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



Affiliated to



Savitribai Phule Pune University [SPPU]

# **B.Sc. Chemistry / B.Sc. Honors Chemistry**

(Three Years B. Sc. and Four Years B. Sc. Honors Program)

# **M. Sc-I Analytical Chemistry**

(After three years B. Sc. in Chemistry)

Choice Based Credit System [CBCS] Under Autonomy and NEP-2020

From Academic Year 2023-2024

Syllabus First Year Graduate (F.Y. B. Sc.) Chemistry

# **Board of Studies Chemistry**

## **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

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

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

- (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,  $PG - 2^{nd}$  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

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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. 1<sup>st</sup> assignment after completing 6 weeks of teaching and 2<sup>nd</sup> on completion of 13<sup>th</sup> 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

	the ronowing tabl	
Semester GPA/ Program	% of Marks	Alpha-Sign / Letter
CGPA		Grade Result
Semester/Program		
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)

CI	<b>3CS Syllabus Under NEP-2020</b>	F. Y. B. Sc. /M. ScI	Department of Cher	nistry
	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.

o 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

#### o 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.**

#### Prof. Ramkrishna More College, Akurdi, Pune 411044

#### 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	СС	Total Credits
					First	Year Certi	ficate Cours	e				
Ι	CHMAT-111 CHMAT-112 CHMAP-113	0	0	CHVST -111	CHIKT- 111	0	1 theory + 1 Practical From Basket	1 theory/ practical From Basket	Marathi /Hindi	Environment Awareness VEAET-111	2 Credit From Basket 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	Marathi /Hindi	1 theory From Basket VECOT-111	2 Credit From Basket CCPEP-111	22
					Secon	d Year Gra	duate Diplon	na				
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 theory From Basket	0	English		2 Credit From Basket	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 Practical From Basket	1 theory/ practical From Basket	English		2 Credit From Basket	22
					Thir	d Year Gra	duate Degree	e				
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	Field Project or Community Engagement and Service (2 Credit)	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	СС	Total Credit s
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
			V	'II and V	/III Sen	nester Hono	urs Degree w	vith Research	l I			
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

## Program: B.Sc. [Chemistry], 2023-24

#### **Program Outcomes**

- 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 modern technologies, handling advanced 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 characteristics 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. Students CO-2: To know how to handle the technical devices for presenting research works. can also create an awareness of the impact of chemistry on the environment, society, and also make development outside the scientific community.
- PO-9: **Environmental Awareness:** As an inhabitant of this green planet a Chemistry graduate student should have many social responsibilities. 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 environmental 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 Chemistry 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. Programme.

#### Program Specific Outcomes

After completing B. Sc. Chemistry, students will be able to

- PSO1: Understand the nature and basic concepts of Physical, Organic and Inorganic chemistry.
- PSO2: Analyze Organic and inorganic compounds qualitatively and quantitatively
- PSO3: Understand the applications of physical, organic, inorganic and analytical chemistry in pharmaceutical, agriculture and chemical industries.
- PSO4: Able to perform experimental procedures as per laboratory manual in thearea of physical, Inorganic and organic chemistry.
- PSO5: interpretation and synthesis of chemical information and data obtained from chemical and instrumental analysis.

## F. Y. B. Sc. Chemistry Syllabus

**CBCS** Semester Pattern

## **Under Autonomy and NEP-2020**

To Be Implemented From

## Academic Year 2023-2024

## Courses Offered by Chemistry Department at First year of Graduation

Major Chemistry Courses							
Semester	Course code	Generic Name	Title of the paper				
Ι	CHMAT-111	Chemistry theory paper-1	Physical Chemistry –I				
	CHMAT-112	Chemistry theory paper-2	Analytical Chemistry –I				
	CHMAP-113	Chemistry practical paper-1	Practical Chemistry -I				
II	CHMAT-121	Chemistry theory paper-3	Inorganic Chemistry –I				
	CHMAT-122	Chemistry theory paper-4	Organic Chemistry –I				
	CHMAP-123	Chemistry practical paper-2	Practical Chemistry -II				
VSC							
	CHSCT-111	Vocational Chemistry theory-I	Chemical Methods of Pharmaceutical Analysis-I				
	CHSCp-121	Vocational Chemistry Practical-I	Pharmaceutical Chemistry Practical -I				
	Minor	Chemistry Courses [for non-chei	mistry majors]				
II	CHMIT-121	Minor Chemistry Theory-1	Fundamentals of Analytical				
			Chemistry				
IKS Related for Chemistry Major							
Ι	CHIKT-111	Indian knowledge system	Chemistry of Ayurvedic				
		chemistry paper	preparations				
SEC for science faculty students							
Ι	CHSET-111	Skill Enhancement Chemistry	Practical: Formulation of Soaps				
		Course Practical-I	and related products				
II	CHSEP-121	Skill Enhancement Chemistry	Formulation of Soaps Detergents				
		Course Theory-I	and related products				

## **Equivalence to Previous i.e. 2019 CBCS pattern of SPPU**

Sr. No	2019 CBCS Pattern		NEP-2020 Pattern		
SP. NO.	<b>Course Code</b>	Course Name	<b>Course Code</b>	Course Name	
1	CH-101	Physical Chemistry	CHMAT-111	Physical Chemistry –I	
2	CH-102	Organic Chemistry	CHMAT-122	Organic Chemistry –I	
3	CH-103	Chemistry Practical -I	CHMAP-113	Practical Chemistry -I	
4	CH-201	Inorganic Chemistry	CHMAT-121	Inorganic Chemistry –I	
5	CH-202	Analytical Chemistry	CHMAT-112	Analytical Chemistry –I	
6	CH-203	Chemistry Practical -II	CHMAP-123	Practical Chemistry -II	

## **Course Wise Detailed Syllabus**

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#### CHMAT-111; Chemistry Theory paper-1; Physical Chemistry-I [2 Credit]

Chapter No	Name of the Chapter	Lectures Assigned
1	First law of thermodynamics	7 L
2	Thermochemistry	8 L
3	Chemical Equilibrium	9 L
4	Ionic Equilibria	6 L

#### **Module-1**

#### **Chapter-1. First law of thermodynamics**

Thermodynamic Terms: System, Boundary, Surround. Homogeneous and Heterogeneous systems, Types of thermodynamic systems, Intensive and extensive properties, State of system, Equilibrium and non-equilibrium states, Thermodynamic processes, Reversible and irreversible processes, Nature of heat and work, Internal energy Units of internal energy, First law of thermodynamics, Enthalpy of system, Molar heat capacities, Joule Thomson effect, Adiabatic expansion of an ideal gas, Work done in adiabatic reversible expansion, numerical, (Reference -1 Page no. 236 - 270).

#### **Chapter-2.** Thermochemistry

Introduction, units of energy changes, enthalpy of a reaction, exothermic and endothermic reactions, sign of  $\Delta H$  and  $\Delta E$ , calculation of  $\Delta H$  from  $\Delta E$  and *vice versa*, thermochemical equations, heat of reaction or enthalpy of reaction, variation of heat (or enthalpy) of reaction with temperature, Different types of heat (enthalpy) of reaction: heat of formation, standard heat of formation, heat of combustion, application of heat of combustion, heat of solution, heat of neutralization. Heat changes during transition or phase changes: Heat of fusion, heat of vaporisation, heat of sublimation, heat of transition. Hess's law of constant summation; applications of Hess's law, Bond energy. Numerical, (Reference -1 Page no. 271 - 302).

