids, Proteins, Nucleic Acid, etc.
CO-2: Describe structure of amino acids, DNA, RNA, protein, carbohydates, etc.
CO-3: Explain the terms anomer, epimer, Enzyme specificity, Carbohydrates, Amino Acids, proteins, Lipids, etc.
CO-4: Classify carbohydrates, lipids, Nucleic acids, Enzymes, Proteins, etc.
CO-5: Illustrate Structure of DNA, Structure of RNA, Structural organization of proteins,
CO-6: Distinguish DNA and RNA, Purines and Pyrimidines, Primary and secondary structure of proteins

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Major Practical Course, Sem.-IV

CHMAP: 244: Major Practical Chemistry-IV

[Practical, Two Credit, 60 L]

Inorganic Chemistry Section (Any Six Experiments)

1. Synthesis of double salt – Potash Alum and qualitative test for its cations and anions. Explain how it is different from coordination complex?

2. Synthesis of Werner's Complex $[Co(NH_3)_6]Cl_3$ and $[Co(NH_3)_5\ Cl]Cl_2$

3. Investigation of number of ionisable chlorides in Werner's complexes by conductometry or by argentometric titration. Draw the Werner's structure of complexes.

4. Synthesis of Coordination complex with monodentate ligand: $[Cu(NH_3)_4]SO_4$ and $[Ni(NH_3)_6]Cl_2$. Comment on colour and magnetic properties of complexes.

5. Synthesis of Coordination complex with bidentate ligand: Tris(acetylacetone)iron(III) by green chemistry method by reaction between $Fe(OH)_3$ and acac. Comment on colour and magnetic properties of the complex using CFT.

OR

Synthesis of Tris(ethylenediamine)nickel(II) from Ni(II) salt, ethylenimine and sodium thiosulfate. Comment on colour and magnetic properties of the complex using CFT.

6. Determination of metal ligand ratio in Fe(III) or Cu(II)–Salicylic acid complex by colorimetry.

7. Determination of equilibrium constant of $[Fe(SCN)]^{2+}$ complex by colorimetry.

Part-II: Analytical Chemistry Experiment (Any Six Experiments)

1. a) Understanding conductometer b) determine the cell constant of the given cell c) determine dissociation constant of a weak acid acetic acid by conductometric measurement.

2. To investigate the conductometric titration a) Strong acid against strong base or b) Strong base against weak acid.

3. pH measurement: a) Working of glass electrode b) Standardization of pH meter c) Investigate acid-base titration curve (strong acid – weak base; Strong acid – strong base) by pH measurement hence to find out best indicator that can be used in the titration.
4. Verification of beers law and determination of linearity range using standard solutions of $KMnO_4$.

5. Determination of pH range of methyl orange indicator by Colorimetry.

6. Determination of Hardness of water from given sample by complexometric titration (Using E.D.T.A.) method and total dissolve solids by conductometry. Express your results as average ± standard deviation. (Standardization of Na_2EDTA must be performed with standard Zn(II) solution)
7. Determination of $CaCO_3$ content in a given sample by precise determination of volume of CO_2 (Ref-2).

References:

1. Iron Analysis by Redox Titration A General Chemistry Experiment, Journal of Chemical Education, Volume 65, Number 2, February 1988.183.
2. A Precise Method for Determining the CO2 Content of Carbonate Materials, Journal of Chemical Education, Vol. 75, No. 12, December 1998.
3. Vogel's Textbook Quantitative Chemical Analysis, 3rd and 6th Ed.
4. Advanced Practical Chemistry, Jagdamba Sing et al, Pragati Prakashan, Merrut.
5. Practical Chemistry, Panday, Bajpai, Giri, S.Chand and Co.
6. Vogel's Textbook Quantitative Chemical Analysis, 3rd and 5th Ed.
7. Experiments in chemistry, D. V. Jahagirdar, Himalaya Publication.
8. Handbook of Preparative Inorganic Chemistry, Volume 2, Second Edition, Edited By Georg Braue R, Academic Press, New York, London, 1965. (Page-1541)

Course Outcomes (CO): CHMAP: 243: Major Practical Chemistry-IV

CO-1: Determine the rate of reaction experimentally, activation energy, critical solution temperature, hardness of water, pH range of methyl orange indicator, calcium content.

CO-2: Analysis of water, calcium carbonate, strong acid – weak base; Strong acid – strong base volumetrically, pH range of methyl orange indicator

CO-3 Design to make solutions of different concentrations

CO-4: Uses of pH metery, Conductometry, Calorimetry for sample analysis.

CO-5:. Categorized chemical reactions according order of chemical reactions

CO-6: Demonstrate Volumetric analysis, Beers law and determination of linearity range, Conductometry titration, phase diagram of two component system.

