

GANDHI INSTITUTE OF TECHNOLOGY AND MANAGEMENT (GITAM)
(Deemed to be University)
VISAKHAPATNAM * HYDERABAD * BENGALURU

Accredited by NAAC with A⁺ Grade



CURRICULUM AND SYLLABUS

of

B.Sc. Chemistry

(w.e.f. 2021-22 admitted batch)

Academic Regulations

Applicable for the Undergraduate programmes in the Faculties of
Engineering, Humanities, Management and the Sciences

<https://www.gitam.edu/academic-regulations>

B.Sc. Chemistry Program Educational Objectives

The PEOs are broad statements that describe the career and professional accomplishments that the program is preparing its graduates to achieve in a few years (for example, three years) subsequent to receiving the degree. The PEOs of the B.Sc. program in Chemistry are as follows:

PEO 1: GU Chemistry graduates will be well prepared for successful careers in the profession at industry and/or in government in one or more of the discipline of chemistry.

PEO 2: GU Chemistry graduates will be academically prepared to become licensed professional chemists in due course and contribute effectively to serving society.

PEO 3: GU Chemistry graduates will be engaged in professional activities to enhance their own achievement and contribute to humankind's service.

PEO 4: GU Chemistry graduates will be successful in higher education in Chemistry.

PEO 5: GU Chemistry graduates will provide leadership quality to work in all kinds of circumstances and diverse environments such as interdisciplinary and multidisciplinary learning systems.

Program Outcomes

Programme Outcomes (POs) are attributes of the graduates of the programme that are indicative of the graduates' ability and competence to work as science professional upon graduation. Program Outcomes are statements that describe what students are expected to know or be able to do by the time of graduation. They must relate to knowledge and skills that the students acquire from the programme. The achievement of all outcomes indicates that the student is well prepared to achieve the program educational objectives down the road. The following 12 POs have been chosen by the Chemistry Department of GITAM Deemed to be University. The B.Sc. Chemistry curriculum at GU has been designed to fully meet all the 12 Programme Outcomes. The students will be able to

- Apply knowledge of Chemistry to solution of complex scientific problems. (*Scientific knowledge*)
- Identify, formulate and analyze complex scientific problems using principles of chemistry. (*Problem analysis*)
- Propose of solutions for complex scientific problems and plan of chemical processes that meet the specified needs with appropriate considerations of public health and safety, and cultural, societal, and environmental considerations (*Design/development of solutions*)
- Use research based methods including analysis and interpretation of data and synthesis of chemical products leading to logical conclusions (*Conduct investigations of complex problems*)
- Create, select, and apply appropriate techniques, resources, and modern scientific and IT tools including prediction and modeling complex scientific activities with an understanding of limitations (*Modern tool usage*)
- Apply reasoning within the contextual knowledge to access societal, health, safety, legal, and cultural issues and the con-sequent responsibilities relevant to the professional scientific practice (*The chemist and society*)
- Understand the impact of the professional scientific solutions in the societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable developments (*Environment and sustainability*)
- Apply ethical principles and commit to professional ethics and responsibilities and norms of scientific practice (*Ethics*)
- Function effectively as an individual independently and as a member or leader in diverse teams, and in multidisciplinary settings (*Individual and team work*)
- Communicate effectively on complex scientific activities with the science community and with society at large such give and receive clear instructions (*Communication*)
- Demonstrate knowledge and understanding of scientific management principles and apply those to one's own work as a member of a team to manage projects in multidisciplinary environments (*Project management and finance*)

- Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (*Life-long Learning*).

Program Specific Outcomes

The Programme Specific Outcomes (PSOs) are specific statements that describe the professional career accomplishments that the program is designed. The PSOs of the B.Sc. Program in Chemistry are designed in such a way that at the end:

- GU Chemistry graduates will be able to understand the basic concepts related with organic chemistry covering various organic reagents and various types of reactions along with their mechanisms. Along with this, students will also learn practical aspects of organic chemistry specially elemental analysis and functional groups.
- GU Chemistry graduates will understand various topics of inorganic chemistry which will be a base to improve their career in the area of inorganic chemistry. Here student will learn various theories of inorganic chemistry and their application to define coordination complexes.
- GU Chemistry graduates will learn herein physical properties of various compounds through thermodynamics, electrochemical study, colligative properties etc.

CURRICULUM STRUCTURE OF B.Sc. CHEMISTRY

(2021-22 ADMITTED BATCH)

University Core (UC)

Course code	Level	Course title	L	T	P	S	J	C
CSEN1001	1	IT Productivity Tools^	0	0	2	0	0	1*
LANG1001	1	Communication Skills in English - Beginners	0	0	4	0	0	2*
LANG1011	1	Communication Skills in English	0	0	4	0	0	2
LANG1021	1	Advanced Communication Skills in English	0	0	4	0	0	2
CLAD1001	1	Emotional Intelligence & Reasoning Skills (Softskills 1)	0	0	2	0	0	1
CLAD1011	1	Leadership Skills & Quantitative Aptitude (Softskills 2)	0	0	2	0	0	1
CLAD1021	1	Verbal Ability & Quantitative Ability (Softskills 3)	0	0	2	0	0	1
CLAD1031	1	Practicing Verbal Ability & Quantitative Aptitude (Softskills 4)	0	0	2	0	0	1
VEDC1001	1	Venture Development	0	0	0	2	0	2
DOSP10XX	1	Sports 1#	0	0	0	2	0	2*
DOSL10XX	1	Club Activity#	0	0	0	2	0	2*
POLS1001	1	Indian Constitution and History	2	0	0	0	0	2*
PHPY1001	1	Gandhi for the 21st Century	2	0	0	0	0	2*
DOSL10XX	1	Community Service#	0	0	0	0	2	2*
ENVS1001	1	Environmental Studies^	3	0	0	0	0	3*
MFST1001	1	Health and Welbeing#	0	0	2	0	0	1*
CLAD20XX	2	Softskills 5A/5B/5C	0	0	2	0	0	1
CLAD20XX	2	Softskills 6A/6B/6C	0	0	2	0	0	1
FINA3001	3	Personal Financial Planning#	0	0	2	0	0	1*

* Pass/Fail courses

Opt any three courses among the five

^ Online/Swayam/NPTEL Courses

Softskills courses 5 and 6

Course code	Level	Course title	L	T	P	S	J	C
CLAD2001	2	Preparation for Campus Placement - 1 (Softskills 5A)	0	0	2	0	0	1
CLAD2011	2	Preparation For Higher Education (GRE/ GMAT) - 1 (Softskills 5B)	0	0	2	0	0	1
CLAD2021	2	Preparation for CAT/ MAT - 1 (Softskills 5C)	0	0	2	0	0	1
CLAD2031	2	Preparation For Campus Placement - 2 (Softskills 6A)	0	0	2	0	0	1
CLAD2041	2	Preparation For Higher Education (GRE/ GMAT) - 2 (Softskills 6B)	0	0	2	0	0	1
CLAD2051	2	Preparation for CAT/ MAT - 2 (Softskills 6C)	0	0	2	0	0	1

Sports courses

Course code	Level	Course title	L	T	P	S	J	C
DOSP1001	1	Badminton	0	0	0	2	0	2
DOSP1011	1	Chess	0	0	0	2	0	2
DOSP1021	1	Carrom	0	0	0	2	0	2
DOSP1031	1	Football	0	0	0	2	0	2
DOSP1041	1	Volleyball	0	0	0	2	0	2
DOSP1051	1	Kabaddi	0	0	0	2	0	2
DOSP1061	1	Kho Kho	0	0	0	2	0	2
DOSP1071	1	Table Tennis	0	0	0	2	0	2
DOSP1081	1	Handball	0	0	0	2	0	2
DOSP1091	1	Basketball	0	0	0	2	0	2
DOSP1101	1	Tennis	0	0	0	2	0	2
DOSP1111	1	Throwball	0	0	0	2	0	2

Club Activity courses

Course code	Level	Course title	L	T	P	S	J	C
DOSL1001	1	Club Activity (participant)	0	0	0	2	0	2
DOSL1011	1	Club Activity (Member of club)	0	0	0	2	0	2
DOSL1021	1	Club Activity (Leader of Club)	0	0	0	2	0	2
DOSL1031	1	Club Activity (Competitor)	0	0	0	2	0	2

Community Service courses

Course code	Level	Course title	L	T	P	S	J	C
DOSL1041	1	Community Services - Volunteer	0	0	0	0	2	2
DOSL1051	1	Community Services - Mobilizer	0	0	0	0	2	2

Faculty Core (FC)

Course code	Level	Course title	L	T	P	S	J	C
MATH1081	1	Mathematics for Science	3	0	0	0	0	3
PHYS1051	1	Physics I	3	0	0	0	0	3
MATH1111	1	Statistics	3	0	0	0	0	3
PHYS1061	1	Physics I Lab	0	0	2	0	0	1
PHYS1071	1	Physics II	3	0	0	0	0	3
CSCI1011	1	Programming with C	3	0	0	0	0	3
CSCI1021	1	Programming with C Lab	0	0	2	0	0	1
PHYS1081	1	Physics II Lab	0	0	2	0	0	1

Programme Core/ Major Core (PC/MaC)

Course code	Level	Course title	L	T	P	S	J	C
CHEM1061	1	Inorganic Chemistry I	3	0	0	0	0	3
CHEM1071	1	Inorganic Chemistry I Lab	0	0	2	0	0	1
CHEM1081	1	Physical Chemistry I	3	0	0	0	0	3
CHEM1091	1	Physical Chemistry I Lab	0	0	2	0	0	1
CHEM2001	2	Organic Chemistry I	3	0	0	0	0	3
CHEM2011	2	Organic Chemistry I Lab	0	0	2	0	0	1
CHEM2021	2	Inorganic Chemistry II	3	0	0	0	0	3
CHEM2031	2	Inorganic Chemistry II Lab	0	0	2	0	0	1
CHEM2041	2	Physical Chemistry II	3	0	0	0	0	3
CHEM2051	2	Physical Chemistry II Lab	0	0	2	0	0	1
CHEM3001	3	Organic Chemistry II	3	0	0	0	0	3
CHEM3011	3	Organic Chemistry II lab	0	0	2	0	0	1
CHEM3021	3	Analytical Chemistry	3	0	0	0	0	3
CHEM3031	3	Analytical Chemistry lab	0	0	2	0	0	1
CHEM3041	3	Green Chemistry	3	0	0	0	0	3
CHEM3051	3	Green Chemistry Lab	0	0	2	0	0	1

Programme Elective (PE)#

Course code	Level	Course title	L	T	P	S	J	C
CHEM2061	2	Concepts of Medicinal Chemistry	3	0	0	0	0	3
CHEM2071	2	Concepts of Medicinal Chemistry lab	0	0	2	0	0	1
CHEM2081	2	Fundamentals of Instrumental Methods of Analysis	3	0	0	0	0	3
CHEM2091	2	Fundamentals of Instrumental Methods of Analysis Lab	0	0	2	0	0	1
CHEM3071	2	Pharmaceutics 1	3	0	0	0	0	3
CHEM3081	2	Pharmaceutics 1 Lab	0	0	2	0	0	1
CHEM2101	2	Unit Operations in Chemical Engineering	3	0	0	0	0	3
CHEM2111	2	Industrial Chemicals and the Environment	3	0	0	0	0	3
CHEM2121	2	Industrial Safety, Chemical Technology & Society	3	0	0	0	0	3
	2	Concepts of Organometallic Chemistry & Catalysis						
CHEM2131	2	Electrochemistry	3	0	0	0	0	3
CHEM2141	2	Regulatory affairs and Quality assurance	3	0	0	0	0	3
CHEM2151	2	Chemical Process Calculations	3	0	0	0	0	3
CHEM3061	3	Nanochemistry	3	0	0	0	0	3
	3	Chemistry of Materials	3	0	0	0	0	3
	3	Bioorganic and bioinorganic chemistry	3	0	0	0	0	3
CHEM3101	3	Pharmaceutics 2	3	0	0	0	0	3

Note 1: Students should acquire a minimum of 16 credits from the program elective courses

Note 2: Theory and corresponding lab course are co-requisites (For example if a student opts to study CHEM2061 then he/she has to study CHEM2071 in the same semester)

Open Elective (OE)*

* Opt eligible Programme Elective (PE) courses from other programmes as an open elective courses and earn 18 credits

Eligible MINOR courses to be offered to the students of B.Sc Chemistry Program

Stream	Major course	Minor course (Select one) *
Chemical Sciences	Chemistry	Electronics
		Data Sciences
		Statistics
		Biotechnology
		Microbiology
		Biochemistry
		Mathematics
		Bioinformatics
		Food Science & Technology
		Environmental Science