#### **Module-2**

#### **Chapter-3. Chemical Equilibrium**

Reversible reactions, characteristics of chemical equilibrium, law of mass action, equilibrium constant, equilibrium law, equilibrium constant expression in terms of partial pressures, units of equilibrium constant, heterogeneous equilibria, Le Chatelier's, Conditions for maximum yield in industrial processes, synthesis of ammonia (Haber process), Manufacture of sulphuric acid (contact process), manufacture of nitric acid (Birkeland -Eyde process). Numericals, (Reference -1 Page no. 621-671)

## **Chapter-4.** Ionic Equilibria

Ostwald's dilution law, experimental verification of Ostwald's law, limitation of Ostwald's law, theory of strong electrolytes, Ghosh's formula, Debye-Huckel theory, degree of dissociation, solubility equilibria and solubility product, applications of solubility product. Numerical, (Reference -1 Page no. 909 -922)

Reference-1: Essentials of physical Chemistry, 4th Ed., Arun Bahl, B. S. Bahl, G. D. Tuli, publisher-S. Chand.

#### Course Outcome: At the end of couse student will -

- CO-1: Able to remember Ostwald's law, first law of thermodynamics, Debye-Huckel theory, Le Chatelier's principle etc.
- CO-2: Explain the fundamentals of thermodynamics, thermochemistry, ionic equilibria and chemical equilibria

#### **Department of Chemistry**

## [12 L + 3T][7 L]

[8 L]

## [12 L + 3T][9 L]

[6 L]

#### 14

**CO-3:** The students able to solve numerical problems related to solubility products, enthalpy of various reactions, bond energy.

**CO-4:** Interpret the various types of heat of reactions with respect to thermodynamic parameters.

**CO-5:** Justify the conditions for maximum yield in industrial processes

**CO-6:** Differentiate among various thermochemical parameters

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	09 L
	chromatography	

#### CHMAT-112; Chemistry Theory paper-2; Analytical Chemistry-I [2 Credit]

#### **Module-1**

#### **Chapter-1: The Nature of Analytical Chemistry**

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 L]

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**

#### **Chapter-3: pH-Measurement**

Revision of Arrhenius definition of acids and bases, dissociation of acid and bases in aqueous solution, Units to express H<sup>+</sup> ion conc.: molar H<sup>+</sup> 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

#### 15

## [12 L + 3T][6 L]

[12 L + 3T]

[4 L]

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<sup>th</sup> (ELBS publication) or 6<sup>th</sup> Ed (Pearson Education).
- **Reference-3:** Chromatographic method, A Braithwaite and F. J. Smith, 5<sup>th</sup> Edition, Kluwer Academic publishers Pp 44-92

#### **Further Reading**

- **Reference-4:** Analytical Chemistry, Gary Christian, Kevin A. Schug, Purnendu Dasgupta, Wiley, 9<sup>th</sup> Ed.
- **CO-1:** To identify a role of analytical chemist, and analytical chemistry in chemical analyses of substances.
- **CO-2:** Define / discuss/ explain basic concepts in stoichiometric calculations in analytical chemistry, acid base equilibria, pH measurement and planar chromatographic methods and their uses in analytical chemistry.
- **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.

#### CHMAT-113; Chemistry Practical Paper-1; Practical Chemistry-I [2 Credit, 60 L]

**Experiment-1: Introduction to laboratory safety:** a. Toxicity of the compounds used in chemistry laboratory. b. Safety symbol on labels of pack of chemicals and its meaning c. What is MSDS sheets? Find out MSDS sheets of at least hazardous chemicals ( $K_2Cr_2O_7$ , Benzene, cadmium nitrate, sodium metal, etc.) d. Precautions in handling of hazardous substances like Conc. acids, ammonia, organic solvents, etc. e. Handling of glassware's

**Experiment-2: Table work:** Selecting and Handling Reagents and Other Chemicals, Cleaning and Marking, of Laboratory Ware, Evaporating Liquids, Measuring Mass, Equipment and Manipulations Associated with Weighing, Filtration and Ignition of Solids, Measuring Volume, Calibrating Volumetric Glassware, Laboratory notebook.

**Experiment-**3: Determination of oxidation state and equivalent of reactive metals like Zinc, Aluminium, Magnesium by eudiometry.

#### Thermochemistry (Any three)

- **Experiment-4:** Determination of enthalpy of neutralization of hydrochloric acid and acetic acid with sodium hydroxide. Calculation of heat of ionization of acetic acid.
- Experiment-5: Determination of integral enthalpy of solution of salts (KCl, NaCl) and Born Haber Cycle.

**Experiment-6:** Determination of enthalpy of displacement reaction of Cu from CuSO<sub>4</sub> by Zn metal.

**Experiment-7:** Study of the solubility of benzoic acid in water and determination of  $\Delta H$ .

#### b. pH-metry (Any two experiments)

- **Experiment-8**: Standardization of pH meter and measurement of pH of a) different samples of water (tap water, waste water, Bore well water) and compare them, b) detergents different brands (Nirma, Aerial, surf Excel, Wheel, etc.) and compare them, c) pH of cold drinks. Calculate H<sup>+</sup> ion conc. in each of these solution.
- **Experiment-9:** Calculate amount of sodium acetate (0.1M) and acetic acid (0.1M) for the preparation of acetate buffer of pH = 4.0, 4.5, 5.0, 5.5 and 6. Prepare series of acetate buffer and determination of their pH by pH meter. Compare observed value with theoretically expected values. Calculate H<sup>+</sup> ion conc. in each of these solution.
- **Experiment-10:** Determination of buffer capacity: preparation of 50 ml ammonia ammonium hydroxide buffer of pH 10 from 5 M Ammonium chloride and 10 M ammonia and determine its buffer capacity with 1 M HCl.

#### Section C: Paper Chromatography (two experiments)

- Experiment-11: Separation of constituents of mixtures by Paper Chromatography: Measure the Rf value Plant Pigments from plant extract. OR
- **Experiment-12:** Separation of constituents of mixtures by paper Chromatography and measure the Rf value of organic dyes or food colours thereby identification of dyes.
- **Experiment-13:** Separation of constituents of mixtures of two metal ions by paper Chromatography, their identification and measure the Rf value. **OR**
- **Experiment-14**: Separation of constituents of mixtures of two amino acids by Paper chromatography, their identification and measure the Rf value.

#### Section D: Thin Layer Chromatography (two experiments)

- **Experiment-13:** 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<sub>f</sub> value in each case organic compounds.
- **Experiment-14:** Choice of composition of mobile phase for the separation of mixture of colourless substances (benzoic acid and naphthalene) by thin layer chromatography and measure the  $R_f$  value in each case organic compounds.
- **Experiment-15:** Synthesis of azo dye between aniline and beta-napthol. Identify colourless impurities by thin layer chromatography, and measure the Rf value in each case organic compounds.

#### **Reference Books:**

- **Reference-1:** Laboratory Manual Prepared by Department of Chemistry, Prof. Ramkrishna More College Akurdi.
- **Referenc-2.** Text book of Practical Organic Chemistry, Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. and Smith, P.W.G., Prentice-Hall, 5<sup>th</sup> edition, 1996.

**Referenc-3.** Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R.Chand & Co.: New Delhi (2011).

Referenc-4. Prof. Robert H. Hill Jr., David C. Finster Laboratory Safety for Chemistry Students, 2<sup>nd</sup> Edition, Wiley ISBN: 978-1-119-02766-9 May 2016

#### **Course Outcome: Students will learn**

**CO-1:** Importance of chemical safety and Lab safety while performing experiments in laboratory

- CO-2: Determination of thermochemistry parameters of some chemical reactions and related concepts
- CO-3: Techniques of pH measurements using pH meter and application of pH measurement.
- **CO-4:** Preparation of buffer solutions using Henderson equation and determination of buffer capacity
- **CO-5**: Technique of thin layer and paper chromatography for separation and identification from mixture of compound.