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Vocational Skill Course, SEM-III

CHVST-231: Pharmaceutical Analysis-III

Module-1; 15 L

1. Errors in Pharmaceutical Analysis [6L]

Errors in Pharmaceutical Analysis; Introduction; Classification of Errors; Determinate (Systematic) Errors; Indeterminate (Random) Errors; Accuracy; Precision; Minimising Systematic Errors; Statistical treatment to data: Significant figures and rounding of figures, mean, median, Standard deviation, Error, absolute error. ***(Ref-1: 71-87)***

2. Non Aqueous Titrations [4L]

Introduction; Theory; Solvents; Methodology; Preparation of 0.1 N Perchloric Acid; Standardization of 0.1 N Perchloric Acid; Choice of Indicators; Effect of Temperature on Assays; Assay by Non-Aqueous Titrations; Acidimetry in Non-Aqueous Titrations; Alkalimetry in Non-Aqueous Titrations. ***(Ref-1: 106-117)***

3. Iodimetric and Iodometric Titrations [4L]

Introduction, Theory, Assay Methods, Iodimetric Assays, Iodometric Assays. ***(Ref-1: 137-144)***

4. Viscosity and its Measurement [4L]

Liquid state, Viscosity the property of liquids; Theory of Viscosity; methods of determination of viscosity.

5. Karl Fischer Method for Determination of Water [2L]

Introduction; Theory; Instrumentation; Automated Electrochemical Karl Fischer Analysis; Applications of Karl Fischer Method for Determination of Water in Pharmaceutical Analysis; Examples ***(Ref-1: 223-226)***

6. Refractometry [4L]

Introduction, Theory, Instrumentation, Determination of Refractive Index of Pharmaceutical Substances, Applications of Refractivity. ***(Ref-1: 265-271)***

Reference-1: Pharmaceutical Drug Analysis, Ashutosh Kar, New Age International (P) Limited.

Course Outcomes

CO-1: Define terms related to: errors, non-aqueous solution, viscosity, Accuracy; Precision, Refractive Index, Iodimetric Assays, volumetric analysis.

CO-2: Explain the terms and facts related to: Determinate (Systematic) Errors; Indeterminate (Random) Errors, Minimising Systematic Errors, Viscosity the property of liquids,

CO-3: Describe the Refractive Index determination of Pharmaceutical Substances, Iodometric Assays, Automated Electrochemical Karl Fischer Analysis.

CO-4: Determine Refractive Index of Pharmaceutical Substance, Water in Pharmaceutical Analysis, viscosity of organic liquids.

CO-5: Illustrate Electrochemical Karl Fischer Analysis, Assay Methods, Iodimetric Assays, Effect of temperature on Assays.

CO-6: Calculate mean, median, Standard deviation, refractive index, viscosity of liquids.

Minor Theory Paper-1, SEM-III

CHMIT-231; Fundamentals of Analytical Chemistry

[Theory, 2 Credit paper, 30L]

Chapter No	Name of the Chapter	Lectures Assigned
1	The Nature of Analytical Chemistry	04 L
2	Aqueous Solutions and Chemical Equilibria	11 L
3	pH-Measurement	06 L
4	Analytical Separation: Paper and Thin layer chromatography	09 L

Module-1 **[15 L]**

Chapter-1: The Nature of Analytical Chemistry **[4 L]**

The Role of Analytical Chemistry, Quantitative Analytical Methods, Typical Quantitative Analysis (Choosing a Method, Processing the Sample, Eliminating Interferences, Calibrating and Measuring Concentration, Calculating Results, Evaluating Results by Estimating Reliability, Acquiring the Sample, An Integral Role for Chemical Analysis: Feedback Control Systems, Deer Kill: A Case Study Illustrating the Use of Analytical Chemistry to Solve a Problem in Toxicology. **Ref-1:** pp: 1-13

Chapter-2: Aqueous Solutions and Chemical Equilibria in Analytical Chemistry [11)

Theories of acids and bases-Arrhenius definition of acids, bases and salts, Bronsted theory, Lewis theory. The Chemical Composition of Aqueous Solutions, Classifying Solutions of Electrolytes, The Chemical Composition of Aqueous Solutions, Acids and Bases, Amphiprotic Species, Autoprotolysis, Strengths of Acids and Bases, Chemical Equilibrium, The Equilibrium State, Equilibrium-Constant Expressions, Types of Equilibrium Constants in Analytical Chemistry, Applying the Ion-Product Constant for Water, Using Solubility-Product Constants, The Solubility of a Precipitate in Pure Water, The Effect of a Common Ion on the Solubility of a Precipitate, Using Acid/Base Dissociation Constants, Hydronium Ion Concentration of Solutions of Weak Bases, Buffer Solutions, Calculating the pH of Buffer Solutions, Properties of Buffer Solutions, Buffer Capacity, Preparation of Buffers. Problems, ***Ref-1: pp: 197-232***