Minor courses in Electronics

Course code	Level	Course title	L	T	P	S	J	C
PHYS1191	1	Electronic Devices & Circuits	3	0	0	0	0	3
PHYS1201	1	Electronic Devices & Circuits Lab	0	0	2	0	0	1
PHYS1211	2	Digital Electronics	3	0	0	0	0	3
PHYS2061	2	Analog & Digital IC Applications	3	0	0	0	0	3
PHYS2081	2	Basic Electronic Instrumentation	3	0	0	0	0	3
PHYS2101	2	Microcontrollers& Applications	3	0	0	0	0	3
PHYS2111	2	Microcontrollers& Applications Lab	0	0	2	0	0	1
PHYS3061	3	Electronic communications	3	0	0	0	0	3
PHYS3071	3	Electronic Communications Lab	0	0	2	0	0	1
PHYS3101	3	Introduction to Embedded systems	3	0	0	0	0	3

* Eligibility: This minor course is offered to the students of B.Sc Physics/ Mathematics/ Chemistry/ Statistics

Minor courses in Data Science

Course code	Level	Course title	L	T	P	S	J	C
CSCI1031	1	Introduction to Python Programming	3	0	0	0	0	2
CSCI1271	1	Introduction to Python Programming Lab	0	0	2	0	0	2
CSCI2311	2	Basics of Data Structures and Algorithms	3	0	0	0	0	3

Minor Courses in Microbiology

Course code	Level	Course title	L	T	P	S	J	C
MFST1051	1	Introductory Microbiology	3	0	0	0	0	3
MFST1061	1	Introductory Microbiology Practical	0	0	2	0	0	1
MFST1071	2	Microbial Genetics	3	0	0	0	0	3
MFST2061	2	Cell and Molecular Biology	3	0	0	0	0	3
MFST2071	2	Microbial Physiology and Biochemistry	3	0	0	0	0	3
MFST2081	2	Microbial Physiology and Biochemistry Practical	0	0	2	0	0	1
MFST3061	2	Immunology	3	0	0	0	0	3
MFST3071	3	Industrial Microbiology	3	0	0	0	0	3
MFST3091	3	Industrial Microbiology lab	0	0	2	0	0	1
MFST3101	3	Medical Microbiology	3	0	0	0	0	3

* Eligibility: This minor course is offered to the students of B.Sc Biochemistry/Biotechnology/Food Science & Tech/Environmental Science/Chemistry

Minor Courses in Biochemistry*

Course code	Level	Course title	L	T	P	S	J	C
BCBI1021	1	Protein Chemistry and Enzymology	3	0	0	0	0	3
BCBI1031	1	Protein Chemistry and Enzymology Lab	0	0	2	0	0	1
BCBI2001	2	Metabolism and Bioenergetics	3	0	0	0	0	3
BCBI2021	2	Biochemical Techniques	3	0	0	0	0	3
BCBI2041	2	Molecular Biology	3	0	0	0	0	3
BCBI2051	2	Molecular Biology Lab	0	0	2	0	0	1
BCBI3001	3	Genetic Engineering	3	0	0	0	0	3
BCBI3021	3	Clinical Biochemistry	3	0	0	0	0	3
BCBI3031	3	Clinical Biochemistry Lab	0	0	2	0	0	1
BCBI3041	3	Immunology	3	0	0	0	0	3

Minor courses in Mathematics

Course code	Level	Course title	L	T	P	S	J	C
MATH1231	1	Differential Equations	3	0	0	0	0	3
MATH1241	1	Differential Equations Lab	0	0	2	0	0	1
MATH2001	2	Real Analysis	3	0	0	0	0	3
MATH2011	2	Algebra	3	0	0	0	0	3
MATH2041	2	Linear Algebra	3	0	0	0	0	3
MATH2051	2	Linear Algebra Lab	0	0	2	0	0	1
MATH3011	3	Vector Calculus	3	0	0	0	0	3
MATH3001	3	Numerical Methods	3	0	0	0	0	3
MATH3021	3	Numerical Methods using MATLAB	0	0	2	0	0	1

MATH3041	3	Discrete Mathematics	3	0	0	0	0	3
* Eligibility: This minor course is offered to the students of B.Sc Physics/Electronics/Chemistry								

Minor Courses in Bioinformatics

Course code	Level	Course title	L	T	P	S	J	C
BCBI1081	1	Computational Biology	3	0	0	0	0	3
BCBI1091	1	Computational Biology Lab	0	0	2	0	0	1
CSCI1261	1	Basics of Python Programming	3	0	0	0	0	3
BCBI2241	2	Immunology and Immunoinformatics	3	0	0	0	0	3
CSCI2341	2	Fundamentals of Database Management System	3	0	0	0	0	3
BCBI2251	2	Genomics and Proteomics	3	0	0	0	0	3
BCBI2261	2	Genomics and Proteomics Lab	0	0	2	0	0	1
BCBI3151	3	Molecular Modeling and Structural Bioinformatics	3	0	0	0	0	3
BCBI3161	3	Molecular Modeling and Structural Bioinformatics Lab	0	0	2	0	0	1
BCBI3171	3	Drug Designing	3	0	0	0	0	3

Minor Courses in Food Science and Technology*

Course code	Level	Course title	L	T	P	S	J	C
MFST1001	1	Principles of Food Science	3	0	0	0	0	3
MFST1011	1	Principles of Food Science Practical	0	0	2	0	0	1
MFST1021	1	Fundamentals of Food Technology	3	0	0	0	0	3
MFST2001	2	Technology of Plantation Crops	3	0	0	0	0	3
MFST2011	2	Food Processing and Preservation Technology	3	0	0	0	0	3
MFST2031	2	Food Processing and Preservation Technology Practical	0	0	2	0	0	1
MFST2041	2	Food Microbiology	3	0	0	0	0	3
MFST3001	3	Technology of Animal Foods	3	0	0	0	0	3
MFST3021	3	Technology of Animal Foods Practical	3	0	0	0	0	3
MFST3011	3	Food Biochemistry	3	0	0	0	0	3

* Eligibility: This minor course is offered to the students of B.Sc Biochemistry/Microbiology/ Biotechnology/ Environmental Science/Chemistry

Minor courses in Environmental Science

Course code	Level	Course title	L	T	P	S	J	C
ENVS1011	1	Understanding Environment & Ecology	3	0	0	0	0	3
ENVS1021	1	Understanding Environment & Ecology Lab	0	0	2	0	0	1
ENVS1031	1	Environmental Chemistry	3	0	0	0	0	3
ENVS2021	2	Geological Sciences and its resources	3	0	0	0	0	3
ENVS2001	2	Air Pollution and Control	3	0	0	0	0	3
ENVS2041	2	Environmental Microbiology	3	0	0	0	0	3

ENVS2011	2	Air Pollution and Control Lab	0	0	2	0	0	1
ENVS3001	3	Solid Waste Management and Soil Pollution	3	0	0	0	0	3
ENVS3011	3	Solid Waste Management and Soil Pollution Lab	0	0	2	0	0	1
ENVS3041	3	Industrial Safety	3	0	0	0	0	3
* Eligibility: This minor course is offered to the students of B.Sc Biochemistry/Microbiology/Food Science & Tech/Biotechnology/Chemistry								

Allocation of credits for 3-year B.Sc Program

Type of Course	Credits	% of Program (in credits)
University Core	12	10%
Faculty Core	18	15%
Major Core	32	26%
Major Electives	16	14%
Program Minor	24	20%
Open elective	18	15%
Total	120	100%

CSEN1001: IT Productivity Tools

L	T	P	S	J	C
0	0	2	0	0	1*

This course introduces all software tools that improve the productivity of a student in enhancing his learning experience with all the activities taken up as part of his coursework.

Course Objectives

- to enable the learner, the skill in preparing technical documents of professional quality using docs, sheets and forms.
- to involve the student in designing and creating of websites and acquaint the student with the skill of processing audio, images, documents etc.
- to create awareness in analysing data using pivot tables, query manager etc.
- to create awareness in composing emails, mail merge, e-mail merge etc.
- to provide the exposure to work with collaborative tools.

List of Experiments

1. Create a typical document consisting of text, tables, pictures, multiple columns, with different page orientations.
2. Create a technical paper / technical report consisting of table of contents, table of figures, table of tables, bibliography, index, etc.
3. Compose and send customized mail / e-mail using mail-merge.
4. Create / modify a power point presentation with text, multimedia using templates with animation.
5. Create spreadsheet with basic calculations with relative reference, absolute reference and mixed reference methods.
6. Simple report preparation using filtering tool / advanced filtering commands / pivot tables in spreadsheet application.
7. Analyse the results of a examination studentwise, teacherwise, coursewise, institute-wise.
8. Collecting and consolidating data using collaborative tools like google docs, sheets, forms.
9. Create charts / pictures using online tools like: www.draw.io or smartdraw
10. Create a website of his interest.

Text Books:

1. Katherin Murray, 'Microsoft Office 365 Connect and collaborate virtually anywhere, anytime', Microsoft Press, ISBN: 978-0-7356-5694-9
2. EXCEL 2021 The Comprehensive Beginners to Advanced Users Guide to Master Microsoft Excel 2021. Learn the Essential Functions, New Features, Formulas, Tips and Tricks, and Many More
3. <https://drawio-app.com/tutorials/video-tutorials/>
4. Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics Fourth Edition ISBN-13: 978-1449319274

References/Online Resources

1. <https://www.coursera.org/learn/introduction-to-computers-and-office-productivity-software>
2. <https://www.coursera.org/projects/analyze-data-pivot-tables-crosstabs-google-sheets>
3. <https://www.coursera.org/learn/excel-advanced#syllabus>
4. <https://www.coursera.org/learn/how-to-create-a-website>
5. <https://support.microsoft.com/en-us/office>
6. <https://www.diagrams.net/>
7. <https://edu.google.com/>

Course Outcomes

- Create / alter documents / Technical Paper / Project report with text, pictures, graphs of different styles.
- Create / modify power point presentations with text, multimedia and to add animation using / creating templates.
- Perform basic calculations / retrieve data / create pivot tables / chart using a spreadsheet application.
- Create simple diagrams / charts using online tools like: www.draw.io .
- Manage documents, presentations, spreadsheets and websites in collaborative mode.

LANG1001: Communication Skills in English - Beginners

L	T	P	S	J	C
0	0	4	0	0	2*

Communication Skills in English (Beginner) is the first of the three-level courses for a developmental enhancement of learners' communication skills in English. This course focuses on giving learners exposure to factual level of comprehension (listening and reading) and application of the learning (Speaking/Writing) with an awareness for social and personality-based variations in communication. In addition to the LSRW skills, the focus of the course is on schematic thinking skills. This course is activity-based and practice-oriented in terms of procedural knowledge of vocabulary and grammatical structure. This syllabus is carefully developed to enable learners to engage in communication in English avoiding errors and be prepared for next level of learning English.

Course Objectives

- Train learners to listen actively, follow what is spoken in standard English, and answer questions to demonstrate their understanding of the main points of the speech, repeat part of what someone has said to confirm mutual understanding, though occasionally, there may be a need to ask for repetition or clarification. (Bloom's Taxonomy Level/s: 2 & 3)
- Equip learners with the skills to read and comprehend straightforward texts and simple argumentative writing to identify the topic, the desired/relevant information, the main points of the argument, and the major conclusion/s. (Bloom's Taxonomy Level/s: 2 & 4)
- Help learners apply their knowledge and language skills to make mini oral presentations, and produce short coherent written texts using appropriate cohesive devices, suitable vocabulary and grammatical structures. (Bloom's Taxonomy Level/s:3)
- Enable learners to communicate with reasonable accuracy in familiar contexts with adequate fluency and generally good control by equipping them with a repertoire of frequently used vocabulary, structures, and speech patterns. (Bloom's Taxonomy Level/s: 2 & 3)

List of Activities & Tasks for Assessment

1. Listening to others and getting to know their experiences, interests and opinions
2. Introducing oneself: Salutation, basic information, relating to the context
3. Starting a conversation: Salutation, expressing purpose, expressing gratitude
4. Sharing one's experiences, interests and opinions
5. Reading short newspaper articles for gist
6. Picking new words from an article and working on them to know the meaning and usage
7. Using the new (unknown) words in own sentences
8. Sharing news with others - initiate, sustain and conclude
9. Understanding the relevance of intonation to meaning from recorded conversations, and applying the learning in pair work (role play)
10. Writing a summary of a story/personal narrative after listening to it twice and making individual notes
11. Reading graphs, charts and maps for specific information, making note of the important information and talking briefly about it within a small peer group
12. Writing a paragraph about oneself: a brief profile including major successes, failures, and goals. Giving compliments/gratitude to others

13. Writing a paragraph (descriptive, complimentary) about others (Family, friends, role model, etc.)
14. Correcting each other's drafts: errors in language - word choice, structure, and conventions/etiquette
15. Writing a short structured descriptive/narrative essay in 3 paragraphs, reading others' essays and sharing feedback

References

1. V. Sasikumar, P. Kiranmayi Dutt, Geetha Rajeevan. (2007). Listening and Speaking - Foundation Books Cunninham, S. & Moor, P. (nd). New Cutting Hedge (Intermediate). Longman
2. Cambridge Academic English: An Integrated Skills Course for EAP (Intermediate) By Craig Thaine, CUP (2012)
3. Rutherford, Andrea J. (2007). Basic Communication Skills for Technology: Second Edition. Delhi: Pearson Education.
4. McCarthy, M., O'Dell, F., Mark, G. (2005). English Vocabulary in Use. Spain: Cambridge University Press.
5. New Headway Academic Skills: Reading, Writing, and Study Skills Student's Book, Level-1 by Sarah Philpot. OUP
6. Philpot, S. & Curnick, L. (2017). Headway: Academic Skills: Reaing, Writing, and Study Skills. Introductory Level. OUP.
7. Thaine, C. (2012). Cambridge Academic English: An Integrated Skills for EAP . Intermediate. CUP.