**CO-6:** Preforming analytical chemistry calculations.

#### CHMAT-121: Chemistry Theory paper –3; Inorganic Chemistry-I

Chapter	Name of the Chapter	Lectures
No		Assigned
1	Electronic Structure of Atom	07 L
2	Long form of periodic table and Periodic properties	08 L
3	Introduction to bonding	02 L
4	The Covalent Bond	09 L
5	Hydrogen bond	04 L
le-1	[1	2 L+ 3T]

#### Module-1

#### **Chapter-1: Electronic Structure of Atom**

Definition of atom, Constituent of atom (electron, nucleus-neutron and protons and their characteristics), atomic number atomic mass number, The atom as a nucleus with orbital electrons, Atomic spectra of hydrogen atom and Bohr theory, Refinement to the Bohr theory, the Heisenberg uncertainty principle, the Schrodinger wave equation, radial and angular functions (type of orbitals and their shapes), Pauli exclusion principle, Buildup of the elements, Hund's rule, Sequence of energy levels, *Reference-1: pp 3 to 25; Rreferenc-2-Relevent pages.* 

#### Chapter-2: Long form of periodic table and Periodic properties [8 L]

Modern periodic law Long form of periodic table (IUPAC system of labeling of group only -1 to 18 groups), electronic configuration and arrangement of elements in the groups in periodic table, four blocks in periodic table, Periodic Properties-Size of atoms and ions, Ionization energies, electron affinity, polarizing power and polarizibility, electronegativity, metallic character, variable valence and oxidation state, types of elements-metals, non-metals, inert gases. *Reference-1: pp 25 to 27 and 146 to 165; Referenc-2: Relevant pages.* 

#### Module-2

Chapter-3:	Introduction	to bonding
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Attainment of a stable configuration, Types of chemical bonds-Ionic, Covalent, co-ordinate and metallic bonds; *Reference-1: pp 30 to 39*.

#### **Chapter-4: The Covalent Bond**

Introduction, General characteristics of the molecules, Lewis theory, the Octet rule, Exceptions to

[9 L]

[2 credits]

[7 L]

[12 + 3T]

[2 L]

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the Octet rule, Sidgwick-Powell Theory, Valence Shell Electron Repulsion (VSEPR) Theory, Valence Bond Theory, Hybridization, the extent of d-orbitals participation in molecular bonding, Sigma and Pi bonds, Structure of some molecules BeF<sub>2</sub>, BF<sub>3</sub>, HClO<sub>4</sub>, PCl<sub>5</sub>, SF<sub>6</sub>, *Reference-1: pp 72 to 89. Referenc-2: Relevant pages*.

F. Y. B. Sc. /M. Sc. -I

#### Chapter-5: Hydrogen Bond

Origin of intermolecular forces in liquids: dipole-dipole interaction, dipole-induced dipole attraction, induced dipole-induced dipole attraction, Definition of hydrogen bond, Hydrogen bond and liquid state of matter, types of hydrogen bond (intra and intermolecular with suitable examples), anomalous behavior of water. *Refence-2:* 287-292

**Refence-1:** Concise Inorganic Chemistry, J. D. Lee, 5<sup>th</sup> Ed. Blackwell Science

**Reference-2:** University general chemistry, an introduction to chemical science, Edited by CNR Rao, published by Macmillan.

#### **Course Outcome: Students will learn**

- **CO-1:** Define basic concepts included in syllabus of atomic structure, periodic table, valance bond theory and hydrogen bonding.
- **CO-2:** Discuss/ explain basic concepts included in syllabus of atomic structure, periodic table, valance bond theory and hydrogen bonding.
- **CO-3:** Differentiate / compare among various concepts such as electron and proton; different types of orbitals; different series in spectra of hydrogen atom, different types of bonds; periodic properties, types of hybridization, etc.
- **CO-4:** Apply his knowledge to write correct electronic configuration of elements, to explain or predict structure of some molecules, predict trends in periodic properties of elements, effect of hydrogen bonding on physical properties of compounds, etc.
- **CO-5:** Solve numerical or logical problem on atomic structure, periodic table, Octet rule, valance bond theory and hydrogen bonding.
- **CO-6:** Predict / elucidate structure of small molecules on the basis of VSEPR theory and hybridization, observed periodic properties, etc.

Chapter No	Name of the Chapter	Lectures Assigned
1	Fundamentals of Organic Chemistry	08 L
2	Stereochemistry part-I	07 L
3	Stereochemistry part-II	07 L
4	Chemistry of Hydrocarbons	08 L

#### CHMAT-122: Chemistry Theory paper –4; Organic Chemistry-I [2 credits]

#### Module-1

#### **Chapter-1: Fundamentals of Organic Chemistry**

Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation, Toutomerism, Steric effect, Hydrogen bonding. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. **Ref. 1. pp. 01 to 74** 

Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. **Ref. 7. pp. 236, 245, 258.** 

Aromaticity: Benzenoids and Hückel's rule. Ref. 7. pp. 39 to 48.

[12 + 3T]

[8 L]

[4 L]

#### representations. Conformations with respect to ethane, butane and cyclohexane. Configuration: Geometrical - cis - trans, and E / Z Nomenclature (for upto two C=C systems). 09 to 44.

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**Chapter-2: Stereochemistry part-I** 

## Module-2

#### **Chapter-3: Stereochemistry part-II**

Optical isomerism Enantiomerism, Diastereomerism and Meso compounds). Concept of chirality (upto two carbon atoms). Three and erythro; D and L; nomenclature; CIP Rules: R/S (for upto 2 chiral carbon atoms) Ref. 2. pp. 73 to 88.

## **Chapter-4: Chemistry of Hydrocarbons**

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Up to 5 Carbons) Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

Alkenes: (Up to 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. KMnO<sub>4</sub>) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: (Up to 5 Carbons) Preparation: Acetylene from CaC<sub>2</sub> and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalide Reactions: formation of metal acetylides, addition of bromine and alkaline KMnO4, ozonolysis and oxidation with hot alk. KMnO<sub>4</sub>. Ref. 3. pp 75 to 89.

Aromatic Hydrocarbons: benzene, Naphthalene, Anthracene (Preparation and Reactions) Ref. 3. pp. 432 to 437.

## **Reference Books**

Reference-1: Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).

Reference-2: Stereochemistry of Organic Compounds, V. K. Ahluvalia, Springer (2022).

Reference-3: Textbook on Organic Chemistry, K. S. Mukherjee, NCBA, 2007.

Reference-4: Morrison, R.T. & Boyd, R. N. Organic Chemistry, Pearson, 2010.

Reference-5: Organic Chemistry-Clayden, Oxford Uni. Press.

Reference-6: Stereochemistry of Organic Compounds-Eliel Tata Mc Graw Hill 1989.

Reference-7: Advanced Organic Chemistry-Jagdamba Singh and L.D.S. Yadav, Pragati prakashan,  $20^{\text{th}}$  edition 2014.

## **Course outcome**

## Students will learn

- **CO-1:** Define and explain the fundamentals, principles, and recent developments in the Organic Chemistry
- **CO-2:** Discuss the concept of Acidity and basicity with respect to Structural effect.
- **CO-3:** Interpreted various reactive intermediates.
- **CO-4:** Apply stereochemistry knowledge to the organic Compounds. To assign exact configurations

[8 L]

Introduction, classification, Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer

**Ref. 2. pp.** 

[7 L]

[7 L]

**CO-5:** Explain reaction and synthesis of hydrocarbons. **CO-6:** Differentiate among the Hydrocarbons, name them according to IUPAC

## CHMAP- 123: Chemistry Practical –2 (2 Credits, 60 L)

#### Section A: Inorganic Chemistry

#### Part-I: Synthesis of commercially important inorganic compounds (any three)

- Experiment-1: Synthesis of potash alum from aluminium metal (scrap Aluminium metal)
- Experiment-2: Synthesis of Mohr's Salt [(FeSO<sub>4</sub>) (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>]•6H<sub>2</sub>O

Experiment-3: Synthesis of FeSO<sub>4</sub>•7H<sub>2</sub>O

- **Experiment-4:** Preparation of Dark red inorganic pigment: Cu<sub>2</sub>O (compulsory)
- **Note:** In synthesized compound student must confirm the particular Cation and anion by performing qualitative tests.