Module-2 **[15 L]**

Chapter-3: pH-Measurement **[6 L]**

Revision of Arrhenius definition of acids and bases, dissociation of acid and bases in aqueous solution, Units to express H^+ ion conc.: molar H^+ ion conc. and concept of pH and pH Scale, Electrochemical cell, Def. reference and indicator electrode,, Calomel and silver-silver chloride electrode, glass electrode for pH measurement (composition and structure of glass electrode,

membrane potential, boundary potential, asymmetry potential, glass membrane potential, the alkaline error, the acid error), Potentiometric pH Measurement with the Glass Electrode, Errors Affecting pH Measurements, The Operational Definition of pH, pH meter, combine glass electrode, Standard Buffers as reference for pH measurement (preparation of phthalate buffer of pH = 4 and sodium tetraborate buffer of pH- 9.2), Calibration of pH meter, measuring pH of aqueous solutions using pH meter. Problems ***Ref-1 and 2 relevant pages***

Unit-4: Analytical Separation: Paper and Thin layer chromatography [9 L]

Introduction to chromatography, Definition of chromatography, IUPAC definition of chromatography, History of Chromatography, Classification of Chromatographic methods. ***Ref-3:*** *pp 1 to 14*

Theoretical Basis: Introduction, Distribution ratio and separations, Factors influencing retention, retention and equilibrium in chromatography, ***Ref-3****: pp17-26*

Thin Layer Chromatography: theory and principle; outline of the method; surface adsorption process and spot shape; composition of thin layer with other forms of chromatography, adsorbents: additives, silica gel, Kieselguhr, alumina, cellulose powder, DEAE cellulose; preparation of plate - spreading, pouring, spraying, dipping; activation; application of sample, auto-spotter; documentations; Development: only Ascending, Descending methods and two dimensional methods; solvents; system, development of plate, location of separated substances – chemical methods and ultraviolet lamp method, only, Preparative TLC (def., method and uses). Definition of R_f and measurement of R_f, qualitative analysis by TLC. ***Ref-3:*** *pp 44-80*

Paper Chromatography: Origin, overview of the technique, sample preparation (preparation of specimens, removal of matrix), types of paper (Ion exchange papers, reverse phase methods, dual phase PC), solvents, equilibrium, developments (radial development), sample application and detection, quantitative method, application of paper chromatography, **Ref-3: 81-92**

Text Books

Referenc-1: Fundamentals of Analytical Chemistry, Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, Ninth Edition

Referenc-2: Vogel's Textbook of Quantitative Chemical Analysis, 5 th (ELBS publication) or 6th Ed (Pearson Education).

Reference-3: Chromatographic method, A Braithwaite and F. J. Smith, 5th Edition, Kluwer Academic publishers Pp - 44-92

Course Outcomes (CO): CHMIT-231; Fundamentals of Analytical Chemistry

CO-1: To identify a role of analytical chemist, and analytical chemistry in chemical analyses of substances.

CO-2: Define / explain basic concepts in stoichiometric calculations in analytical chemistry, acid base equilibria, pH measurement and planar chromatographic methods and their uses.

CO-3: Differentiate / compare among acid and base, weak acid-strong acid, weak base-strong base, pH measurement, paper and thin layer chromatography, molarity-normality,

CO-4: Apply his knowledge in - stoichiometric calculations of analytical chemistry, explaining acid base equilibria, pH measurement and related calculations, preparation of standard and stock solutions, TLC or Paper chromatographic methods for separation of compounds, etc.

CO-5: Solve numerical on stoichiometric calculations in analytical chemistry, acid base equilibria and pH measurement.

CO-6: Design / plan TLC or Paper chromatographic methods for separation of compounds.

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Minor Practical Paper-2, Sem.-III
CHMIP-232, Minor Chemistry Practical-1,
Analytical Chemistry Practical

[Practical, 2 Credit paper, 60L]

Section-I: Volumetric Analysis

Experiment-1: Table work on mole concept: Molarity, normality, calculations for the preparation of i) Molar solutions ii) Normal solutions iii) percent solutions iv) ppm solutions v) milli-mols

Experiment-2: Statistical analysis

Experiment-3: Determination of molarity and strength of given HCl solution by titration with NaOH.

Experiment-4: Determination of acetic acid in commercial vinegar solution

Experiment-5: Determination of strength and percent of H_2O_2 in commercially available H_2O_2

Experiment-6: Determination of hardness of bore well water sample.

Section III: pH measurement

Experiment-7: Preparations of acetate buffers using CH_3COONa and CH_3COOH of required pH by using Henderson's equation and confirm pH by pH meter.