Online References

- www.teachingenglish.org.uk
- learnenglishteens.britishcouncil.org
- <https://eslflow.com/>
- <https://www.englishclub.com/>
- <https://www.oxfordlearnersdictionaries.com/>
- <https://dictionary.cambridge.org/>
- learnenglishteens.britishcouncil.org
- <https://freerice.com/categories/english-vocabulary>

Course Outcomes

- Listen actively, understand and extract the essential information from short talks/conversations/discussions that are delivered in clear, standard speech. (Bloom's Taxonomy Level/s: 2 & 3)
- Read, understand, and extract specific information from straightforward factual and simple argumentative texts on general topics and subjects of interest. (Bloom's Taxonomy Level/s: 2 & 3)
- Speak clearly with some confidence on matters related to his/her interests and academic work, and make short structured oral presentations on topics of personal interest. (Bloom's Taxonomy Level/s: 3)
- Write short straightforward connected texts on a range of familiar/general topics using appropriate linking devices to achieve a clear sequence of ideas. (Bloom's Taxonomy Level/s: 3)
- Acquire sufficient language competency to express oneself in speech and writing with some confidence, using appropriate vocabulary and simple grammatical structures though lexical limitations and/or difficulty with formulation might be evident at times. (Bloom's Taxonomy Level/s: 2 & 4)

LANG1011: Communication Skills in English

L	T	P	S	J	C
0	0	4	0	0	2

Communication Skills in English (Intermediate) is the second of the three-level graded courses for a developmental enhancement of communication skills in English. Based on the learning outcomes set in the beginner level syllabus, this course focuses on giving learners more exposure to the use of language for communicative purposes and equip them with next level skills (ref. Bloom's taxonomy) and practice in terms of complexity and cognitive engagement. This course also includes inferential level of comprehension (listening and reading) that involves analysis and application of the language skills and decision-making skills while speaking/writing with an awareness for social and personality-based variations in communication. This course emphasizes guided writing through adequate tasks with pre and post context building. The focus is on stimulation and application of critical thinking in addition to schematic thinking for communication in real-life situations.

Course Objectives

- Train learners to actively listen to short audio texts with familiar content; guided activity like question-making and responding to others' questions based on the audio text would help learners engage in transactional dialogue; extended activities like extrapolating/critiquing the responses would help learners enhance their schematic thinking. (Bloom's Taxonomy Level/s: 2 & 4)
- Equip learners with strategies to read actively and critically and understand the writers' viewpoints and attitude by providing reading comprehension tasks using authentic texts such as op-ed articles from newspapers, and reports on contemporary problems. (Bloom's Taxonomy Level/s: 4 & 5)
- Help learners understand various aspects and techniques of effective presentations (group/individual) through demonstration and modelling, and enabling them to develop their presentation skills by providing training in using the tips and strategies given. Learners would be encouraged to observe and express opinion on teacher-modelling. Reflection on issues like anxiety, stage-fear, confidence, and levels of familiarity with topic and audience would be addressed. Practice would be given on tone, pitch, clarity and other speech aspects. Detailed peer feedback and instructor's feedback would cover all the significant aspects. (Bloom's Taxonomy Level/s: 2 & 4)
- Enable learners to become aware of the structure and conventions of academic writing through reading, demonstration, scaffolding activities, and discussion. Corrective individual feedback would be given to the learners on their writing. (Bloom's Taxonomy Level/s: 2 & 3)

List of Tasks and Activities

S. No.	Tasks	Activities
1	Listening to subject related short discussions/ explanations/ speech for comprehension	Pre-reading group discussion, Silent reading (Note-making), Modelling (questioning), Post-reading reflection /Presentation
2	Asking for information: asking questions related to the content, context maintaining modalities	Group role-play in a context (i.e. Identifying the situation and different roles and enacting their roles)

3	Information transfer: Verbal to visual (familiar context), demonstration by teacher, learners' task (guided with scaffolding), learners' task (free), presentation and feedback	Pair work for discussion & feedback, Presentations, question-answer
4	Information transfer: Visual to verbal (unfamiliar context); demonstration by teacher, learners' task (guided with scaffolding), learners' task (free), presentation and feedback	Pre-reading game/modelling, discussion in small groups, individual writing, and feedback
5	Introducing officials to peers and vice versa - Formal context	AV support, noticing, individual performance (3-4), pair work (in context), teacher modelling, group work for Introducing self and others in a formal context
6	Introducing friends to family and vice versa - Informal context	Teacher modelling/AV support, noticing structure & note-taking, Introducing friends and family in an informal context
7	Vocabulary in context: Find clues in a text and use them to guess the meaning of words/phrases. Apply the newly learnt vocabulary in communication (speaking and writing).	Comprehending verbal communication: Identifying the contextual clues in oral and written texts; guessing the meaning of words/phrases in context while reading texts and listening to discussions/talks
8	A five-day journal (diary) writing based on learners reading from newspaper on a single relevant/current social issue. Individual oral presentation and feedback from peers and instructor.	Note-making (group work), Discussion, Feedback
9	Follow the essentials of lectures, talks, discussions, reports and other forms of academic presentations and make individual and group presentations aided with images, audio, video, tabular data, etc.	Making power point presentation aided with images, audio, video, etc. with a small group by listening to academic lectures/talks/ discussions, etc.
10	Self-reflection: Re-reading one's own drafts, identifying errors, correcting the errors, and giving rationalize the changes	Pre-task discussion/modelling, Editing the texts by careful reading and identifying the errors, peer-exchange (Pair work), feedback/consolidation
11	Collaborative work (speaking and writing) in small groups of 3 or 4 learners: discussing a general/discipline-specific topic: creating outline, assigning specific roles to members of the group; and group presentation followed by peer and instructor feedback	Pre-task modelling (peer/teacher), general discussion on structure, group work (collaboration), feedback
12	Independent reading of different text types using appropriate reference sources by adapting suitable reading styles and speed. Focus on active reading for vocabulary: low-frequency collocations and idiomatic expressions.	Brain-storming, mapping of key terms (content specific), reading and note-making (individual), oral questioning, discussion
13	Role-play (specific social and academic situations): planning (making notes), understanding nuances of speaking in context, coordinating with situational clues and fellow speakers/participants	Peer discussion for outline, A-V support, observing (teacher modelling), role play (guided), role-play (free), feedback
14	Writing instructions: Guidelines - Flowcharts - Procedures to be followed	Pre-task reading, pair work, teacher/peer-discussion, feedback
15	Speaking spontaneously on topics of interest and writing short structured essays on the same topics adopting appropriate academic conventions and grammatical accuracy.	Reading for task preparation, note-making, speaking, reflection and corrective peer and teacher feedback

Reference Books

1. P. Kiranmayi Dutt, Geetha Rajeevan. (2007). Basic Communication Skills. Foundation Books. CUP
2. Harmer, J. (1998). How to teach English. Longman
3. Sanjay Kumar & Pushp Lata. (2018). Communication Skills: A Workbook. OUP.
4. Cambridge IGCSE: English as a Second Language Teacher's Book Fourth Edition. By Peter Lucantoni. CUP (2014).
5. Cambridge Academic English: An Integrated Skills Course for EAP (Upper Intermediate) By Martin Hewings, CUP (2012)
6. Richards, J.C. and Bohlke, D. (2012). Four Corners-3. Cambridge: CUP.
7. Headway Academic Skills: Reading, Writing, and Study Skills Student's Book, Level-2 by Sarah Philpot. OUP
8. Latham-Koenig, C. & Oxenden, C. (2014). American English File. Oxford: OUP.
9. McCarthy, M. & O' Dell. F. (2016). Academic Vocabulary in Use. Cambridge: CUP

Online Resources

1. <https://www.grammarly.com/blog/>
2. <https://www.nationalgeographic.org/education/>
3. <https://www.bbc.co.uk/teach/skillswise/english/zjg4scw>
4. <https://www.englishclub.com/>
5. <https://www.oxfordlearnersdictionaries.com/>
6. <https://dictionary.cambridge.org/>
7. learnenglishteens.britishcouncil.org
8. <https://freerice.com/categories/english-vocabulary>
9. <http://www.5minuteenglish.com/>
10. <https://breakingnewsenglish.com/>
11. <https://www.digitalbook.io/>
12. <https://librivox.org/>

Course Outcomes

- Understand the speaker's point of view in fairly extended talks on general or discipline-specific topics, and follow simple lines of argument in discussions on familiar contemporary issues. (Bloom's Taxonomy Level/s: 3)
- "Read and demonstrate understanding of articles and reports on limited range of contemporary issues in which the writers adopt particular stances. Also provide samples of written communication containing fairly complex information and reasons for choices/opinions/stances. (Bloom's Taxonomy Level/s: 2 & 3)"
- Make short presentations on a limited range of general topics using slides, and engage in small group discussions sharing experiences/views on familiar contemporary issues and give reasons for choices/opinions/plans. (Bloom's Taxonomy Level/s: 3 & 4)
- Write clear, fairly detailed text (a short essay) on a limited range of general topics, and subjects of interest, and communicate clearly through email/letter to seek/pass on information or give reasons for choices/opinions/plans/actions. (Bloom's Taxonomy Level/s: 3)
- Reflect on others' performance, give peer feedback on fellow learners' presentations, responses to writing tasks and reading comprehension questions. (Bloom's Taxonomy Level/s: 5)

LANG1021: Advanced Communication Skills in English

L	T	P	S	J	C
0	0	4	0	0	2

Communication Skills in English (Advanced) is the third of the three-level graded courses for a developmental enhancement of communication skills in English. Based on the learning outcomes set in the upper-intermediate syllabus, this course focuses on giving learners exposure to higher level of skills/input processing (ref. Bloom's taxonomy) and practice in terms of complexity and cognitive engagement. This course includes advanced level of comprehension i.e. analytical, evaluative and extra-polative processing (listening and reading) and involves problem-solving, logical reasoning and decision-making skills in terms of application of the learning (speaking/writing) with an awareness for social and personality based variations in communication. This course provides opportunities with activity-based practice of advanced oral and written communicative skills besides building awareness on the finer nuances of language use for various purposes. This course emphasizes free writing through meaningfully engaging tasks with a pre and post context building. There is ample scope for application of critical thinking through simulated activities for effective communication in real life situations.