#### Part-II: Inorganic Volumetric Analysis, Investigative Practical's (compulsory)

- **Experiment-5:** Determination of equivalent weight of oxidizing agent KMnO<sub>4</sub> and K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> by titration with standard Fe(II) solution.
- **Experiment-6:** Determination of basicity of boric acid or oxalic acid or citric acid hence determination of their equivalent weigh by acid base titration.
- Experiment-7: Estimation of water of crystallization in Mohr's salt by titrating with KMnO<sub>4</sub>.

#### Section B: Organic Chemistry Practical

#### Part-III: Organic purification Techniques

- **Experiment-9:** Purification of two organic compounds by Crystallization (one from water one from water-alcohol) with respect to melting point of pure and impure compound and percent yield of purified product.
- **Experiment-10:** Purification of organic compounds by sublimation with respect to melting point of pure and impure compound and percent yield of purified product.
- **Experiment-11:** Purification of organic liquid by distillation with respect to boiling point of pure and impure liquid and percent yield of purified product.

#### **Part-IV: Organic preparations: (any three)**

- Derivatives Preparations: Mechanism of various reactions involved to be discussed. Recrystallization, determination of melting point and calculation of quantitative yields to be done.
- Experiment-12: Bromination of Cinnamic acid using sodium bromide and Sodium bromate. (Green Chemistry Approach)
- Experiment-13: Bromination of acetanilide using KBr and Ceric ammonium nitrate in aqueous medium. (Green Chemistry Approach)
- **Experiment-14**: Semicarbazone derivatives of aldehydes and ketones
- Experiment-15: Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone
- Note: Presence of extra element in the synthesized compound must be tested (Br and N in respective compound)
- **Reference-1:** Laboratory Manual Prepared by Department of Chemistry, Prof. Ramkrishna More College Akurdi.
- Reference-2: Handbook of inorganic chemistry,
- Referenc-3. Preparative Inorganic Chemistry, Brauer G., Academic publisher, 1965
- **Referenc-4**. (editor), G. Leib (translator Practical Inorganic Chemistry, K. M. Dunaeva, E. A. Ippolitova, N. S. Tamm, V. I. Spitsyn) O.I. Vorobyova Mir Publishers (1987).

Referenc-5. Practical Inorganic Chemistry Preparations, reactions and instrumental methods, Geoffrey Pass B.Sc., Ph.D., Haydn Sutcliffe B.Sc., Ph.D., F.R.I.C., Springer Netherlands (1974)

**Reference-6.** Text book of Practical Organic Chemistry, Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. and Smith, P.W.G., Prentice-Hall, 5<sup>th</sup> edition, 1996.

#### **Course outcome**

#### Students will learn

- **CO-1**. Chemical synthesis and controlling reaction parameters in laboratory synthesis of inorganic and organic compounds.
- CO-2. Preparation of commercially important inorganic compounds and their qualitative analysis.
- **CO-3.** Concepts like molecular wt. and equivalent weight and how to determine equivalent weight of oxidizing agent.
- **CO-4**. Acid base titration and determination of equivalent weight of polyprotic acids.
- **CO-5.** Preparation of derivatives of organic compounds and identification of new element introduced in product.
- CO-6. Preforming analytical chemistry calculations.

#### CHVST-111, Vocational Chemistry theory-I

#### **Chemical Methods of Quality Control of Pharmaceuticals-I**

Chapter	Name of the Chapter	Lectures
No		Assigned
1	Basic terms and definitions in pharmaceuticals	02 L
2	Chemical purity and its control	03 L
3	Preliminary Methods of Pharmaceutical Analysis	05 L
4	Calculation in Analytical Chemistry	05 L
5	Basics of Volumetric Methods for Pharmaceuticals Analysis	15 L

#### Module-I

#### Chapter-1. Basic terms and definitions in pharmaceuticals

Definition of Pharmaceuticals, drug, raw material and finished products, active pharmaceutical ingredient, excipients, pharmaceutical dosage forms, pharmacopeia and different types of pharmacopeia, monograph, meaning of different terms in monograph.

#### Chapter-2. Chemical purity and its control

Introduction, Source of impurities in pharmaceutical chemicals, Chemical and physical instability, Manufacturing hazards, Standardization of pharmaceutical chemicals and formulated products.

#### **Chapter-4. Preliminary Methods of Pharmaceutical Analysis**

Description of material, melting and boiling point and their importance, functional group tests, solubility, colours of solution, limit tests for inorganic ions (iron, heavy metals, chloride, sulphate only), moisture and volatile matter content, ash and sulphated ash, TLC method for determination of impurities.

#### Chapter-5. Calculation in Analytical Chemistry

SI units, The distinction between mass and weight, the Mole, the milli-mole, Solutions and their concentrations, *Molar concentration, Percent concentration, equivalent weight, equivalent weight of acids bases, oxidizing agents and reducing agents, normal solutions, Parts per million and Parts per billion*, Density and specific gravity of solutions, Chemical stoichiometry, Empirical formulas and molecular formulas, Stoichiometric calculations, Numericals, *Rfe-2: Chapter-2, 62 to 81., Ref-4: Relevant pages* 

#### 22

#### [3 L]

[2 L]

## [5 L]

[5 L]

[12L + 3T]

#### Module-II

#### Chapter-6. Basics of Volumetric Methods: Pharmaceuticals Analysis

[15 L]

[12+3]

**a. Definitions-**Volumetric analysis, standard solution, primary standards, stock solution, titrant, equivalence point, end point, indicator. Numericals, *Ref-2, Chapter-13, 322-321* 

**b.** Acid base titration: Solutions and indicators for acid/base titrations, titration of strong acids and bases; titrating a strong acid with a strong base, Titration curves for weak acids; the effect of concentration, the effect of reaction completeness, choosing an indicator: The feasibility of titration, titration curves for weak bases, The composition of solutions during acid/base titrations, Locating titration end points from pH measurements, Numericals, *Rfe-2: Chapter-14, 322 to 347.* 

**c.** Complexation and Precipitation Reactions and Titrations; The Format ion of complexes, complexation equilibria, The formation of insoluble species, Ligands that can protonate, Titrations with inorganic, complexing agents, precipitation titrations, *End points for argentometric titrations*, Organic complexing agents, Aminocarb oxylic acid titrations, ethylenediaminetetraacetic acid (EDTA), EDTA titration curves, Indicators for EDTA titrations, Titration methods involving EDTA, The scope of EDTA titrations, Numericals, *Rfe-2: Chapter-17, 400 to 440*.

**d. Oxidation/Reduction Titrations:** Auxiliary oxidizing and reducing reagents, applying standard reducing agents, Iron(II) solutions, Sodium Thiosulfate, applying standard oxidizing agents, Potassium Dichromate, Iodine, Numericals, *Rfe-2: Chapter-10, 510 to 532*.

**Reference-1:** *Practical Pharmaceutical Chemistry: Quantitative Analysis, Beckett*, A. H., Stenlake, 4<sup>th</sup> ED, CBS publisher.

**Reference-2:** Fundamentals of Analytical Chemistry by Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, 9<sup>th</sup> Ed., Books Cole, Cengage Learning

**Reference-3:** Pharmaceutical Drug Analysis, Ashutosh Kar, New Age International Pvt Ltd Publishers (2005)

**Reference-4:** Vogel's textbook of inorganic quantitative analysis, 6<sup>th</sup> Ed.

#### **Course Outcome: Students will learn / able**

**CO-1:** Types pharmaceutical compounds and pharmaceutical dosage form

CO-2: Preliminary methods of pharmaceutical analysis/quality assurance

CO-3: Basics of analytical calculations in pharmaceutical analysis/quality assurance

**CO-**4: Volumetric methods of pharmaceutical analysis/quality assurance.

**CO-5**: Differentiate among the different methods of volumetric methods of analysis

**CO-6**: Perform analysis of pharmaceutical compound for its purity or for quality assurance and quality control purpose.