Experiment-8: Determination of buffer capacity of sodium acetate buffer

Experiment-9: Determination of best indicator for acid base titration from pH Curve constructed by pH metric titration.

Section III: Paper Chromatography (two experiments)

Experiment-10: Separation of constituents of mixtures of food colour or Plant Pigments by Paper Chromatography

Experiment-11: Separation of constituents of mixtures of two metal ions by paper Chromatography, their identification and measure the Rf value.

Experiment-12: Choice of composition of mobile phase for the separation of o-nitro and p-nitro phenol/aniline by thin layer chromatography, and measure the R_f value in each case organic compounds.

Course Outcomes (CO): CHMIP-232, Minor Chemistry Practical-1

CO-1: Define Enthalpy, Entropy, Gibbs free energy, Heat of solution, Neutralization, Mole, pH. Buffer solution, Chromatography

CO-2: Prepare standard solution, Buffer solution, MSDS sheets of hazardous chemicals

CO-3: Detect elements present in organic compounds

CO-4: Handle chemicals, Glassware, Equipment's and instruments with safety for his/her self as well as others. Know Hazards in chemistry laboratory

CO-5: Measure temperature of solution, pH of solution, and end point of titration

CO-6: Separate components of given mixture by chromatography and identify Safety symbols and should know meaning of it.

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Minor Chemistry Theory-1, SEM- IV

CHMIT-241: Solid State Chemistry

[Theory, 2 Credit Paper, 30 L]

Module-1; 15 L

1. Introduction to Bonding in solids **[5 L]**

Ionic bond, covalent bond, metallic bond and metallic structures, melting points, conductivity, solubility.

2. Ionic Solids: **[10 L]**

Structure of ionic solids, radius ratio rules, calculation of limiting radius ratio, close packing, classification of ionic structures, ionic compounds of the type AX, and AX_2, a more critical look at radius ratio, a cautionary word of radius ratio, lattice energy, features of solids, Defects in ionic solids, Semiconductors and transistors, rectifiers, photovoltaic cells, transistors **Ref-1: 43 – 68**

Module-2; 15 L

3. Metals and Semiconductors **[8 L]**

General properties of metals; Theories of bonding; Conductors-insulators and semiconductors; Alloys, Superconductivity. Ref-1: 121 – 145.

4. Nanomaterials **[7 L]**

Definition of nanomaterials, Change in properties from bulk to nanomaterials, Synthetic method of nanomaterials (precursor, sol-gel, chemical vapor deposition, Solid state methods), Synthesis of silver nanoparticle, gold nano-particles, Fe_2O_3, ZnO, Applications of nanomaterials. **Ref-4:** Relevant pages

Ref-1: Concise Inorganic chemistry, J. d. Lee, Chapman and Hall, Fifth Ed.

Ref-2: Descriptive Inorganic, Coordination, and Solid-State Chemistry, Glen E. Rodgers, Third Ed., Brooks/Cole, Cengage Learning.

Ref-3: Solid State Chemistry and its Applications; Second Edition; Anthony R. West, Wiley

Ref-4: Nanotechnology: Principles and Practices, Sulbha Kulkarni, Springer

Course Outcomes (CO): CHMIT-241: Solid State Chemistry

CO-1: Define nanomaterials, Crystalline Amorphous Solid, Ionic, Radius, Lattice Energy, Zeolites, Nano chemistry, metals and semiconductors.

CO-2: Explain Theories of bondings, Nature of Solids, Defects in Solids, Nanoparticle Synthesis, Impact of Toxic Chemical on Enzyme.

CO-3: Illustrate the Strength of Various Types of chemical bonds, Crystal Structure of Solids, Haber Cycle, Properties and Application of Nanoparticle,

CO-4: Compare ionic solid and amorphous solids, Frenkel and Schottky Defect, Metals and Semiconductors, and n-type and p-type semiconductors.

CO-5: Evaluate the Different Properties solids, metals and semiconductors, Types of Voids, Application of Zeolites, Application of Nano chemistry.

CO-6: Write Coordination Number of Ions in Ionic Solids, Stabilization of nano-particle in Solution, Draw crystal structure of ionic solids.