Course Objectives

1. Enable learners to listen actively become aware of tone and attitude in speech, and demonstrate their comprehension of fairly complex lines of argument presented by a variety of speakers in talks/presentations/discussions. (Bloom's Taxonomy Level/s: 2 & 4)
2. Enable learners to become aware of tone and attitude in written texts, and demonstrate their comprehension of fairly complex lines of argument and points of view presented in a variety of texts by equipping them with upper intermediate to advanced level reading skills and strategies. (Bloom's Taxonomy Level/s: 2 & 3)
3. Make effective presentations, engage in formal group discussions, and write structured essays/ short reports to highlight the significance of actions/decisions/experiences, and sustain views by providing relevant evidence and argument. (Bloom's Taxonomy Level/s: 3 & 4)
4. Equip learners with the skills and strategies to communicate effectively in speech and writing using the language with a degree of fluency, accuracy and spontaneity, and fairly good grammatical control adopting a level of formality appropriate to the context. Encourage learners to apply their knowledge of language and their communication skills in real life situations. (Bloom's Taxonomy Level/s: 3 & 5)

List of Activities & Tasks for Assessment

S.No.	Tasks	Activities	CO
1	Evaluative and extrapolative reading of a long text/short texts on a current topic related to technology and society, identifying and questioning the author's intention, post-reading discussion in small groups, maintaining group dynamics, arriving at a consensus	Pre-reading group discussion, silent reading (Note-making), modelling (questioning), post-reading reflection and brief presentation of thoughts/ideas/opinions on the theme of the text	3
2	Debate in pairs based on listening to two recorded contemporary speeches by well-known leaders in different fields. Peer feedback and instructor feedback.	Pre-recorded audio/video for listening, student checklist for noticing key words/concepts, pre-task orientation (by teacher), pair work, feedback	1
3	Information transfer: Verbal to visual (unfamiliar context); demonstration by teacher, learners' task (guided with scaffolding), learners' task (free), presentation, question-answer (among students), modification and feedback before the final version is done	Pair work for discussion and feedback, presentations, question-answer	2
4	Information transfer: Visual to verbal (unfamiliar context); demonstration by teacher, learners' task (guided with scaffolding), learners' task (free), presentation, question-answer (among students), modification, editing, proofreading, and feedback before the final version is done	Pre-reading game/modelling, discussion in small groups, independent writing and feedback	4
5	Expressing opinion on a short argumentative text (e.g. a journal article or a newspaper editorial) and justifying one's opinion/stance; focus on the use of appropriate conventions of formal and polite speech, and managing bias	Listening to group discussions/debates, reading news-paper articles on the current issues and expressing opinions in favour or against the topic (in GDs, debates or writing argumentative essays).	3
6	Role-play (complex social and academic/professional situations): Focus on significant aspects of delivery including clarity, tone, and use of contextually appropriate vocabulary and conventions, observation, reflective discussion, and self-reflective writing	Reading newspaper/magazine articles/blog posts on current social issues, listening to talks/discussions/debates etc. and participating in role-plays using expressions appropriate to the context.	1
7	Collaborative writing in groups of 3 -4 on topics that would require data collection and reading followed by recorded peer-reflection and peer-feedback, group presentation and feedback	Pre-task modelling (peer), general discussion on structure, group work (collaboration), presentation, peer feedback, Open-class discussion	5
8	Formal Group Discussion on topics of current interest and relevance; focus on effective participation, reflection on control over argument/counter argument, and adherence to the conventions of formal GD	Noticing strategies from AV modelling, teacher scaffolding through open-house discussion, Note-making (Group work), Group Discussion (free), post performance discussion, Feedback	2

9	Mind-mapping for advanced reading, making correlations across texts, extending author's point of view	Reading texts on abstract topics and comprehending the author's perspective by inferring the unknown words' meaning in the context and making notes using mind-map strategy and presenting it orally.	3
10	Handling question and answer sessions after presentations: justifying arguments, taking counter-arguments, agreeing and disagreeing with rationale	Listening to some lectures, talks, and presentations in the academic seminars and adapting some strategies to handle the Q&A sessions using polite and formal expressions to agree or disagree with the statements.	1
11	Modelling an interview: with a panel of four judges (peers)	Pre-task activity for orientation/strategies (controlled/guided), Model interview (AV support), Group work (role play), interview in pair (one-to-one), Interview in group (many -to-one), oral corrective feedback (peer/teacher)	2
12	Writing a short reflective report of an event - incident/meeting/celebration	Writing a report on meetings/celebrations/events etc. by actively involving in such events and giving a short oral presentation on the same.	4
13	Speaking on abstract and complex topics beyond his/her own area of interest/field of study, using the language flexibly and effectively.	Reading texts on abstract topics and comprehending the author's perspectives. Similarly, listening to talks and discussions on an abstract topic of other discipline and making short oral presentation by sharing views and opinions.	3
14	Self-reflection on own speech in context(recorded): tone, pitch, relevance, content; extending the reflections/ideas to others	Listening to selected general discussions (audios and videos) and observing the language production. Recording own speech on some general topic and providing a critical review (self-reflection) on it by focusing on the tone, expressions and relevance of the content, etc.	1
15	Collaborative and individual task: planning, preparing (preparing an outline, structure, setting objectives and presenting the plan of action) and executing a mini-project, and submitting a brief report on the same peer and instructor feedback after the planning stage and on completion of the mini project	Pre-task modelling (peer/teacher), general discussion on structure, group work (collaboration), oral corrective, task distribution, presentation, feedback	5

Reference Books

1. Latham-Koenig, C. & Oxenden, C. (2014). American English File-5. Oxford: OUPRichards,
2. J.C. and Bohlke, D. (2012). Four Corners-4. Cambridge: CUP.
3. Cambridge Academic English: An Integrated Skills Course for EAP (Advanced) By Martin Hewings and Craig Thaine, CUP (2012)

4. Berlin, A. (2016). 50 Conversation Classes: 50 Sets of Conversation Cards With an Accompanying Activity Sheet Containing Vocabulary, Idioms and Grammar. Poland: CreateSpace Independent Publishing Platform
5. Zemach, D. E., Islam, C. (2011). Writing Paragraphs: From Sentence to Paragraph. Germany: Macmillan Education.
6. Stewart, J. P., Fulop, D. (2019). Mastering the Art of Oral Presentations: Winning Orals, Speeches, and Stand-Up Presentations. United Kingdom: Wiley.
7. Kroehnert, Gary. (2010). Basic Presentation Skills. Sidney: McGraw Hill.
8. Cunningham, S. & Moor, P. (nd). Cutting Edge (Advanced) With Phrase Builder. Longman Publishers. CUP
9. McCarthy, M & O'Dell, F. (2017). English Idioms in Use (Advanced). Cambridge: CUP.

Online Resources

1. <https://www.grammarly.com/blog/>
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4. <https://www.englishclub.com/>
5. <https://www.oxfordlearnersdictionaries.com/>
6. <https://dictionary.cambridge.org/>
7. learnenglishteens.britishcouncil.org
8. <https://freerice.com/categories/english-vocabulary>
9. <http://www.5minuteenglish.com/>
10. <https://breakingnewsenglish.com/>
11. <https://www.digitalbook.io/>
12. <https://librivox.org/>

Course Outcomes

- Listen to extended lectures, presentations, and discussions on a wide range of contemporary issues and demonstrate understanding of relatively complex lines of argument. (Bloom's Taxonomy Level/s: 2)
- Make presentations using suitable AV aids and engage in formal group discussions on a wide range of topics of contemporary interest, demonstrating awareness of standard/widely accepted conventions. (Bloom's Taxonomy Level/s: 3)
- Read and demonstrate understanding of the writer's stance/viewpoint in articles and reports on a wide range of contemporary issues and discipline-specific subjects. (Bloom's Taxonomy Level/s: 2 & 4)
- Write analytical essays on a wide range of general topics/subjects of interest, and engage in written communication (emails/concise reports) to exchange relatively complex information, giving reasons in support of or against a particular stance/point of view. (Bloom's Taxonomy Level/s: 3 & 4)
- Complete a mini project that necessitates the use of fairly advanced communication skills to accomplish a variety of tasks and submit a report in the given format. (Bloom's Taxonomy Level/s: 4 & 5)

CLAD1001: Emotional Intelligence & Reasoning Skills (Soft Skills 1)

L	T	P	S	J	C
0	0	2	0	0	1

Course Description:

Emotional intelligence is a set of skills that are thought to contribute to the appraisal of emotions in oneself and others. It can also help contribute to the effective regulation of emotions as well as feelings (Salovey & Mayer, 1990). In terms of emotional intelligence, self-awareness and self-management have to do with our ability to relate to ourselves. Social awareness and relationship management have to do with our ability to relate to others. Similarly, the ability to solve questions on Analytical Reasoning and Data Sufficiency is a critical area tested in almost all competitive examinations and admission tests. Upon completion, students should be able (1) to deal with their own emotions as well as the emotions of others and relate better with both. Using better knowledge of EI, students will also be able to set more meaningful goals for themselves, choose suitable time management techniques that work best for them and work in teams more effectively. (2) to apply different concepts, ideas and methods to solve questions in reasoning and data sufficiency

Course Objectives:

1. Use EI to relate more effectively to themselves, their colleagues and to others. Apply self awareness and self assessment (SWOT) to better understand and manage their own emotions. Apply social awareness to empathize with others and build stronger relationships with others.
2. Set meaningful goals based on their strengths and weaknesses and apply time management techniques, such as Q4 organizing to put first things first.
3. Manage conflicts and work in teams in an emotionally intelligent manner.
4. Solve questions on non-verbal and analytical reasoning, data sufficiency and puzzles

Unit	Topics	Hours
1	Self Awareness & Self Regulation: Introduction to Emotional Intelligence, <i>Self Awareness</i> : Self Motivation, Accurate Self Assessment (SWOT Analysis), Self Regulation: <i>Self Control, Trustworthiness & Adaptability</i>	3
2	Importance, Practising Social Awareness, Building Relationships, Healthy and Unhealthy Relationships, Relationship Management Competencies- Influence, Empathy, Communication, Types of Conflicts, Causes, Conflict Management	3
3	Social Media: Creating a blog, use of messaging applications, creating a website to showcase individual talent, creation of a LinkedIn Profile	2
4	Goal Setting & Time Management: Setting SMART Goals, Time Wasters, Prioritization, Urgent Vs Important, Q2 Organization	3
5	Teamwork: Team Spirit, Difference Between Effective and Ineffective Teams, Characteristics of High Performance Teams, Team Bonding, Persuasion, Team Culture, Building Trust, Emotional Bank Account	4
6	Verbal Reasoning: Introduction, Coding-decoding, Blood relations, Ranking, Directions, Group Reasoning	6
7	Analytical Reasoning: Cubes and Dices, Counting of Geometrical figures	3
8	Logical Deduction: Venn diagrams, Syllogisms, Data Sufficiency, Binary logic	4
9	Spatial Reasoning: Shapes, Paper Cutting/Folding, Mirror images, Water images and Rotation of figures	2
	Total Hours	30

Course Outcomes

- Students will be able to relate more effectively to themselves, their colleagues and to others
- Students will be able to set their short term and long term goals and better manage their time
- Students will be able to manage conflicts in an emotionally intelligent manner and work in teams effectively
- Students will be able to solve questions based on non-verbal and analytical reasoning, data sufficiency and puzzle

References:

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

CLAD1011: Leadership Skills & Quantitative Aptitude (Soft Skills 2)

L T P S J C
0 0 2 0 0 1

Course Description:

Communication Skills is having the ability to convey information to others so that messages are understood and outcomes delivered. Some essential qualities of Communication Skills include understanding the needs of others, clearly communicating messages, adapting the communication style, and using a range of communication methods. Presentation Skills is having the ability to confidently deliver an engaging message to a group of people which achieves the objectives. Some essential qualities of Presentation Skills include a thorough preparation of content, structuring content logically, managing nerves, engaging your audience, delivering presentation objectives, positively influencing the audience, and responding to audience needs. Tackling questions based on numbers, arithmetic, data interpretation and puzzles requires the application of different rules and concepts of numerical computation, numerical estimation, and data estimation.

Course Objectives:

1. Learn and apply, through different individual and group activities, different ideas and skills to communicate in a positive and impressive manner.
2. Apply the goal setting process (based on SWOT) and Q2 organizing for effective time management.
3. Apply different concepts in numbers, numerical computation and numerical estimation to solve questions that often appear in various competitive examinations and admission tests.
4. Apply different concepts for tackling questions based on data interpretation, progression and series that are frequently given in various competitive examinations and admission tests.

Unit	Topics	Hours
1	Communication Skills: <i>The Communication Process</i> , Elements of Interpersonal Communication, <i>Non-Verbal Communication</i> : Body Language, Posture, Eye Contact, Smile, Tone of Voice, <i>Barriers to Communication</i> . Effective Listening Skills: Active Listening, Passive Listening, Asking Questions, Empathizing, Being Non Judgemental, Being Open Minded, Mass Communication: Design of Posters, Advertisements, notices, writing formal and informal invitations	5
2	Focus on Audience Needs, Focus on the Core Message, Use Body Language and Voice, Start Strongly, Organizing Ideas & Using Visual Aids: SPAM Model, Effective Opening and Closing Techniques, Guy Kawasaki's Rule (10-20-30 Rule), Overcoming Stage Fear, Story Telling	3
3	Problem Solving & Decision Making: Difference Between the Two, Steps in Rational Approach to Problem Solving: Defining the Problem, Identifying the Root Causes, Generating Alternative Solutions, Evaluating and Selecting Solutions, Implementing and Following-Up, Case Studies	3

4	Group Discussion: Understanding GD, Evaluation Criteria, Nine Essential Qualities for Success, Positive and Negative Roles, Mind Mapping, Structuring a Response, Methods of Generating Fresh Ideas	4
5	Number Theory: Number System, Divisibility rules, Remainders and LCM & HCF	3
6	Numerical Computation and Estimation - I : Chain Rule, Ratio Proportions, Partnerships & Averages, Percentages, Profit-Loss & Discounts, Mixtures, Problems on Numbers & ages	6
7	Data Interpretation: Interpretation and analysis of data in Tables, Caselets, Line-graphs, Pie-graphs, Box-plots, Scatter-plots and Data Sufficiency	3
8	Mental Ability: Series(Number, Letter and Alphanumeric), Analogy(Number, Letter and Alphanumeric) and Classifications	3
	Total Hours	30

Course Outcomes

- Students will be able to communicate 'one-on-one' and 'one-on-many' confidently using both verbal and non-verbal messages and deliver impressive talks/ presentations to a group both with and without the use of PPTs and create posters, advertisements, etc.
- Students will be able to apply the the rational model of problem solving and decision making in their problem solving and decision making efforts.
- Students will be able to solve questions based on numbers and arithmetic given in various competitive examinations
- Students will be able to solve questions based on data interpretation, progressions and series.