## CHVSP-121, Vocational Skill Chemistry Practical –I, [2 credits, 60 L]

#### **Chemical Methods of Pharmaceutical Analysis-I**

**Experiment-1.** Determination of moisture, ash and sulfated ash in aspirin.

**Experiment-**2. Identification tests of aspirin and deamination of melting point and salicylic acid in aspirin by TLC method.

Experiment-3. Determination of limit test of heavy metal and iron in pharmaceutical compound.

**Experiment-**4. Determination of limit test of chloride and sulphate in pharmaceutical compound.

Experiment-5. a) Appearance and clarity of solution in alkali. b) Determination of salicylic acid.

Experiment-6. Identification test and assay of aspirin (acid-base titration)

CBCS Syllabus Under NEP-2020 F. Y. B. Sc. /M. Sc. -I **Department of Chemistry Experiment-**7. Identification test for NaHCO<sub>3</sub> and purity of NaHCO<sub>3</sub> (acid-base titration)

**Experiment-8**. Identification test for FeSO<sub>4</sub> and Assay of FeSO<sub>4</sub> (redox titration) or Determination of Fe(II) in ferrous sulfate injection.

**Experiment-9**. Identification test for paracetamol and Assay of Paracetamol (redox titration)

- **Experiment-**10. Identification test and assay of calcium in calcium carbonate and in calcium supplementary tablet (Na<sub>2</sub>EDTA titration)
- Experiment-11. Identification tests and assay of ZnO (Na<sub>2</sub>EDTA titration).
- **Experiment-12**. Identification test for and assay of ascorbic acid (Iodometric titration)
- Experiment-13. Identification test and assay NaCl by argentometric titration (Precipitation titration)
- **Experiment-**14. Identification test of form iodine in Table salt and iodine content of Table salt (iodometric titration)

Note: In experiment of 6 to 14 standardization appropriate reagents must be performed.

**Reference:** Indian Pharmacopeia, 7<sup>th</sup> Ed. Vol. 1, 2 and 3.

#### Student will acquire the skills of -

**CO-1.** Basic methods of analysis of pharmaceuticals

- **CO-2.** Preparation of stock and standard solutions and methods of standardization of volumetric reagents.
- **CO-3**. Determination of limit tests of metallic and non-metallic impurities in pharmaceutical compounds.
- **CO-4**. Volumetric analysis of pharmaceutical compounds.
- **CO-5**. Determination methods of purity of pharmaceutical compounds.
- **CO-6:** Comparing different method of volumetric analysis of pharmaceutical compounds.

## CHIK-111, Indian Knowledge System-Chemistry Paper, **Chemistry of Ayurvedic Medicines**

Chapter	Name of the Chapter	Lectures
No		Assigned
1	Process for Drug Development	02 L
2	Standardization of Raw Drugs	04 L
3	Test Parameters	09 L
4	Test Protocols	15 L
l		[12+3]

#### Module-1

#### **Chapter-1: Process For Drug Development**

Introduction, Classification of Ayurvedic Drugs, Plant parts used in Ayurveda, Good Agricultural Practices, Components of Drug Development With Chart, General Research Guidelines And Methodologies For Drug Development For Ayurveda Siddha And Unani Medicine. Reference-1: pp-1 to 8 [4 L]

#### **Chapter-2: Standardization of Raw Drugs**

Standard Operating Procedure (SOPs) For Drug Development (Chart), Extraction techniques for herbal drugs (Chart), Shelf life or date of expiry of Ayurvedic Medicines, Shelf life or date of expiry of Siddha Medicines, Shelf life or date of expiry of Unani Medicines. Stability Testing and Shelf Life Determination for New and Existing Ayurvedic Drugs, **Reference-1:** pp-8 to 26

## [2 L]

[12+3]

[15 L]

#### **Chapter-3: Test Parameters**

Raw Plant Material, Plant Extract, Arka/ Distillates, Asava And Arishta (Fermented Liquids), Avachumam Yoga (Ayurvedic Dusting Powder), Avaleha/Leham/Modak/Ilagam (Confectionary/ Semi Solid), Chewing Candy, Chuma/Choomam (Fine Powder)/Kvatha Chuma/ Kudinir Choomam (Corase Powder For Decoction), Lepa/Malhara/Kalimbu/Pasai/Medicated Wax /Cream/ Poultice, Netrabindu/Kan Chottu Marunthu (Eye Drops), Pishti/Bhasma/Parpam/ Sindur (Processed Fine Sikta/Siruthugalgal (granules), Sharbat/Manappagu (syrup), Powder). Sharkara Tailas/ Ghritas/Thylam/Nei (medicated oils and ghee), Vati/ Gutika/Kuligai/marthirai/ Vadagam (tablet/ pills), Vartti, Netra Vartti, Suppositories, Good Manufacturing practice, List of machinery, equipment and minimum manufacturing premises required for the manufacture of various categories of Ayurvedic, Siddha system of medicines, List of machinery, equipment and minimum manufacturing premises required for the manufacture of various categories of Unani system of medicines, List Of Equipment Recommended For In House Quality Control Section, Guidelines for issue of license with respect to Ayurveda, Siddha or Unani drugs. Phyotopharmaceutical Drug. Reference-1: pp- 27 to 69

#### Module-2

#### **Chapter-4: Test Protocols**

Identification of Single Drugs, Systematic Study of Crude Drugs, Microscopical Methods of Examining Crude Drugs, Leaves, Herbs and Flowers, Fruits and Seeds, Barks, Roots and Rhizomes, Types of Stomata, Determination of Stomatal Index, Determination of Stomatal Index, Determination of Vein-Islet Number, Determination of Stomatal Number, DETERMINATION OF QUANTITATIVE DATA: Foreign Matter, Determination of Total Ash, Determination of Acid insoluble Ash, Determination of water soluble Ash, Determination of Sulphated Ash, Determination of Alcohol-soluble Extractive, Determination of Water-soluble Extractive, Determination of Ethersoluble Extractive (Fixed Oil Content), Determination of Moisture Content (Loss on Drying), Determination of Water-insoluble Matter, Determination of Volatile Oil in Drugs, Thin-Layer Chromatography (TLC), Determination of Acidity, Method for Alkaloid Estimation, Refractive Index, Weight Per Millilitre And Specific Gravity, Determination Of Ph Values, Determination Of Melting Range And Congealing Range, Determination Of Optical Rotation And Specific Optical Rotation, Determination Of Viscosity, Determination Of Total Solids, Solubility In Water, Determination Of Saponification Value, Determination Of Iodine Value, Determination Of Acid Value, Determination Of Peroxide Value, Determination Of Un Saponifiable Matter, Detection Of Mineral Oil (Holde's Test), Rancidity Test (Kreis Test), Determination Of Alcohol Content. Reference-1: Pp-70-100

**Reference-1:** Guidelines Series-I, General Guidelines for Drug Development of Ayurvedic Formulations, Central Council for Research in Ayurvedic Sciences Ministry of Ayush, Government of India, New Delhi.