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Minor Chemistry Practical paper-2, SEM-IV

CHMIP: 242 - Practical on Solid State Chemistry

1. Purification of ionic solids by crystallization (NaCl in presence of $CuCl_2$ as impurity).
2. Heat of solution of ionic solids (KCl).
3. Determination of heat of hydration of $CuSO_4$ / Na_2SO_4.
4. Study of Born-Haber cycle – determination of lattice energy (https://chemrevise.org/wp-content/uploads/2018/11/3-15-born-haber-cycle.pdf)
5. Table work: Assembling different types of unit cells using plastic ball.
6. Synthesis of Fe_2O_3 by precursor method from ferrous oxalate.
7. Synthesis of ZnO by precursor method and determination of its band gap.
8. Photocatalysis by ZnO: Photodegradation of organic dyes.
9. Synthesis of copper oxide by chemical precipitation method (It may form CuO or Cu_2O)
10. Determination of Purity there by stoichiometry of synthesized copper oxide by chemical precipitation method (identify it is Cu_2O or CuO)
11. Synthesis of CuS by chemical precipitation method.
12. Study of non-stoichiometry of synthesized CuS.
13. Synthesis of silver nano-particles and determination of their bandgap.
14. Study of semiconductor characteristics.
15. Determination of temperature dependence conductivity of semiconductor film by two probe / for probe method.

References:

1. Practicals in physical Chemistry – P. S. Sindhu, Macmillan
2. Experimental Inorganic and physical chemistry, Mounir A. Malati, Harwood Science Series, Chemical Sciences.
3. Experiments in chemistry, D. V. Jahagirdar, Himalaya.

Course Outcomes

CO-1: Define Enthalpy, Entropy, Gibbs free energy, Heat of solution, Neutralization, Mole, pH. Buffer solution, Chromatography

CO-2: Prepare standard solution, Buffer solution, MSDS sheets of hazardous chemicals

CO-3: Detect elements present in organic compounds

CO-4: Handle chemicals, Glassware, Equipment's and instruments with safety for his/her self as well as others. Know Hazards in chemistry laboratory

CO-5: Measure temperature of solution, pH of solution, and end point of titration

CO-6: Separate components of given mixture by chromatography and identify Safety symbols and should know meaning of it.

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Skill Enhancement Paper-1, SEM-IV

[Practical, 2 Credit paper, 60L]

CHSEP-241: Chemo-Informatics and Organic synthesis

Experiment - 1:.Use of chemdraw/chemoffice/chewin/Avagadro for structure drawing and writing chemical reactions.

Experiment-2: Writing three dimensional structures of simple organic molecules and their computational properties.

Experiment-3: Drawing organic structures using SMILES codes.

Experiment-4: Study of molecular properties (Bond angle, polarity, geometry) of some molecules using Avagadro (HF, HCl, HBr, HI, CO, CO_2, H_2O, BF_3, PCl_5)

Experiment-5: Conformational analysis of n-Butane using chemdraw 3D.

Experimet-6: Chemo-metrics using EXCEL- Use of EXCEL for graphs and Calculations

Organic Preparations (Any 6)

Experiment No- 7: Synthesis of azo dye-1.

Experiment No- 8: Synthesis of azo dye-2.

Experiment No- 9: Synthesize of Methyl Orange.

Experiment No- 10: Synthesis of flurosene dye.

Experiment No- 11: Preparation of benzamide / phthalimide.

Experiment No- 12: Preparation of benzocaine.

Experiment No- 13: Preparation bioactive heterocyclic compound dihydro pyrimidinone.

Experiment No- 14: Preparation bioactive heterocyclic compound quninaxaline.

Experiment No- 15: Preparation of Aspirin from acetyl chloride by green chemistry method.

Course Outcomes: At the end of syllabus student will able-

CO-1: Calculations, statistical analysis of results and graphs using Microsoft EXCEL.

CO-2: Drawing organic structures using SMILES codes

CO-3: Writing three dimensional structures of simple organic molecules and their computational properties.

CO-4: Chemical synthesis of organic compounds with safely.
CO-5: control reaction conditions and monitor progress of the chemical reaction.
CO-6: Isolate and purify synthesized organic compound. Perform necessary calculations (molecular weight, theoretical yield, practical yield, percent practical yield).

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Generic Elective (GE) Paper-1 (Theory), SEM-IV

[Practical, 2 Credit paper, 60L]

CHGET-231: Agriculture and Dairy Chemistry

Module-1; 15 L

Chapter 1: Agriculture Chemistry [4 L]
Defination, Scope and importance of Agriculture Chemistry, Components of Agriculture Chemistry.

Chapter 2: Soil Chemistry and Problematic Soil [7 L]
Soil – Defination, Componants, Physical Properties, Chemical properties, Surface soil and Sub-soil, buffer capacity, soil reactions-Types and importance. Ion exchange. Problemaic soil-Acidic Soil, Alkali Soil-Classification. Lime Requirement, Gypsom Requirement. Soil Testing- Objectives Importance and Steps of soil testing.

Chapter 3: Plant nutrition and Fertilizers and Manures. [4 L]
Plant nutrient, Classification of plant nutrient. Role and deficiency symptoms of plant nutrients. Fertilizers-Types. Action of Urea and Ammonium sulphate on soil, Nitrogen, Phosphorus fertilizers and Potassiu fertilizers. Micronutrient fertilizers and manures.