References:

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

CLAD1021: Verbal Ability & Quantitative Ability (Soft Skills 3)

L	T	P	S	J	C
0	0	2	0	0	1

Course Description:

Vocabulary is an important part of verbal ability. An understanding of word formation, prefixes, suffixes and roots is necessary to remember and use a vast repository of words. Approaching words through word families and other ways of groupings is an effective way of gaining mastery over vocabulary. Understanding and getting acquainted with the different rules and exceptions in the use of grammar and structure, especially from the relevant examination point of view, is crucial to cracking questions given in many competitive tests. Similarly, improving reading comprehension skills and test taking abilities in this area takes time and effort, especially given the fact that most students do not possess strong reading habits. In so far as quantitative aptitude is concerned, students need to develop a strong foundation on the basic mathematical concepts of numerical estimation, geometry, mensuration, data sufficiency, etc. to be able to crack different round 1 tests of major recruiters and admission tests of top Indian and foreign universities.

Course Objectives:

1. List and discuss the different word formation methods, word denotation, connotation, collocation, etc. and introduce selected high frequency words, their antonyms, synonyms, etc
 2. Apply different advanced reading skills to solve questions based on author's tone, main ideas and sub-ideas, inferences, parajumbles, etc. that are frequently asked in various competitive exams and admission tests.
 3. Solve different types of questions based on vocabulary, such as word analogy; structure, grammar and verbal reasoning; introduce common errors and their detection and correction.
 4. Solve questions on numerical estimation, mensuration, data sufficiency based on quantitative aptitude. This includes questions on time and work, time and distance, pipes and cisterns, lines and angles, triangles, quadrilaterals, polygons and circles, 2 & 3 dimensional mensuration.
-
1. **Vocabulary Builder:** Understanding Word Formation, Prefixes, Suffixes and Roots, Etymology, Word Denotation, Connotation and Collocation, Synonyms and Antonyms
 2. **Reading Comprehension:** Advanced Reading Comprehension: Types of RC passages, Types of Text Structures, Types of RC Questions: Distinguishing Between Major Ideas and Sub Ideas, Identifying the Tone and Purpose of the Author, Reading Between the Lines and Beyond the Lines, Techniques for Answering Different Types of Questions
 3. **Para Jumbles:** Coherence and Cohesion, Idea Organization Styles, Concept of Mandatory Pairs and Its Application: Transitional Words, Antecedent-Pronoun Reference, Article Reference, Cause and Effect, Chronological Order, General to Specific, Specify to General, Idea-Example, Idea-Explanation, Etc.

4. **Grammar Usage:** Rules Governing the Usage of Nouns, Pronouns, Adjectives, Adverbs, Conjunctions, Prepositions and Articles
5. **Numerical Computation and Estimation - II:** Time and Work, Pipes and Cisterns, Time and Distance, Problems on Trains, Boats and Streams, Races and Games of Skill, Simple Interest & Compound Interest
6. **Geometry:** Lines and Angles, Triangles, Quadrilaterals & Polygons, and Circles
7. **Mensuration:** 2-Dimensional Mensuration (Triangles, Quadrilaterals and Circles), 3-Dimensional Mensuration (Cubes, Cuboids, Cylinder, Cone, Sphere)

Course Outcomes:

1. List and discuss word formation methods, selected high frequency words, their antonyms, synonyms, etc.
2. Analyze reading passages and quickly find out the correct responses to questions asked, including para jumbles, by using reading skills like skimming, scanning, reading between the lines, etc.
3. Solve different types of questions based on vocabulary, structure, grammar and verbal reasoning
4. Solve questions on numerical estimation, mensuration, data sufficiency based on quantitative aptitude

References:

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

CLAD1031: Practicing Verbal Ability & Quantitative Aptitude (Soft Skills 4)

L	T	P	S	J	C
0	0	2	0	0	1

Course Description:

A sound knowledge of the rules of English grammar, structure and style and its application in detecting errors in writing are important areas of Verbal Ability frequently tested as a part of the written test in many competitive examinations and admission tests of major recruiters and universities respectively. This module focuses on all important areas of grammar and structure commonly asked in major tests, such as GMAT, CAT, XLRI, CRT, etc. Similarly, in the area of Quantitative Aptitude, different kinds of questions are asked from Combinatorics (Permutations & Combinations, Probability], Cryptarithmic & Modular Arithmetic (Cryptarithmic, Application of base system (7, 24), Clocks (Base 24), Calendars (Base 7), and Mental Ability (Number series, Letter series & Alpha numeric series, Analogies (Numbers, letters), Classifications, Algebra (Exponents, Logarithms, Problems related to Equations, Special Equations, and Statistics) . This module focuses on all these areas by building on what the students already learnt in their earlier studies.

Course Objectives:

1. Apply the rules of grammar to solve questions in Error Detection, Sentence Correction and Sentence Improvement.
 2. Apply the rules of structure to solve questions in Error Detection, Sentence Correction and Sentence Improvement, Fill-in-blanks and Cloze Passages.
 3. Explain methods of solving problems in Combinatorics (Permutations & Combinations, Probability], Cryptarithmic & Modular Arithmetic (Cryptarithmic, Application of base system (7, 24), Clocks (Base 24), Calendars (Base 7)]
 4. Explain how to solve questions in Mental Ability (Number series, Letter series & Alpha numeric series, Analogies, Numbers, letters, Classifications] and Algebra (Exponents, Logarithms, Problems related to Equations, Special Equations, Statistics)
-
1. Error Detection: Pronouns, Conjunctions, Prepositions and Articles
 2. Error Detection: Tenses and their Uses
 3. Sentence Correction: Subject-Verb Agreement, Antecedent-Pronoun Agreement, Conditional Clauses
 4. Sentence Correction: Modifiers (Misplaced and Dangling) & Determiners, Parallelism & Word Order, and Degrees of Comparison
 5. Combinatorics: Permutations & Combinations, Probability

6. Crypt arithmetic & Modular Arithmetic: Crypt arithmetic, Application of Base System (7, 24), Clocks (Base 24), Calendars (Base 7)
7. Algebra: Exponents, Logarithms, Word-problems related to equations, Special Equations, Progressions, Statistics

Course Outcomes:

1. Identify and correct errors in English grammar and sentence construction
2. Identify and correct errors in Structure, Style and Composition
3. Solve problems in Combinatorics, Cryptarithmic, and Modular Arithmetic
4. Solve problems in Mental Ability and Algebra

References:

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

VEDC1001: Venture Development

L	T	P	S	J	C
0	0	0	2	0	2

Course Description

In this course, you will discover your deeper self in terms of how you might contribute to society by creating exciting new products and services that can become the basis of a real business. Your efforts, creativity, passion, and dedication to solving challenging problems are the future of our society, both in your country and worldwide.

The course is divided into four sections:

1. Personal discovery of your core values and natural skills
2. Ideation and improving the impact
3. Business model design for the innovation
4. Presenting your idea in a professional manner suitable for a new venture pitch

Each section has key frameworks and templates for you to complete, improving your idea step by step until the final presentation.

First, you will discover your personal values and emerging areas of knowledge that are the foundations of any successful company. Next, you will learn how to develop insight into the problems and desires of different types of target customers and identify the design drivers for a specific innovation. Then, you will learn specific design methods for new products and services. And as important as the product or service itself, it is a strategy for monetizing the innovation – generating revenue, structuring the operating costs, and creating the operating profit needed to support the business, hire new employees, and expand forward.

This project is intended to be for teams of students. Innovation and entrepreneurship are inherently team-based. This course will give you that entrepreneurial experience.

This is the beginning of what might be the most important journey of personal and career discovery so far in your life, one with lasting impact. This is not just a course but potentially an important milestone in your life that you remember warmly in the years to come.

Course Objectives

Students will have the opportunity to:

- Discovery who you are – Values, Skills, and Contribution to Society
- Understand how creativity works and permeates the innovation process
- Learn the basic processes and frameworks for successful innovation.
- Gain experience in actually going through the innovation process.
- Conduct field research to test or validate innovation concepts with target customers.
- Understand innovation outcomes: issues around business models, financing for start-ups, intellectual property, technology licensing, corporate ventures, and product line or service extensions.

Course Materials

- Meyer and Lee (2020), Personal Discovery through Entrepreneurship, The Institute for Enterprise Growth, LLC. Boston, MA., USA
- Additional readings

- Additional videos, including case studies and customer interviewing methods.

Expectations of you in the classroom: Each student is expected to be prepared to discuss the readings/exercises assigned for each class. It's not optional! Students will be randomly asked to discuss and summarize the material. Your learning – and your success—in this course are heavily dependent upon your willingness to participate actively in class discussion. Your class participation will be assessed on the quality and consistency of your effort in each and every class.

Late assignments: Late assignments are subject to grade penalty. Lateness will only be considered for grading if prior notice was given to the instructor before the due date.

Presentation: Achieving success with an innovative idea requires you to package and present the idea in a crisp, creative, and powerful manner. The activity of presenting helps you to internalize your idea -- as you talk about it and obtain feedback – and improve upon it. There would be two major presentations during the course, plus a series of other smaller unscheduled presentations of work in progress or course material. Prepare, practice, and succeed!

Time spent outside of class: The course is hands-on and requires students to conduct field research through direct interactions with people (interviews/surveys) and online/in the library. Specifically, the course requires that students conduct studies with potential target users and stakeholders. You must be prepared to go out of your comfort zone to dig for information. You will need to search for information online and arrange to meet or talk to relevant people who may have the information you need.

Group Project Overview

This is a semester length project and the cornerstone component of the course. The group project will give you the opportunity to apply the course concepts to a real situation. You will learn about the entrepreneurship for your own business or your work in organizations. Even if you are not going to be an entrepreneur, you need to know how to identify the opportunities, who to persuade people, and how to create economic and social values in many different contexts.

Talking to customers is one of the most important steps in investigating your business because your entrepreneurial vision must correspond to a true market opportunity. With your group, select 5-6 potential customers willing to be interviewed. They should represent a cross-section of our target market and should provide information that helps you refine your opportunity. This is not a simple survey: you are seeking in-depth understanding of the lifestyle and behaviors of your customer that can help you shape your opportunity. Please remember, you are not simply looking to confirm you have a great idea, but to shape your idea into a great opportunity. You will maximize your chances for success and your ability to execute your business cost-effectively by making early (rather than later) changes to your concept.

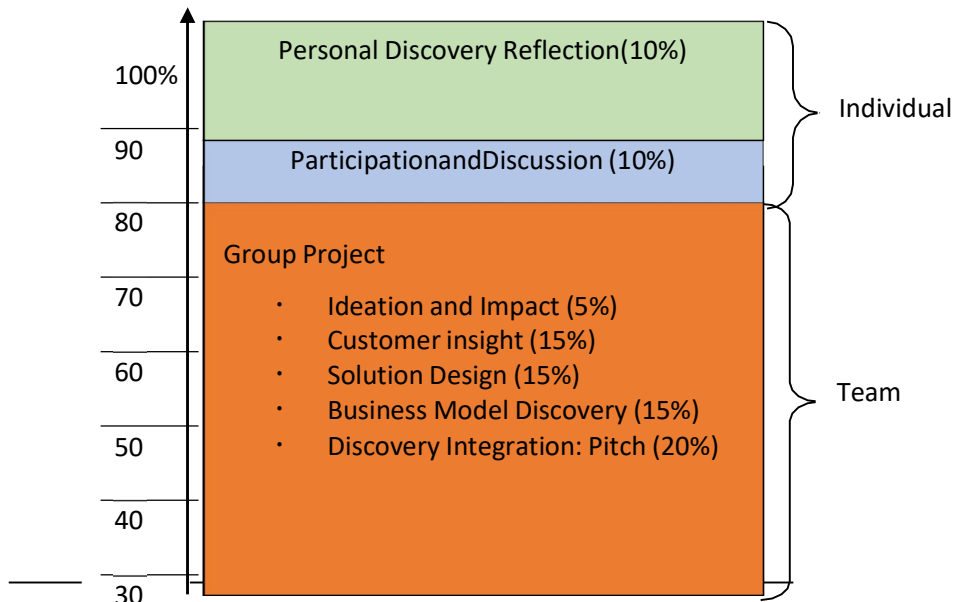
“Design” is fun, particularly when you merge customer insight with your own creativity. Enjoy! In this book, we provide structured methods to be an active listener and learner from customers as well as a product or service designer.