#### **Further Readings**

Reference-2: Ayurveda, The Devine Science of Life, Michael Tierra, Elsevier

**Reference-3:** Regulatory and Pharmacological Basis of Ayurvedic Formulations, Amritpal Singh Saroya, CRC press

#### **Course Outcome: Students will learn / able**

- CO-1: Medicines and lifestyle in ancient India.
- CO-2: Define forms of medicine in Ayurveda.
- CO-3: Methods of preparation of some Ayurvedic medicines.
- CO-4: Uses of some Ayurvedic medicines.
- CO-5: Richness of knowledge and science in ancient India.
- CO-6: Relationship of modern chemistry with Ayurveda

Chapter No	Name of the Chapter	Lectures Assigned
1	Analytical Objectives	03 L
2	Stoichiometric Calculations	12 L
3	Acid–Base Equilibria	08 L
4	Acid–Base Titrations	07 L

#### CHMIT-121, Minor Chemistry Theory-1, Fundamentals of Analytical Chemistry

#### Module-1

#### [12 L+3 T][3 L]

#### **Chapter-1: Analytical Objectives**

What is analytical science, qualitative and quantitative analysis: What does each tell us?, getting started: The analytical process, validation of a method—you have to prove it works!, analyse versus determine-they are different, some useful websites, **Ref-1**: Chapter-1, pp 2 to 16

#### Chapter-2: Stoichiometric Calculations: The Workhorse of the Analyst [12 L]

Introduction, Review of the fundamentals, how do we express concentrations of solutions? (molarity-the most widely used, normality, formality-instead of molarity, molality-the temperatureindependent concentration, density calculations-how do we convert to molarity?, analytical and equilibrium concentrations-they are not the same, dilutions-preparing the right concentration, more dilution calculations), expressions of analytical results-so many ways (solid samples, concentrations of gases and particles in air, liquid samples, reporting concentrations as different chemical species), volumetric analysis: how do we make stoichiometric Calculations? Titration-what are the requirements?, standard solutions-there are different kinds, classification of titration methods-what kinds are there?, volumetric calculations-let's use molarity, some useful things to know for molarity calculations, standardization and titration calculations-they are the reverse of one another, what if the analyte and titrant can react in different ratios? If the reaction is slow, do a back-titration, titerhow to make rapid routine calculations, weight relationships-you need these for gravimetric, calculations, numericals, Ref-1: Chapter-5, pp 149 to 182

#### Module-2

#### Chapter-3: Acid–Base Equilibria

The early history of acid-base concepts, acid-base theories-not all are created equal, acid-base equilibria in water, the pH scale, pH at elevated temperatures: blood pH, weak acids and bases-what is the pH?, salts of weak acids and bases-they aren't neutral, buffers-keeping the pH constant (or nearly so), physiological buffers-they keep you alive, buffers for biological and clinical measurements, diverse ion effect on acids and bases: *ck*<sup>a</sup> and *ck*<sup>b</sup>-salts change the pH, log c-pH diagrams, exact pH calculators, numericals. Ref-1: Chapter-7, pp 188-245, 261-269.

#### **Chapter-3: Acid–Base Titrations**

Basic definitions (volumetric analysis or titration, neutralization reaction, standard solution, sample solution, titrant, end point, equivalence point, indicator), strong acid versus strong base-the easy titrations, detection of the end point: indicators, standard acid and base solutions, weak acid versus strong base-a bit less straightforward, Weak base versus strong acid, titration of sodium carbonatea diprotic base, numericals. Ref-1: Chapter-8, pp 281-298.

**Reference-1:** Analytical Chemistry, Seventh Edition by Gary D. Christian Purnendu K. (Sandy) Dasgupta, Kevin A. Schug, Publisher-Wiley.

#### **Course Outcome**

#### At the end of course, student will able -

- **CO-1:** To identify a role of analytical chemist, and analytical chemistry in chemical analyses of substances.
- CO-2: Define / discuss/ explain basic concepts in stoichiometric calculations in analytical chemistry, acid base equilibria and acid base titration, and their uses in analytical chemistry.

## [8 L]

[7L]

## [12L+3T]

- **CO-3:** Differentiate / compare among acid and base, weak acid-strong acid, weak base-strong base, different types of titrations, molarity-normality,
- **CO-4:** Apply his knowledge a) of stoichiometric calculations in analytical chemistry, acid base equilibria and acid base titration to explain practical observations. b) Choice of indicator c) preparation of standard and stock solutions, etc.
- **CO-5:** Solve numerical on stoichiometric calculations in analytical chemistry, acid base equilibria and acid base titration.
- **CO-6:** Design / plan acid base titration for the analysis acidic or basis substances.

#### CHSEP-111: Skill Enhancement Chemistry Course-1

#### **Practical: Formulation of Soaps and related products**

- **Experiment-1:** List the material required for soap, shampoo, hand wash, dish wash, toilet and bathroom cleaning. Find out their sources and cost. Function of some ingredients in the soap and soap making.
- **Experiment-2:** Saponification value of oil.
- Experiment-3-4: Soap making cold process (prepare two three types of soaps by cold process such as awesome Bar Soap, Bay Rum Soap Bar, Big 'N' Beautiful Bubbles Soap Bar, Bubble Gum Kid-Approved Soap Bar, Bug Repellent Soap, etc)
- **Experiment-5-6:** Soap making hot process (prepare two three types of soaps by cold process such as marbled Clay Soap, Lard-Base Soap, Bastille Soap, Lemon Poppy Seed Soap, etc.).

Experiment-7: Melt and Pour soap making

- **Experiment-8:** Facial and Shaving Soap Products almond & Tea Tree Oil Facial Wash, Almond Oil & Black Tea Facial Scrub, Aloe Vera & Tea Tree Shaving Soap, Foaming Shave Soap
- Experiment-9: Preparation of hand wash (different types)
- Experiment-10: Preparation of hand sanitizer (different types)
- Experiment-11: Preparation of dish wash different types.
- Experiment-12: Preparation of Toilet Cleaner.
- **Experiment-13:** Determination of CMC of detergent / soap
- **Experiment-14:** Determination of soap solution by stalganometer.
- Experiment-15: Determination pH of different detergent / soap solution
- **Experiment-16:** Calculating costing of production of at least two product, their packaging, labelling and marketing
- **Reference-1:** Soap Making Step-by-Step Guide to Make Homemade Soaps. Advanced and Beginner Recipes Included, Carol Varney.
- Webliography: <u>https://5.imimg.com</u> (swachh herbl manufacture of cleaning and hygiene products)
- **CO-1:** Explain various ingredients required to manufacture particular product, their source and cost.
- **CO-2:** Discuss composition of particular product and choice of ingredients for the formulation of particular product.

#### **Module-1**

#### **Chapter-1: Introduction to Detergents**

Introduction, Common Detergent Ingredients, Surfactants, Dispersing Polymers, Builders and Chelants, Bleaching Systems, Solvents, Performance Enhancing Minor Ingredients, Representative Detergent Formulations, Detergent Formulations for Cleaning Food Processing Equipment, Detergency Theory and Mechanisms, Suspension Mechanisms, Ref-2: pp 1 to 25

#### **Chapter-2: Soaps and Detergents**

Introduction, Historical Background, Production of Soap Base, Soap Boiling, Conversion to Finished Bars, Soap Perfume and Additive Systems, Other Types of Soaps, Detergent/Combination Bars, Liquid Soaps and Handwashes, Contents This page has been reformatted by Knovel to provide easier navigation, Sun Damage and Sunscreen Preparations, Introduction, Sun-Induced Skin Damage: Its Causes and Measurement, Product Ingredients, Formulations, Materials and Suppliers. Ref-1: pp 453-464

#### **Chapter-3 Hair Shampoos**

Introduction, The Action of Shampoo on the Hair, The Foaming of Shampoos, Shampoo Ingredients, Antidandruff Agents, Preparation and Manufacture of Shampoos, Representative Shampoo Formulations, Ref-1: pp 289-306,

#### **Module-2**

#### **Chapter-4: Dishwashing Detergents for Household Applications**

Introduction, Chemistry of Hand Dishwashing, Hand Dishwashing Process, Methods of Hand Dish Washing, Mechanisms of Cleaning by Hand Dishwashing Detergents, Basic Building Blocks of Hand Dishwashing Detergents, Surfactants, Foam or Suds Stabilizers, Hydrotropes and Dissolution Aids, Recent Developments in Key Hand Dishwashing Technologies Surfactants, Low-IFT Grease Cleaning Technologies Suds Boosting Polymers, Product Dissolution Aids, Enzymes, Bleaches, New Product Forms, Dish Wipes, Hand Dishwashing Implement Ref-2: pp 105 to 122

**Chapter-5: The Formulation of Liquid Household Cleaners** 

**CO-4:** Actually, formulate and produce particular product at a laboratory scale.

CO-5: Able to evaluate cost manufacture and of product and decide cost for marketing of product.