Module-2; 15 L

Chapter 4: Introduction to Milk [4 L]
Milk definition, constituents and composition of milk, Physiochemical properties and nutritive value. Microbiology of milk. Detection of adulteration and preservatives in milk.

Chapter 5: Common Dairy Processes [5 L]
Cream Separation- Basic Principle and methods of cream separation, Pasteurization-Types. Flowsheet of pasteurization and process. Homogenization, Storage and Packing.

Chapter 6: Milk products [6 L]
Flowsheet and process involved in manufacturing of market milk, special milks, cream, butter, cheese and ice cream.

References:
1. A text book of soil science (Recise Ed) J.A. Daji, Revised by J.R. Adam, N.D. Patil, Media promoters and publishers, Mumabi, 1996
2. Text book of soil science, T.D. Biswas, S.K. Mukharjee, Tata McGraw Hill Publishing company, New Delhi
3. Introduction to Agronomy and soil, water management, V.G. Vaidya, K.R. Sahashtra Buddhe (Continental Prakashan)
4. Qutline of Dairy Technology- Oxfored University press By- Sukumar De. (Edition-1983)
5. Dairy Chemistry and Animal Nutrition- M.M. Rai, Kalyani, Publishers, New Delhi 3rd Edition, 1980

Course Outcomes: At the end of syllabus student will able-

CO-1: Understand relationship between plant soil and fertilizer for good agriculture production
CO-2: Remember components of soil, soil fertility and soil fertility evaluation by soil testing.

CO-3: Apply knowledge of fertilizer in plant nutrition and agriculture production

CO-4: Understand milk and milk components
CO-5: Remember flow sheets for common dairy processes
CO-6: Understand processes involved manufacturing of different milk products.
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Generic Elective (GE) Paper-2 (Practical) SEM-IV

[Practical, 2 Credit paper, 60L]

CHGET-231: Food and Water quality analysis

Section I: Analysis of Food products (any six)

Experiment-1: Preparation of Milk Sample for qualitative analysis of milk,

Experiment-2: Detection of Glucose, Starch and sucrose in Milk by qualitative method

Experiment-3: Qualitative detection of Urea, Ammonium Salts and sulphate in Milk sample

Experiment-4: Detection of Anionic Detergents, Formaldehyde and Hydrogen peroxide in Milk

Experiment-5: Detection of Nitrates, Boric acid and Borates in Milk

Experiment-6: Determination of Moisture in Dried Milk products

Experiment-7: Preparation of Sample of Dahi and detection of Starch from it

Experiment-8: Determination of Titratable Acidity from Dahi sample.

Experiment-9:. Detection of Starch and sucrose in Khoa

Experiment-10: Determination of Total Ash in Khoa

Experiment-11: Determination of Salt Content in Butter

Section –II: Water Quality Analysis Waters (Any six experiments)

Experiment-12: Colour of water by Platinum cobalt (visual comparison) method

Experiment-13: pH of water by Electrometric Method

Experiment-14: Turbidity of water by Nephelometric method

Experiment-15: Total Dissolved Solids (TDS) and determination of TDS based on conductivity

Experiment-16: Hardness of water by complex-metric titration

Experiment-18: Determine the moisture content of soil

Experiment-19: Determination of pH of soil a) pH (H_2O) b) pH (KCl) c) pH (H_2O_2)

Experiment-20: Determination of Exchangeable acidity of soil

Experiment-21: Determination of Lime requirement to correct soil acidity.

Reference Books:

1) Manuals of Methods of Analysis of Food; Dairy and dairy products. Food Safety and standards authority of India (FSSAI), September 2022.

2. Inspiring Trust Assuring Safe and Nutritious food. Ministry of Health and Family Welfare Government of India

3) Manual of Methods of Analysis of Water; Food Safety and Standards Authority of India (FSSAI). Ministry of Health and Family Welfare Government of India, New Delhi (2016)

3) Soil Analysis Manual (June 2014). Rokupr Agriculture Research Centre (RARC) and Japan International Cooperation Agency (JICA). Ministry of Agriculture, Forestry and Food Security (MAFFS) Sierra Leone Agricultural Research Institute (SLARI) Rokupr Agricultural Research Centre (RARC)

Course Outcome: Students will learn

CO-1: Awareness of adulteration in dairy products

CO-2: Determination and identification of adulteration in dairy products

CO-3: Techniques of pH measurements using pH meter and application of pH measurement for soil and water samples.

CO-4: Determination of physicochemical parameters of water

CO-5: Determination of physicochemical parameters of soil

CO-6: Preforming analytical chemistry calculations.