Business modeling is not as hard as it might sound. This is the design of your business – how it charges customers, what is spent producing and selling products or services, and the money that can be made for each unit sold. We keep it simple – so should you.

For the final outcome, you will be required to come up with Pitch that can be used as the basis for actually starting a company based on an impactful innovation. Once again, we provide a specific format and tools for creating a compelling Pitch. We also want you to think about an exciting proposition that is more than just making money, but rather, one that helps society. This will give

you innovation and venture concept greater lift with customers – and it will also make you feel better, deep inside.

Project Components and Grading



[20 Steps and activities in this course]

Deliverables

There are a number of different deliverables for the course that follow the templates presented in the book, as applied to your own venture idea. Do your best to keep up with the timeline of the

class; do not fall behind! Later templates build on the learnings from prior templates. Make the most of your team! Everyone needs to pitch in. In no case, should one person be taking the lead on all templates. Rather, different team members should take the lead on specific deliverables. Coordinate well. Let your teacher know if a team member is not carrying his or her load.

Specific Deliverables

Ideation and Impact Hand-in Package: 5% of total grade
clearly written, with a one-page explanation for the team's decision

- Problem to Solve Templates, Step 4, Page 62 and 63
(with a page of additional explanation if needed)
- Idea Impact Template, Step 6, Page 69 (with a page of explanation)

Customer Interviews and Insight Hand-in Package: 15%
(1st Round of Customer Interviews)

- Customer Interviews Template, Step 7, Pages 75-78, plus add additional template forms for each additional customer interview. The more, the better.
- Idea Reshaping Template, Step 7, Pages 84 and 85. Integration into overall conclusions. How have you improved your original idea through customer research?
- Latent Needs Template, Step 7, Page 93 – what are the frustrations of users that are not solved by current products or services?
- Full Use Case Template, Step 7, Page 99 – how do your customers' needs change over the full use case, and what innovative ideas can you propose at each step of the way?

Concept Design (and Test) Hand-in Package: 15%

- Customer Value Proposition Template: Step 8, Page 107. This becomes the landing point for what you learned in your customer interviews.
- Competitive Analysis Template: Step 8, Page 109. (Use the Web or actual stores/dealers)
- Product Vision and Subsystem Design Templates: Step 10, Pages 121 and 126 (You can add additional pages with design illustration and explanations of your bubble chart)
- Reality Check Survey Template and Results: Step 11, Page 141, 143-144
(You can use more than 2 pages for reporting the results.)

Business Model Design Hand-in Package: 15%

- Industry Analysis Templates: Step 12, Pages 153 and 154
- Illustrate the Business Model Template: Step 13, Page 170
(Use different colours or line patterns to show the flows of product, money, and information)
- Revenue Model Template: Step 14, Page 177
- Operating Model Template: Step 15, Page 187
- Customer Journey Template: Step 16, Page 195
- Validating the Business Model Template: Step 17, Pages 199 and 200

Discovery Integration Hand-in Package: 20%

- Business and Social Vision Impact Statement Template: Step 18, Page 210.
- Per Unit Profitability Template: Step 19, Page 229
- Your Venture Story Pitch: Step 20 (PowerPoint)
- Overall Pitch Design Template: Page 264



Assemble the templates from all your work above, plus any others that you found particularly meaningful, and from these, create your Team's Innovation Pitch. The book has lists specific templates that fit for each part of the final presentation.

Do not just regurgitate the templates in your pitch; rather, take the key points from them to create your own, unique presentation. The templates help you think – but most are too complex to present to outside people who have not taken the course. Therefore, design this pitch as if you presenting to a new set of investors.

And don't forget to add an attractive title page with your team members names and email addresses! You can also add an Appendix at the very back with particularly interesting information, such as industry data or the results of your customer interviews and Reality Check.

Individual Innovation Assignments

You will be required to submit two Reflection Journals as well as a maximum two pages double spaced Synthesis, Integration and Application paper by email at the Week 4 and Week 14 respectively. Please note, this exercise is not about regurgitating the course concepts.

(1) Personal Discovery Reflection Journal (10%)

At the beginning of this semester, you will have a time to think about your self (who you are, what you are good at, what areas you want to contribute on) using a couple of templates. After that sessions, you will have a quiet moment to think about yourself, your career, and your happiness in your life. Please write 2-page reflectional journal what you feel and learning through the personal discovery sessions.

(2) Insight Learning Reflection Journal (10%)

At the end of this semester, you are to prepare a short reflection of impressive sessions as well as related activities outside the classroom. Specially, (1) reflect on the key points from lectures, reading, discussion, guest speakers, and interviews, (2) apply this to your own situation, and (3) outline ways that you intend to use this knowledge in the future.

Course Schedule

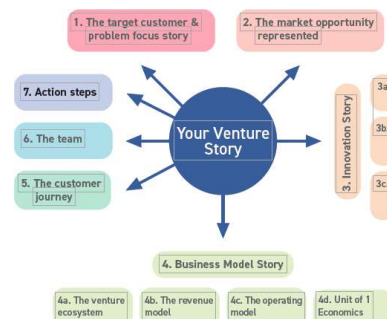
Week	Session	Topics and Steps	Key CONCEPTS Introduced in Class	Class Focus Activity
1	1	Course Overview	<ol style="list-style-type: none"> 1. Why is entrepreneurship important? 2. What is Personal Discovery through Entrepreneurship? 3. Four Stages; Personal Discovery, Solution Discovery, Business Model Discovery, Discovery Integration 4. Preparation (finding interesting areas) 	Lecture and Discussion
	2	Personal Discovery (Step 01, Step 02)	<ol style="list-style-type: none"> 1. Personal Values 2. Strength and Weakness 	Individual: <ul style="list-style-type: none"> • Work with the templates provided on pages: • Core values: 22, 23 • Skills: 27, 28, 29, 30, 31 • Societal Contribution: 33, 34
2	3	Find Teammates (Step 03)	<ol style="list-style-type: none"> 1. Review Problem Area Template at the beginning of the book to find classmates who want to work on the same problem area. 2. Find teammates <ol style="list-style-type: none"> (1) Shared values (2) Levels of commitment (3) Skills and experiences (Same or Different?) 	Problem template: Page 9 <ul style="list-style-type: none"> • Talk to your classmates and find teammates. See who wants to work on in the same problem space, with a shared vision of solutions, and complementary skill sets. • Sit back and assess: Team templates on Pages 44, 45, and 46. • Prepare to present your team, the problem it is going to tackle, and its collective skills.
	4	Define Purpose (Step 04) Create Mission (Step 05)	<ol style="list-style-type: none"> 1. Methods for defining and refining a venture's purpose 2. Defining a Venture's Purpose 3. Creating a Vision Statement 	Team: <ul style="list-style-type: none"> • Purpose and Mission Templates: Pages 49 and 52 • Be prepare to present to the class. • Personal Discovery Reflection Journal Due

We ek	Sess ion	Topics and Steps	Key CONCEPTS Introduced in Class	Class Focus Activity
3	5	Ideation & Impact (Step 06)	Ideation Methods <ul style="list-style-type: none"> An in-class ideation exercise 	Team: <ul style="list-style-type: none"> Problem to Solve Templates, Step 4, Page 62, and 63
	6		Increasing the Impact of an Idea. (The Eat-Your-Coffee Video – a good example of ideation)	Team: <ul style="list-style-type: none"> Idea Impact Template, Step 6, Page 69
4	7	User Insights Frameworks (Step 07)	<ul style="list-style-type: none"> Identify and find the right target users. Interview style and methods The Customer Interview template. 	Team: <ul style="list-style-type: none"> Customer Interviews Template, Step 7, Pages 75 Edit interview template for your project.
	8		Laddering methods for interviews	Team: <ul style="list-style-type: none"> Latent Needs Template, Step 7, Page 93
5	9	User Insights Customer Interviews (Step 07)	<ul style="list-style-type: none"> Finding latent needs Field work check-in 	Team: <ul style="list-style-type: none"> Latent Needs Template, Step 7, Page 93 Field work – customer interviewing
	10		<ul style="list-style-type: none"> Think about innovation across the entire use case Field work check-in 	Team: <ul style="list-style-type: none"> Full Use Case Template, Step 7, Page 99 Field work – customer interviewing
6	11	User Insights Interpreting Results (Step 07)	<ul style="list-style-type: none"> Interpreting customer interview results Field work check-in 	Team: <ul style="list-style-type: none"> Field work – customer interviewing Also talk to retailers/dealers if appropriate
	12		<ul style="list-style-type: none"> Idea Reshaping based on Customer Interviews Field work check-in 	Teams prepare results of results from customer interviews and how the original ideas have been reshaped & improved.
7	13	User Insights Interpreting Results (Step 07)	<ul style="list-style-type: none"> Customer Research Reports Implications for product and service design 	<ul style="list-style-type: none"> Teams prepare PPTs for class presentation Customer Insight Template Hand-in Package
	14			

Week	Session	Topics and Steps	Key CONCEPTS Introduced in Class	Class Focus Activity
8	15	Concept Design (Step 08)	<ul style="list-style-type: none"> • Defining Customer Value • Understanding Customer Value Proposition 	Team: <ul style="list-style-type: none"> • Customer Value Proposition • Template: Step 8, Page 107 • Draft the CVP
	16		<ul style="list-style-type: none"> • Presentation and review of CVPs 	Team: <ul style="list-style-type: none"> • Complete CVP
9	17	Competitive Analysis and Positioning (Step 08)	<ul style="list-style-type: none"> • Understanding of Competitive Matrix • Competitive positioning: creating your separate space 	Team: <ul style="list-style-type: none"> • Identify major competitors, and dimensions for analysis • Template: Step 8, Page 109
	18		<ul style="list-style-type: none"> • Presentations of Competitive Analyses and Positionings 	Team: <ul style="list-style-type: none"> • Perform the competitive analysis and present results, including positioning
10	19	Product Line Strategy (Step 09)	<ul style="list-style-type: none"> • Product line framework: good, better, best on underlying platforms, plus application to Services. 	Team: <ul style="list-style-type: none"> • Identify good, better, best variations based on the underlying concept. • Product line template: Page 115
	20	Product Visioning Subsystem Design, and Prototype Sketch (Step 10)	<ul style="list-style-type: none"> • The structured bubble chart, showing implementation options and the team's choices • Prototype sketching (The Bluereo Video is a good example of iterative prototyping driven by customer discovery.) 	Team: <ul style="list-style-type: none"> • Prototype sketch, and for Web apps, a wireframe. For physical products, an initial bill of materials. • Underlying bubble chart showing your decision process. • Product Vision and Subsystem Design Templates: Step 10, Pages 121 and 126
Week	Session	Topics and Steps	• Key CONCEPTS Introduced in Class	Team or Individual Activity
11	21	Reality Check (Step 11)	<ul style="list-style-type: none"> • The purpose of the Reality Check, testing the product concept, channel preferences, and much other. 	Team: <ul style="list-style-type: none"> • Reality Check Survey Template and Results: Step 11, Page 141, 143-144

	22		<ul style="list-style-type: none"> • Guidance on the number or additional customers for the reality check survey • How to analyze and interpret the results 	<ul style="list-style-type: none"> • Customize the Reality Check template for your venture. • Do a quick round of customer surveying. Aim for 12 more interviews.
12	23	Industry Analysis (Step 12)	<ul style="list-style-type: none"> • Team reports on Reality Check Results • Examine major components of an Industry Analysis • Review Templates 	Team: <ul style="list-style-type: none"> • Prepare and present the results of your reality check, plus any pivots you wish to make. • Concept Design (and Test) Hand-in Package • Industry Analysis Templates: Step 12, Pages 153 and 154s
	24	Business Model (Step 13)	<ul style="list-style-type: none"> • Defining the Business Model: • Lecture on basic structure and different types. • Illustrating it as the flow of product, money, and information. 	Team: <ul style="list-style-type: none"> • Business Model Illustration Template, Step 13, Page 170

Week	Session	Topics and Steps	· Key CONCEPTS Introduced in Class	Team or Individual Activity
13	25	Business Model (Steps 14, 15, 16, 17)	<ul style="list-style-type: none"> • Revenue and Expenses • The key decision points in the Revenue Model • The key decision points in the Operating Model • Designing the Customer Journey • Validating the Business Model (The Polka Dog Bakery Video: an example of creating a new retail experience, plus new products.) 	Team <ul style="list-style-type: none"> • Step 14, Page 177 • Step 15, Page 187 • Step 16, Page 195 • Step 17, Pages 199 and 200 • Validate the Revenue and Operating Model by trying to have phone calls with a few Sellers and Manufacturers to validating pricing, channels, and costs.
	26			
14	27	Impact Visioning (Step 18)	<ul style="list-style-type: none"> • Develop clear statements for business and societal impact. • Look at good existing examples of companies that do both. 	Team: <ul style="list-style-type: none"> • Start integrating your research and templates towards the final presentation, provided in Step 20, Page 264 • Business Model Design Hand-in Package
	28	Creating Value (Step 19)	<ul style="list-style-type: none"> • Develop a project of the profitability in make low volumes for a product, a service, and a Web app. • Discuss applications of the framework to your venture. 	Team: <ul style="list-style-type: none"> • Develop and present Unit of 1 Economics Template, Step 19, Page 229 • Keep working on the Final presentation