F. Y. B. Sc. /M. Sc. -I

**CO-6:** Explain/ Discuss properties and uses/application s of the product which is formulated by him.

## **CHSET-112: Chemistry Skill Enhancement Course Theory** Formulation of Soaps Detergents and related products

Chapter No	Name of the Chapter	Lectures Assigned
1	Introduction to Detergents	06 L
2	Soaps and Detergents	05 L
3	Hair Shampoos	04 L
4	Dishwashing Detergents for Household Applications	06 L
5	The Formulation of Liquid Household Cleaners	06 L
6	Hand wash, hand sanitizers preparations	03 L

## [4 L]

[12 L+3 T]

[6 L]

[12 L+ 3 T]

[6 L]

[5 L]

28

Introduction, Classification of Household Surfaces, Test Methods, Surface Cleaner Formulations, All-Purpose Cleaners, Bathroom Cleaners, Toilet Bowl Cleaners, Bleach Cleaners, Glass Cleaners, Carpet Cleaners, *Ref-2, pp 153-175*.

Chapter-6: Hand wash, hand sanitizers preparations [3 L]

Definitions, properties, types and formulations (Internet resources)

- **Reference-1:** Poucher's Perfumes, Cosmetics and Soaps, Edited by Hilda Butler Editor and Consultant to the Cosmetic Industry, Kluwer Academic Publishers Dordrecht / Boston / London
- **Refwence-2:** Handbook of Detergents Part D: Formulation, Edited by Michael S. Showell, Taylor and Fransis.
- **CO-1:** Define and explain terms soap, detergent, shampoo, dish wash, hand wash, hand sanitizer, mechanism of surfactant action.
- **CO-2:** Discuss method of preparation of soap, hand wash, dish wash, hand sanitizer, shampoo, etc.
- **CO-3:** Apply his knowledge to prepare particular product and able to select appropriate ingredients for synthesis.
- **CO-4:** Differentiate among various product on the basis of their characteristics and uses.
- **CO-5:** Design and upgrade own product by varying either ingredients or proportion of ingredients.

**CO-6:** Decide the process and cost of product that he want to manufacture.

## VEC-1

## Value Education Course

(30 Lecture of 60 min.; 2-credits)

## **MODULE-1** [12 L + 3T]

**Environment Awareness** 

#### Unit 1: Introduction to environmental studies [02 L]

- Multidisciplinary nature of environmental studies;
- Scope and importance; Concept of sustainability and sustainable development.

## Unit 2: Ecosystems [06 L]

- Concept and structure.
- Ecosystem functions.
- Types of Ecosystem.

## Unit 3: Biodiversity and Conservation [07 L]

- India as a mega-biodiversity nation; Endangered and endemic species of India
- Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions;
- Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

## **MODULE-2** [12 L + 3T]

## Unit 4: Environmental Pollution [07 L]

- Environmental pollution: types, causes, effects and controls; Air, water, and soil pollution.
- Solid and liquid waste management: Control measures of urban and industrial waste.

## Unit 5: Environmental Programs and Policies [08 L]

- Developed countries, Developing countries.
- New environmental policy of India; Government initiatives.

## **References:**

1. Singh R. B. (1993) Environmental Geography. Delhi, India: Heritage Publishers.

2. Odum, E.P., Odum, H.T. & amp; Andrews, J. 1971. Fundamentals of Ecology. Philadelphia: Saunders.

- 3. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. Principles of Conservation Biology. Sunderland: Sinauer Associates, 2006.
- 4. Rosencranz, A., Divan, S., & amp; Noble, M. L. 2001. Environmental law and policy in India. Tripathi 1992.
- 5. Carson, R. 2002. Silent Spring. Houghton Mifflin Harcourt.
- 6. Gadgil, M., & Guha, R. 1993. This Fissured Land: An Ecological History of India. Univ. of California Press.
- 7. Gleeson, B. and Low, N. (eds.) 1999. Global Ethics and Environment, London, Routledge.
- 8. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi
  - CO-1: Define and explain terms Environment, Sustainability Ecosystem biodiversity.
  - CO-2: Discuss Conservation of Biodiversity and Pollution control
  - CO-3: Apply his knowledge to find out impact of pollution on environment
  - **CO-4:** Differentiate among different types of pollution, biodiversity and ecosystems.
  - **CO-5:** Explain Environmental Programs and Policies
  - **CO-6:** Evaluate Threats to biodiversity and pollution.

## **OE/GE: 2 Credit, 30 L CHGET: 111:- Chemistry for Competitive Examination (Part-I)**

Module	Chapter No.	Title of Topic/Chapter	No. of lecture
Ι	1	Introduction to Physical Chemistry	08
	2	Introduction to Inorganic Chemistry	07
II	3	Introduction to Organic Chemistry	10
	4	Miscellaneous Chemistry	05

## Module-I: (12L+3T)

## Chapter-1: Introduction to Physical Chemistry (8 L)

- 1. Atom and its structure: Introduction, constituents of an atom, Thomson model, Rutherford model, Bohrs model, Quantum model, Atomic number, atomic mass, Isotope, Isobar, Quantum numbers.
- 2. Chemical bonding: Introduction, Valency, Types of bonding, Dipole moment, Fajan rule, VSEPR, VBT, MOT, Hydrogen bond.
- 3. Concept of matter: Introduction, Classification of matter, Gas laws, change of states, latent heat, Specific heat capacity, Temperature.

### Reference: II Page no 2 to 30

### **Chapter-2: Introduction to Inorganic Chemistry**

- 1. Periodic Table: Introduction, Dobereiner triads, Newlands octaves, Mendeleeves periodic law, modern periodic table, Important elements and its properties and function, Perodic properties of element.
- 2. Classification of Elements: Introduction, Metals, non-metal, Metalloids and its properties, uses, Important Reactions with metals.

#### Reference: II Page no 42 to 55

## Module- II:

#### **Chapter-3: Introduction to Organic Chemistry**

- 1 World of Carbon: Introduction, Carbon, Hydrocarbon and its types, Structure of hydrocarbon, Isomerism, Nomenclature, Catenation, Allotrops of carbon, Chemical reactions of carbon compounds, Coal, Petrolium and its purification, some intresting facts.
- 2. Chemical Reactions: Introduction, Important terminology, rules for writing chemical reaction, Types of chemical reactions, Oxidation and reduction, order of reaction, Important points.

#### Reference: II Page no 60 to 86

## **Chapter-4: Miscellaneous Chemistry**

- 1. Polymer: Properties, Types, applications.
- 2. Rubbers: Properties, Types, uses.
- 3. Explosives: TNG, TNT, TNB, TNP, RDX
- 4. Drugs and chemicals: Introduction, Basic terms used in drugs, Classification, Antibiotics, antipyretics, analgesics, antiseptics, Transquilizers, Disinfectant, Antifertility drugs, antacid, pesticide, insecticide, fungicide, insecticide, herbicide

## **Reference: I Relevant pages**

## **Reference Book:**

- 1. Lucent's General Science by Sunil Kumar Singh, Lucent Publication
- 2. General Science book Part-II for competitive examination by Dr.Sachin Bhaske

## Course Outcomes (CO): Chemistry for competitive Examination

## (12L+3T)

(7 L)

## (10 L)

#### (05 L)

- CO-1: Define the terms matter, atom, chemical bond, valency, dipole moment, hydrogen bond, oxidation, reduction, acid, base, catalysis, solution, element, metal, isomerism, polymer, rubber, explosives, drugs, etc.
- CO-2: Describe structure of atom, chemical bonding, Chemical symbol, formula and equation, Periodic classification of elements.
- CO-3: Explain the terms catenation, Petroleum, Allotrops, Polymers, Rubbers, Explosives, Drugs & chemicals, latent heat, specific heat capacity
- CO-4: Distinguish between the metal and nonmetal, VBT and MOT, acid and bases, oxidation and reduction, etc.
- CO-5: Classify chemical bond, polymers, explosives, rubber, Matter, elements, Drugs.
- CO-6: Give uses of polymers, explosives, rubber, petroleum, Drugs and chemical, pesticide, insecticide, fungicide, herbicide, etc.