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Ability Enhancement Course, Semester-III,

ENAET-231: English Communication and Soft Skill-I; 2 Credits, 30 L

Unit-1: Defining Soft Skills [10 L]

i. Introduction to soft skills
ii. Soft skills and hards skills
iii. Enhancing soft skills
iv. Significance of soft skills in today's globalized world

Unit-2: Motivation, Goal Setting and Self-Esteem [10 L]

i. What is motivation?
ii. Importance of goal setting
iii. What is self-esteem?
iv. The power of positive thinking

Unit-3: Time Management [10 L]

i. Importance of time management
ii. Avoiding procrastination
iii. Developing priority-management skills
iv. Strategies for managing time

Course Outcome- At the end of course the students will be able to -

CO-1: Define soft skills.

CO-2: Distinguish between soft skills and hard skills.

CO-3: Define motivation and understand the importance of goal setting.

CO-4: Analyse the concept of self-esteem.

CO-5: Examine the power of positive thinking.

CO-6: Develop strategies for managing time.

CO-7: Relate soft skills to real life.

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Ability Enhancement Course, Semester-IV,

ENAET-241: English Communication and Soft Skill-II; 2 Credits, 30 L

Unit-1: Creative Thinking and Problem Solving [10 L]

i. What is creative thinking?
ii. Difference between critical and creative thinking
iii. Importance of creative thinking in problem solving
iv. Strategies for developing creative thinking for solving problems

Unit-2: Team Building [10 L]

i. What is a team?
ii. Strategies for resolving the interpersonal conflicts
iii. Developing the interpersonal negotiation skills
iv. Importance and significance of effective team building

Unit-3: Leadership [10 L]

i. What are leadership skills?
ii. Types of leadership
iii. Developing leadership skills
iv. Strategies for developing leadership

Course Outcome- At the end of course the students will be able to -

CO-1: Distinguish between critical and creative thinking.

CO-2: Explore strategies for developing creative thinking for solving problems.

CO-3: Analyse the concept of self-esteem and apply it to real life.

CO-4: Examine the power of positive thinking.

CO-5: Develop interpersonal negotiation skills for resolving interpersonal conflicts.

CO-6: Identify different types of leadership and choose strategies for developing leadersthip.

CO-7: Apply soft skills to real life.

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Co-Curricular Course (CC), Sem-III

CCHRT-231: Human Rights: An Introduction

Module-1 15 L

1. Basic Concept [8 L]

a) Human Values- Dignity , Liberty, Equality , Justice, Unity in Diversity, Ethics andMorals
b) Meaning and significance of Human Rights Education

2. Perspectives of Rights and Duties [7 L]

a) Rights: Inherent-Inalienable-Universal- Individual and Groups
b) Nature and concept of Duties

c) Interrelationship of Rights and Duties

3. Introduction to Terminology of Various Legal Instruments [8 L]

a) Meaning of Legal Instrument- Binding Nature
b) Types of Instruments: Covenant-Charter-Declaration-Treaty-Convention-Protocol-Executive Orders and Statutes

4. United Nations and Human Rights [7 L]

a. Brief History of Human Rights- International and National Perspectives
b. Provision of the charters of United Nations
c. Universal Declaration of Human Rights- Significance-Preamble

References:

1. Donnelly, Jack. *Universal Human Rights in Theory and Practice*. Cornell University Press, 2013.
2. Nickel, James W. *Making Sense of Human Rights*. Wiley-Blackwell, 2007.
3. Clapham, Andrew. *Human Rights: A Very Short Introduction*. Oxford University Press, 2007.
4. Freeman, Michael. *Human Rights: An Interdisciplinary Approach*. Polity Press, 2017.
5. Ishay, Micheline R. *The History of Human Rights: From Ancient Times to the Globalization Era*. University of California Press, 2008.
6. Mertus, Julie A. *The United Nations and Human Rights: A Guide for a New Era*. Routledge, 2005.
7. Hunt, Lynn. *Inventing Human Rights: A History*. W.W. Norton & Company, 2008.
8. Goodhart, Michael, editor. *Human Rights: Politics and Practice*. Oxford University Press, 2013.
9. Moyn, Samuel. *The Last Utopia: Human Rights in History*. Harvard University Press, 2012.
10. Steiner, Henry J., Philip Alston, and Ryan Goodman. *International Human Rights in Context: Law, Politics, Morals*. Oxford University Press, 2007.