Week	Session	Topics and Steps	Key CONCEPTS Introduced in Class	Team or Individual Activity
15	29	Tell Your Story	<ul style="list-style-type: none">• Presentation Format and Style• Format:<ul style="list-style-type: none">(1) Title Slide with names and contact information(2) The Target Customer and the Problem to be Solved(3) The Market Opportunity(4) The Innovation Story(5) The Business Model Story(6) The Customer Journey(7) The Team(8) The Proposed Action Steps.(9) Appendices (if needed or desired)• If you have built a prototype during the class, please bring it and show it to us! <p>(The Fortify Video is a good example of how a good technical idea can translate into a business model, and next, into a well-funded venture.)</p>	<p>Team:</p> <ul style="list-style-type: none">• The PPT Presentation  <ul style="list-style-type: none">• Practice, practice, practice!• Not too many words on one slide• Use pictures• Use template to develop your thinking, but try to create slides that are not just the templates.
	30			
Final Course Deliverables			Due on the Monday after the weekend of the final class meeting.	<p>Team: Your Venture PPTs</p> <p>Individual: Insight Learning Reflection Journal</p>

Course Outcomes

- Identify one's values, passions, skills and their will to contribute to society
- Formulate an idea and validate it with customers
- Demonstrate prototyping and analyze the competition for the product
- Create business models for revenue generation and sustainability of their business
- Come up with a pitch that can be used as the basis for actually starting a company based on an impactful innovation and societal impact

DOSP1001: Badminton

L	T	P	S	J	C
0	0	0	2	0	2*

This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.

Course Objectives:

1. Understand training principles used in the sport
2. Demonstrate knowledge of the game in a recreational /competitive play setting
3. Organize an event around the sport
4. Demonstrate concepts of warm up, game conditioning, training plans

Course Outcomes:

1. Learn to play Badminton
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

List of Activities:

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

Instructional Plan:

1. Introduction to Badminton - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Badminton: Grips - Racket, shuttle
4. Sports Specific fitness and warmup drills
5. Stances and footwork
6. Badminton Gameplay: Service, Forehand, Backhand
7. Preparatory Drills and Fun Games
8. Game Variations: Singles/ Doubles/ Mixed

Reference:

1. Handbook of the Badminton World Federation (BWF)

DOSP1011: Chess

L	T	P	S	J	C
0	0	0	2	0	2*

This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.

Course Objectives:

1. Understand training principles used in the sport
2. Demonstrate knowledge of the game in a recreational /competitive play setting
3. Organize an event around the sport
4. Demonstrate concepts of warm up, game conditioning, training plans

Course Outcomes:

1. Learn to play Chess
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

List of Activities:

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

Instructional Plan:

1. Introduction to Chess - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Chess: Pieces & functions, basic play
4. Chess board moves & terminology
5. Chess Gameplay: Openings, castling, strategies & tactics
6. Preparatory Drills and Fun Games
7. Game Variations & Officiating

Reference:

1. International Chess Federation (FIDE) Handbook

DOSP1031: Football

L	T	P	S	J	C
0	0	0	2	0	2*

This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.

Course Objectives:

1. Understand training principles used in the sport
2. Demonstrate knowledge of the game in a recreational /competitive play setting
3. Organize an event around the sport
4. Demonstrate concepts of warm up, game conditioning, training plans

Course Outcomes:

1. Learn to play Football
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

List of Activities:

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

Instructional Plan:

1. Introduction to Football - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Kicking, heading, ball control, Keeping
4. Movement, throwins, tackling, defense, scoring, defense
5. Gameplay- Formations, passing, FKs, CKs, PK, tactics
6. Preparatory Drills and Fun Games
7. Game Variations: Small sided games, 7v7, 11v11

Reference:

1. FIFA Laws of the Game

DOSP1041: Volleyball

L	T	P	S	J	C
0	0	0	2	0	2*

This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.

Course Objectives:

1. Understand training principles used in the sport
2. Demonstrate knowledge of the game in a recreational /competitive play setting
3. Organize an event around the sport
4. Demonstrate concepts of warm up, game conditioning, training plans

Course Outcomes:

1. Learn to play Volleyball
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

List of Activities:

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

Instructional Plan:

1. Introduction to Volley - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Striking, Ball control, Lifting
4. Sports Specific fitness and warmup drills
5. Stances and footwork
6. Preparatory Drills and Fun Games
7. Gameplay: Jumps, strikes, layoffs, attack, defense

Reference:

1. FIVB - Official Volleyball Rules

DOSP1051: Kabaddi

L	T	P	S	J	C
0	0	0	2	0	2*

This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.

Course Objectives:

1. Understand training principles used in the sport
2. Demonstrate knowledge of the game in a recreational /competitive play setting
3. Organize an event around the sport
4. Demonstrate concepts of warm up, game conditioning, training plans

Course Outcomes:

1. Learn to play Kabaddi
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

List of Activities:

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

Instructional Plan:

1. Introduction to Kabaddi - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Raiding, catching
4. Sports Specific fitness and warmup drills
5. Stances and footwork
6. Preparatory Drills and Fun Games
7. Gameplay: Chain system movement

Reference:

1. Amateur Kabaddi Federation of India (AKFI) - Official Rules
2. Rules of Kabaddi - International Kabaddi Federation

DOSP1091: Basketball

L	T	P	S	J	C
0	0	0	2	0	2*

This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.

Course Objectives:

1. Understand training principles used in the sport
2. Demonstrate knowledge of the game in a recreational /competitive play setting
3. Organize an event around the sport
4. Demonstrate concepts of warm up, game conditioning, training plans

Course Outcomes:

1. Learn to play Basketball
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

List of Activities:

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

Instructional Plan:

1. Introduction to Basketball - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Passing, Receiving, Dribbling
4. Sports Specific fitness and warmup drills
5. Stances and footwork: Jumps, dribbles, catching, throws
6. Preparatory Drills and Fun Games
7. Gameplay: Shots, throws, movements, attack, defense

Reference:

1. FIBA Basketball Official Rules

DOSP1111: Throwball

L	T	P	S	J	C
0	0	0	2	0	2*

This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.

Course Objectives:

1. Understand training principles used in the sport
2. Demonstrate knowledge of the game in a recreational /competitive play setting
3. Organize an event around the sport
4. Demonstrate concepts of warm up, game conditioning, training plans

Course Outcomes:

1. Learn to play Throwball
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

List of Activities:

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

Instructional Plan:

1. Introduction to Throwball - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Throwing, Receiving
4. Sports Specific fitness and warmup drills
5. Stances and footwork
6. Preparatory Drills and Fun Games
7. Gameplay: Shots, throws, movements, control

Reference:

1. World Throwball Federation - Rules of the Game

DOSL1001: Club Activity – Participant

L	T	P	S	J	C
0	0	0	2	0	2*

This course recognizes student participation in multiple activities organized by various student organizations that pursue specific co-curricular and extra-curricular interests. These activities allow students to engage in and identify and pursue their personal interests and hobbies.

Course Objectives

- Create opportunities for students to participate in a variety of non-academic experiences
- Interact with and learn from peers in a setting without an external performance pressure
- Allow exploration of interesting activities and reflection about these experiences
- Learn to manage time effectively

List of Student Club Activities

1. Music (vocals, instruments, technical, recording, mixing, production, management)
2. Dance (Indian classical, western, jazz, latin, contemporary, folk, production, event management)
3. Theatre (classical, experimental, one-act, street, production, direction, casting, etc.)
4. Arts (fine arts, painting, calligraphy, sketching, caricaturing, etc)
5. Craft (origami, model making, sculpture, pottery, etc)
6. Cooking (home-style, baking, confectionery, Indian, intercontinental, etc.)
7. Graffiti (street, mural, collage, multi media, etc)
8. Workshops, quizzes, debates, elocution, etc
9. Filmmaking (adventure, drama, film appreciation, documentary, etc)
10. Photography (conventional, immersive (360), landscape, portrait, technical, editing, etc.)
11. College Fests
12. Designing (graphic design, landscape, interior, etc)
13. Competitive coding
14. Recreational sports activities
15. Other club activities organized by student clubs

List of Activities

1. Participation in various club based activities
2. Weekly reflection paper
3. Portfolio (on social media using an instagram account)
4. Two learning papers (one per semester)

Text Books

1. Small move: big Change (Caroline Arnold)
2. How to Win at College: Surprising Secrets for Success from the Country's Top Students (Cal Newport)

References

1. Making the most of college: Students speak their minds (author - Richard Light)
2. Failing Forward: Turning Mistakes into Stepping Stones for Success (John C Maxwell)
3. The Last Lecture (Randy Pausch)
4. Lean in (Sheryl Sandberg)
5. Youtube- Introduction to various club activities

Course Outcomes

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

- Identify personal interest areas
- Learn from diverse perspectives and experiences
- Gain exposure to various activities and opportunities for extra-curricular activities
- Learn to manage time effectively
- gain confidence

DOSL1011: Club Activity – Member of the Club

L	T	P	S	J	C
0	0	0	2	0	2*

This course encourages and acknowledges student members' work in organizing events and activities organized by various student organizations that pursue specific co-curricular and extra-curricular interests. These activities allow students to actively learn from the process of conceptualizing and organizing such activities as part of a team.

Course Objectives

- Create opportunities for students to learn from organizing club activities
- Learn teamwork, leadership, planning and management of events and activities
- Learn to appreciate multiple perspectives, cultures, and individual capabilities
- Learn to manage time effectively

List of Student Club Activities

1. Music (vocals, instruments, technical, recording, mixing, production, management)
2. Dance (Indian classical, western, jazz, latin, contemporary, folk, production, event management)
3. Theatre (classical, experimental, one-act, street, production, direction, casting, etc.)
4. Arts (fine arts, painting, calligraphy, sketching, caricaturing, etc)
5. Craft (origami, model making, sculpture, pottery, etc)
6. Cooking (home-style, baking, confectionery, Indian, intercontinental, etc.)
7. Graffiti (street, mural, collage, multi media, etc)
8. Workshops, quizzes, debates, elocution, etc
9. Filmmaking (adventure, drama, film appreciation, documentary, etc)
10. Photography (conventional, immersive (360), landscape, portrait, technical, editing, etc.)
11. College Fests
12. Designing (graphic design, landscape, interior, etc)
13. Competitive coding
14. Recreational sports activities
15. Other club activities organized by student clubs

List of Activities

1. Be a member of a club and organize activities in that particular interest area
2. Learn from diverse perspectives and experiences
3. Learn to design and execute extra-curricular activities
4. Develop management skills through hands on experience
5. Explore different managerial roles and develop competencies

Text Books

1. Small move: big Change (Caroline Arnold)
2. How to Win at College: Surprising Secrets for Success from the Country's Top Students (Cal Newport)

References

1. Making the most of college: Students speak their minds (author - Richard Light)
2. Failing Forward: Turning Mistakes into Stepping Stones for Success (John C Maxwell)
3. The Last Lecture (Randy Pausch)
4. Lean in (Sheryl Sandberg)
5. Youtube- Introduction to various club activities

Course Outcomes

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

- Be a member of a club and organize activities in that particular interest area
- Learn from diverse perspectives and experiences
- Learn to design and execute extra-curricular activities
- Develop management skills through hands on experience
- Explore different managerial roles and develop competencies

DOSL1021: Club Activity – Leader of the Club

L	T	P	S	J	C
0	0	0	2	0	2*

This course encourages and recognizes student members' work in leading the student organizations through various leadership roles. As leaders they work not just to organize events and activities in specific co-curricular and extra-curricular interests, but also lead the teams that form the core members of the clubs. These activities allow students to learn and practice leadership and management skills through real world experience.