## **CHGEP -112:**

#### **Practical: Formulation of Soaps and related products**

**Experiment-1:** List the material required for soap, shampoo, hand wash, dish wash, toilet and bathroom cleaning. Find out their sources and cost. Function of some ingredients in the soap and soap making.

**Experiment-2:** Saponification value of oil.

- Experiment-3-4: Soap making cold process (prepare two three types of soaps by cold process such as awesome Bar Soap, Bay Rum Soap Bar, Big 'N' Beautiful Bubbles Soap Bar, Bubble Gum Kid-Approved Soap Bar, Bug Repellent Soap, etc)
- **Experiment-5-6:** Soap making hot process (prepare two three types of soaps by cold process such as marbled Clay Soap, Lard-Base Soap, Bastille Soap, Lemon Poppy Seed Soap, etc.).

Experiment-7: Melt and Pour soap making

Experiment-8: Facial and Shaving Soap Products - almond & Tea Tree Oil Facial Wash, Almond Oil & Black Tea Facial Scrub, Aloe Vera & Tea Tree Shaving Soap, Foaming Shave Soap

Experiment-9: Preparation of hand wash (different types)

**Experiment-10:** Preparation of hand sanitizer (different types)

**Experiment-11:** Preparation of dish wash different types.

**Experiment-12:** Preparation of Toilet Cleaner.

**Experiment-13:** Determination of CMC of detergent / soap

**Experiment-14:** Determination of soap solution by stalganometer.

Experiment-15: Determination pH of different detergent / soap solution

- **Experiment-16:** Calculating costing of production of at least two product, their packaging, labelling and marketing
- **Reference-1:** Soap Making Step-by-Step Guide to Make Homemade Soaps. Advanced and Beginner Recipes Included, Carol Varney.
- Webliography: <u>https://5.imimg.com</u> (swachh herbl manufacture of cleaning and hygiene products)

- Department of Chemistry
- **CO-1:** Explain various ingredients required to manufacture particular product, their source and cost.

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- **CO-2:** Discuss composition of particular product and choice of ingredients for the formulation of particular product.
- **CO-3:** To select / design / modify method / process for the formulation of particular product.
- **CO-4:** Actually, formulate and produce particular product at a laboratory scale.
- **CO-5:** Able to evaluate cost manufacture and of product and decide cost for marketing of product.
- **CO-6:** Explain/ Discuss properties and uses/application s of the product which is formulated by him.

#### **OE/GE: 2 Credit, 30 L CHGET: 121:- Chemistry for competitive Examination (Part-II)**

Module	Chapter No.	Title of Topic/Chapter	No. of lecture
Ι	1	Introduction to Physical Chemistry	08
	2	Introduction to Inorganic Chemistry	07
II	3	Introduction to Organic Chemistry	05
	4	Miscellaneous Chemistry	10

#### Module-I:

#### **Chapter-1: Introduction to Physical Chemistry**

CBCS Syllabus Under NEP-2020

- Chemical classification of matter: Introduction, Elements, Compounds, Molecules and compounds, Molecular mass and Mole concept, Formula mass, Emprical and Molecular formula, Mole fraction, Mixture, Homogeneous and Heterogeneous mixture, Important points. Reference: II Page no 34 to 41
- 2. Thermodynamics: Introduction, Heat and Temperature, Specific heat, Effects of heat, Heat transfer, Laws of Thermodynamics, Entropy.

Reference: II Page no 88 to 92

#### **Chapter-2: Introduction to Inorganic Chemistry**

 Minearals and ores: Introduction, Minerals, Ores, Extraction of ore, Roasting, Calcination, Galvanizing, Tinning, Electroplating, Anodising, Alloying, Purification methods of metal, soil and its Types

#### Reference: II Page no 56 to 59

 Acid, Base and Salt: Introduction, Acid and its properties, Effect of indicator on acid and bases, Bases and its properties, The pH Scale, Salts, Different definitions of Acid and Bases, Classification of Acid and Bases, Buffer, Important Point.

#### Reference: II Page no 72 to 79

#### Module- II:

#### **Chapter-3: Introduction to Organic Chemistry**

- i. Alcohol, Phenol and Ether its Structure , properties and applications .
- ii. Aldehyde, Ketones its Structure, properties and applications
- iii. Carboxylic acids its Structure, properties and applications.

## (12L+3T)

#### (05L)

(12L+3T) (8L)

(7L)

(10L)

## Reference: I & II Relevant pages

#### **Chapter-4: Miscellaneous Chemistry**

- i. Fertilizers: Introduction, Classification, Uses
- ii. Dyes: Introduction, Different classes, its uses
- iii. Types of glasses,
- iv. Soap and Detergent,
- v. Food preservative like, benzoates, propionate, sorbates.
- vi. Artificial sweetners: aspartame, saccharin, dulcin, sucralose, Flavers like vanillin, monosodium glutamate.
- vii. Artificial food colourant.
- viii. Environmental Chemistry: Hydrologic cycle, Air Pollution, Water pollution.

### **Reference: I & II Relevant pages**

#### **Reference Book:**

- 1. Lucent's General Science by Sunil Kumar Singh, Lucent Publication.
- 2. General Science Book Part-II for competitive examination by Dr.Sachin Bhaske

#### **Course Outcomes (CO): Chemistry for competitive Examination**

- CO-1: Define the terms fertilizers, dye, glass, colorant, soap, detergents, acids, bases, ores, minerals, alcohols, ketones, phenols, aldehyde, carboxylic acid etc.
- CO-2: Describe properties and applications of alcohols, phenols, carboxylic acids, aldehydes, ketones, hydrologic cycle, air pollution, water pollution and artificial sweeteners.
- CO-3: Explain the terms Roasting, Calcination, Galvanizing, Tinning, Electroplating, Anodising, saccharin, dulcin, sucralose, Flavers like vanillin, monosodium glutamate.
- CO-4: Distinguish between the ores and minerals, aldehydes and ketones, Soap and Detergent.
- CO-5: Classify fertilizers, Dyes, Glasses, sweeteners, ores, colorants,Air Pollution, Water pollution, Acid and Bases, Buffer and esters.
- CO-6: Give uses of <u>fertilizers</u>, <u>dye</u>, <u>glass</u>, <u>colorant</u>, <u>soap</u>, <u>detergents</u>, ores, minerals, alcohols, ketones, aldehydes</u>, Food preservative etc.

## **Generic Open Elective Chemistry Course**

CHGEP-122: Adulteration in Dairy Products and Physico-Chemical parameters of Water and Soil [60-L, 2 Credits]

#### Section I : Adulteration in Dairy 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 Dahiand 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: Physico-Chemical Parameters of Waters (Any Three)

- 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 complexo metric titration

#### Section-III: Physico-Chemical Parameters of Soil (Any Three)

- Experiment-17: Soil Samples preparation
- Experiment-18: Moisture content
- **Experiment-19:** Determination of pH of soil a) pH (H<sub>2</sub>O ) b) pH (KCl) c) pH (H<sub>2</sub>O<sub>2</sub>)
- 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.

## **Question Paper pattern**

Marks: 35		Time: 2 Hour			
Instructions to the Candidate:					
1. All questic	1. All questions are compulsory.				
2. Figures to	2. Figures to right indicate full marks.				
3. Use of Log	table and scientific calculator is allo	wed.			
Question-1	Solve Any five of the following (Short Answers)	Three def. type, two tricky questions and two	5 Marks		
	i. ii. iii. iv. v. v. vi.	applicable)			
	vii.				
Question-2	A. Solve any two of the following i. ii. iii.	Note or Describe type questions	6 Marks		
	<b>B.</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>B. Solve the following</b> 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. v.	Application type, Justification type question	10		