Module - 1

अ.न.	**CCHRT-231:** मानवी हक्क : परिचय (क्रेडिट: 2, 30 L)	|
I	**मूलभूत संकल्पना** अ) मानवी मूल्ये- प्रतिष्ठा, स्वातंत्र्य, समानता, न्याय, विविधतेतील एकता, नैतिकता आणि नैतिकता ब) मानवी हक्क शिक्षणाचा अर्थ आणि महत्त्व	०८
II	**अधिकार आणि कर्तव्यांचा दृष्टीकोन** अ) हक्क: अंतर्निहित-अविभाज्य-सार्वत्रिक-वैयक्तिक आणि गट ब) कर्तव्याचे स्वरूप आणि संकल्पना क) हक्क आणि कर्तव्यांचा परस्परसंबंध	०७

Module - 2

III	**विविध कायदेशीर साधनांच्या शब्दावलीचा परिचय** अ) कायदेशीर साधनाचा अर्थ- बंधनकारक निसर्ग ब) साधनांचे प्रकार: करार-सनद-घोषणा-करार-कन्व्हेन्शन-प्रोटोकॉल- कार्यकारी आदेश आणि कायदे	०८
IV	**संयुक्त राष्ट्र आणि मानवाधिकार** अ) मानवी हक्कांचा संक्षिप्त इतिहास- आंतरराष्ट्रीय आणि राष्ट्रीय दृष्टीकोन ब) संयुक्त राष्ट्रांच्या चार्टरची तरतूद क) मानवी हक्कांची सार्वत्रिक घोषणा- महत्त्व- प्रस्तावना	०७

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CCCST-241: Cyber Security

Module-1:

Chapter 1: Overview of Networking Concepts **[7 L]**

1. Basics of Communication Systems
2. Transmission Media
3. Topology and Types of Networks
4. TCP/IP Protocol Stacks
5. Wireless Networks
6. The Internet

Ref Book1(chapter 1 page no 3 to 28 and 552 to 568)

Chapter 2: Information Security Concepts **[8 L]**

1. Information Security Overview: Background and Current Scenario
2. Types of Attacks
3. Goals for Security
4. E-commerce Security
5. Computer Forensics
6. Steganography

Ref Book2(chapter 1 page no 3 to 79)

Module-2:

Chapter 3: Security Threats and Vulnerabilities **[6 L]**

1. Overview of Security threats
2. Weak / Strong Passwords and Password Cracking
3. Insecure Network connections
4. Malicious Code
5. Programming Bugs
6. Cyber crime and Cyber terrorism
7. Information Warfare and Surveillance

Ref Book3

Chapter 4: Cryptography / Encryption **[9 L]**

1. Introduction to Cryptography / Encryption
2. Digital Signatures
3. Public Key infrastructure
4. Applications of Cryptography
5. Tools and techniques of Cryptography

Ref Book1(chapter 8 page no 766 onwards)

Reference Book:

Ref Book 1 : Computer Networks By Andrew S. Tanenbaum, 5th Edition By Pearson Education

Ref Book 2 : Network Security: A Beginner's Guide, 3rd Edition by Eric Maiwald

Ref Book 3 : Handbook of Information Security: Threats, Vulnerabilities, Prevention, Detection, and Management, Volume 3 by Hossein Bidgoli, Wiley

Course Outcome:

CO1 : Understand the concepts of networking and it's type

CO2 : Interpret the concepts of Information Security

CO3 : Understand the concepts of Security Threats

CO4 : Describe insecure Network Connections, Cyber Crime

CO5 : Interpret the concepts of Basic Cryptography

CO6 : Define the tools and techniques of Cryptography

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GE/OE Basket for Science Students

Sem.-I

1. Basic Course in stock market
2. Entrepreneurial Skill Development-I
3. Indian Constitution and Political Process
4. Introduction to GIS
5. Psychology of adjustment and stress
6. Business Communication.
7. Corporate social responsibility

Sem.-II

1. Advance course in stock market
2. Entrepreneurial Skill Development-II
3. Practical on Indian Constitution and Political Process
4. Practical on GIS
5. Psychological Interpersonal Relationship
6. E-Commerce
7. Basics of hardware and networking

Question Paper Pattern for Chemistry Related Papers

Marks: 35		**Time:** 2 Hour Cresits-02	
Instructions to the Candidate: 1. All questions are compulsory. 2. Figures to right indicate full marks. 3. Use of Log table and scientific calculator is allowed.			
Question-1	**Solve Any five of the following (Short Answers)** **i.** **ii.** **iii.** **iv.** **v.** **vi.** **vii.**	Three def. type, two tricky questions and two questions problem type (if applicable)	5 Marks
Question-2	**A. Solve any two of the following** **i.** **ii.** **iii.**	Note or Describe type questions	6 Marks
	B. Solve the following Single question of four marks or two questions of 2 marks.	Problem type or tricky reasoning type question	4 marks
Question-3	**A. Solve any two of the following** **i.** **ii.** **iii.**	Write Note / Differentiate type questions	6 Marks
	B. Solve the following Single question of four marks or two questions of 2 marks.	Problem type or Derive equation or Tricky discussion type question	4 marks
Question-4	**Solve Any four of the following** **i.** **ii.** **iii.** **iv.**	Application type, Justification type question	10

	v.		