Course Objectives

- Create opportunities for students to learn from organizing club activities
- Learn teamwork, leadership, planning and management of events and activities
- Learn to appreciate multiple perspectives, cultures, and individual capabilities
- Learn to manage time effectively

List of Student Club Activities

1. Music (vocals, instruments, technical, recording, mixing, production, management)
2. Dance (Indian classical, western, jazz, latin, contemporary, folk, production, event management)
3. Theatre (classical, experimental, one-act, street, production, direction, casting, etc.)
4. Arts (fine arts, painting, calligraphy, sketching, caricaturing, etc)
5. Craft (origami, model making, sculpture, pottery, etc)
6. Cooking (home-style, baking, confectionery, Indian, intercontinental, etc.)
7. Graffiti (street, mural, collage, multimedia, etc)
8. Workshops, quizzes, debates, elocution, etc
9. Filmmaking (adventure, drama, film appreciation, documentary, etc)
10. Photography (conventional, immersive (360), landscape, portrait, technical, editing, etc.)
11. College Fests
12. Designing (graphic design, landscape, interior, etc)
13. Competitive coding
14. Recreational sports activities
15. Other club activities organized by student clubs

List of Activities

1. Be the leader of the club and implement the charter, vision and mission of the club
2. Learn from diverse perspectives and experiences
3. Learn to lead the team, design and execute extra-curricular activities
4. Develop management skills through hands on experience
5. Explore different managerial roles and develop competencies

Text Books

1. Small move: big Change (Caroline Arnold)
2. How to Win at College: Surprising Secrets for Success from the Country's Top Students (Cal Newport)

References

1. Making the most of college: Students speak their minds (author - Richard Light)
2. Failing Forward: Turning Mistakes into Stepping Stones for Success (John C Maxwell)
3. The Last Lecture (Randy Pausch)
4. Lean in (Sheryl Sandberg)
5. Youtube- Introduction to various club activities

Course Outcomes

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

- Be the leader of the club and implement the charter, vision and mission of the club
- Learn from diverse perspectives and experiences
- Learn to lead the team, design and execute extra-curricular activities
- Develop management skills through hands on experience
- Explore different managerial roles and develop competencies

DOSL1031: Club Activity – Competitor

L	T	P	S	J	C
0	0	0	2	0	2*

This course encourages and recognizes student members' work in leading the student organizations through various leadership roles. As leaders they work not just to organize events and activities in specific co-curricular and extra-curricular interests, but also lead the teams that form the core members of the clubs. These activities allow students to learn and practice leadership and management skills through real world experience.

Course Objectives

- Create opportunities for students to learn from organizing club activities
- Learn teamwork, leadership, planning and management of events and activities
- Learn to appreciate multiple perspectives, cultures, and individual capabilities
- Learn to manage time effectively

List of Student Club Activities

1. Music (vocals, instruments, technical, recording, mixing, production, management)
2. Dance (Indian classical, western, jazz, latin, contemporary, folk, production, event management)
3. Theatre (classical, experimental, one-act, street, production, direction, casting, etc.)
4. Arts (fine arts, painting, calligraphy, sketching, caricaturing, etc)
5. Craft (origami, model making, sculpture, pottery, etc)
6. Cooking (home-style, baking, confectionery, Indian, intercontinental, etc.)
7. Graffiti (street, mural, collage, multimedia, etc)
8. Workshops, quizzes, debates, elocution, etc
9. Filmmaking (adventure, drama, film appreciation, documentary, etc)
10. Photography (conventional, immersive (360), landscape, portrait, technical, editing, etc.)
11. College Fests
12. Designing (graphic design, landscape, interior, etc)
13. Competitive coding
14. Recreational sports activities
15. Other club activities organized by student clubs

List of Activities

1. Be the leader of the club and implement the charter, vision and mission of the club
2. Learn from diverse perspectives and experiences
3. Learn to lead the team, design and execute extra-curricular activities
4. Develop management skills through hands on experience
5. Explore different managerial roles and develop competencies

Text Books

1. Small move: big Change (Caroline Arnold)
2. How to Win at College: Surprising Secrets for Success from the Country's Top Students (Cal Newport)

References

1. Making the most of college: Students speak their minds (author - Richard Light)
2. Failing Forward: Turning Mistakes into Stepping Stones for Success (John C Maxwell)
3. The Last Lecture (Randy Pausch)
4. Lean in (Sheryl Sandberg)
5. Youtube- Introduction to various club activities

Course Outcomes

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

- Be the leader of the club and implement the charter, vision and mission of the club
- Learn from diverse perspectives and experiences
- Learn to lead the team, design and execute extra-curricular activities
- Develop management skills through hands on experience
- Explore different managerial roles and develop competencies

POLS1001: Indian Constitution and History

L	T	P	S	J	C
2	0	0	0	0	2*

Course Description:

This course analyzes the basic structure and operative dimensions of the Indian Constitution. It explores various aspects of the Indian political and legal system from a historical perspective highlighting the various events that led to the making of the Indian Constitution. The course also deals with various challenges faced by the constitution and its coping mechanisms. Broadly, the students would understand and explain the working of different institutions and political debates ensuing from the operation of the Indian constitution in action.

Course Objectives:

1. To introduce constitutional history of India.
2. To explain the process of making Indian constitution
3. To analyze Fundamental of Rights, Duties and other principles in constitution
4. To create familiarity with political developments which shaped the constitution.

Course Outcomes:

On the successful completion of the course students would be able to:

1. Demonstrate an understanding of the Constitution of India and how constitutional governance is carried out in India
2. Interpret knowledge of the Fundamental Rights and Duties of the Citizens as well as the Obligation of the state towards its citizens
3. Correlate familiarity with key political developments that have shaped the Constitution and amended it from time to time.
4. Equip themselves to take up other courses in law after having done a foundation course on Indian Constitution

Unit I: India as a Nation

6 hrs

Khilani, S. (2004). *Introduction, The Idea of India*, Chapter 1. New Delhi: Penguin Books, pp. 1-15.

Rowat, D. (1950). 'India: The Making of a Nation', *International Journal*, 5(2), 95-108. doi:10.2307/40194264

Brass, P. (2018). 'Continuities and Discontinuities between pre- and post-Independence India', Chapter 1. *The Politics of Idea since independence*, New Delhi: Cambridge University Press. pp. 1-30.

Module Learning Outcomes

1. Understand ideas of India
2. Explain the story behind making constitution and its future.
3. Articulate the differences between pre and post-colonial governments.

Unit 2: Understanding the Constitution

6 hrs

Mehta, U.S. (2011). 'Constitutionalism' in *The Oxford Companion to Politics in India*, (ed) by Nirja Gopal Jayal, and Pratap Bhanu Mehta, New Delhi: Oxford University Press. pp. 15-27.

Austin, G. (2016), 'The Constituent Assembly: Microcosm in Action' in *The Indian Constitution: Cornerstone of a Nation*, New Delhi: Oxford University Press, pp. 1-25.

Beteille, Andre (2008): "Constitutional Morality," *Economic and Political Weekly*, Vol 43, Issue No 40

Prahladan, Vivek (2012): "Emergence of the Indian Constitution," *Economic and Political Weekly*, Vol 47, Issue No 07.

Module Learning Outcomes

Understand the concept of constitutionalism. Demonstrate strength or weakness of constitutional morality in India

Evaluate constituent assembly debates in framing Indian Constitution.

Unit 3: The Preamble, Fundamental Rights and Directive Principles of State Policy 6 hrs

Bhakshi, P.M. (2011). 'Preamble' in *The Constitution of India*, New Delhi: Universal Law. Pp. 1-5.

Laxmikanth, M. (2017). 'Chapter IV: Preamble of the Constitution' in *Indian Polity*, Chennai: McGraw Hills.

Kumar, Virendra (2007): "Basic Structure of The Indian Constitution: Doctrine of Constitutionally Controlled Governance [From Kesavananda Bharati to I.R. Coelho]" *Journal of the Indian Law Institute*, Vol 49, No 3, pp 365-398.

Austin, G (2016), ' ' in *The Indian Constitution: Cornerstone of a Nation*, New Delhi: Oxford University Press, pp.63-105.

Reddy, S (1980). Fundamental Ness of Fundamental Rights and Directive Principles in the Indian Constitution. *Journal of the Indian Law Institute*, 22(3), pp. 399-407.

Bhatia, Gautam (2017): "The Supreme Court's Right to Privacy Judgement," *Economic and Political Weekly*, Vol 52, Issue No 44

Module Learning Outcomes

1. Explain the relationship between 'Preamble' and 'The constitution'.
2. Interpret the key concepts of preamble
3. Analyzes the dynamic nature of Indian constitution
4. Understanding Fundamental Rights
5. Evaluate Directive Principles of State Policy
6. Interpret case studies on Fundamental Rights.

Unit 4: Citizenship

6 hrs

Jayal, N.G. (2019). 'Reconfiguring citizenship in contemporary India' in *South Asia Journal of South Asian Studies*, pp.33-58.

Roy, Anupama. (2010). 'Chapter I: Enframing the citizen in contemporary times' in *Mapping Citizenship in India*, New Delhi: Oxford University Press.

Das, Veena (2010): "State, Citizenship and the Urban Poor," *Citizenship Studies*, Vol 15, pp 319-333.

Valerian Rodrigues

Module Learning Outcomes

1. Explain different dimensions of citizenship in Indian context
2. Evaluate the basis of citizenship
3. Compare 'claim' and 'status' of citizenship

Unit 5: Separation and Distribution of Powers

6 hrs

- Pal, Ruma. (2016). 'Separation of Powers' in *The Oxford Handbook of the Indian Constitution*, (ed) by Sujit Choudhry, Madhav Khosla, and Pratap Bhanu Mehta, Delhi: Oxford University Press.
- Bakshi, P. (1956). 'Comparative Law: Separation of Powers in India'. *American Bar Association Journal*, 42(6), 553-595.
- Rao, P. (2005). 'Separation of Powers in a Democracy: The Indian Experience'. *Peace Research*, 37(1), 113-122.
- Kumar, Ashwani (2019): "Constitutional Rights, Judicial Review and Parliamentary Democracy," *Economic and Political Weekly*, Vol 51, Issue 15
- Tillin, Louise. (2015). 'Introduction' in *Indian Federalism*. New Delhi: Oxford University Press. pp. 1-30.
- Chakrabarty, Bidyut and Rajendra Kumar Pandey. (2008). *Federalism' in Indian Government and Politics*, New Delhi: Sage Publications. pp. 35-53.
- Arora, B. and Kailash, K. K. (2018). 'Beyond Quasi Federalism: Change and Continuity in Indian Federalism', in *Studies in Indian Politics*, pp. 1-7.
- Agrawal, Pankhuri (2020): "COVID-19 and dwindling Indian Federalism," *Economic and Political Weekly*, Vol 55, Issue No 26

Module Learning Outcomes

1. Explain the importance of separation of powers in a democracy
2. Understand the relation between three organs of the government
3. Evaluate the system of 'checks and balances'
4. Understand the difference between unitary and federal political systems
5. Critically analyze the Indian model of Federalism
6. Evaluate the distribution of responsibilities between union and state governments.

Recommended Readings:

- De, Rohit. (2018). *A People's Constitution – The Everyday Life of Law in the Indian Republic*, USA: Princeton University Press.
- Granville Austin, *The Indian Constitution: Cornerstone of a Nation*, Oxford University Press, Oxford, 1966.
- Lahoti, R.C. (2004). *Preamble: The Spirit and Backbone of the Constitution of India*. Delhi: Eastern Book Company.
- Rajeev Bhargava (ed), *Ethics and Politics of the Indian Constitution*, Oxford University Press, New Delhi, 2008.
- Subhash C. Kashyap, *Our Constitution*, National Book Trust, New Delhi, 2011.
- Tillin, Louise. (2015). *Indian Federalism*. New Delhi: Oxford University Press.
- Zoya Hassan, E. Sridharan and R. Sudarshan (eds), *India's Living Constitution: Ideas, Practices, Controversies*, Permanent Black, New Delhi, 2002.

PHPY1001: Gandhi for the 21st Century

L	T	P	S	J	C
2	0	0	0	0	2*

Course Description

This course provides the students with basic knowledge on Gandhi's early life, transformations in South Africa and his entry into India's national movement. While going through the social-political, economic and educational philosophies of Gandhi, the course analyses how his ideologies are relevant even in the 21st century.

Course Objectives

The objectives of the course are;

1. To provide the students with the basic knowledge on Gandhi's life and his philosophies
2. To understand the early influences and transformations in Gandhi
3. To analyse the role of Gandhi in India's national movement
4. To apply Gandhian Ethics while analysing the contemporary social/political issues
5. To appreciate the conflict resolution techniques put forward by Gandhi and its significance in the current scenario.

Module I : MK Gandhi: Childhood and Education

M K Gandhi, Formative Years (1869-1893): Early childhood - study in England - Indian influences, early Western influences.

Module II: From Mohan to Mahatma-South African Experiences

Gandhi in South Africa (1893-1914): South African Experiences - civil right movements in South Africa - invention of Satyagraha - Phoenix settlement- Tolstoy Farm - experiments in Sarvodaya, education, and sustainable livelihood.

Module III: Gandhi and Indian National Movement

Gandhi and Indian National Movement (1915-1947): Introduction of Satyagraha in Indian soil -non-cooperation movement - call for women's participation - social boycott - Quit-India movement - fighting against un-touchability - Partition of India- independence.

Module IV: Gandhi and Sustainable Development

Gandhian Constructive Programs-Eleven Vows-Sarvodaya-Seven Social Sins-Gandhian Economics and Sustainable Development

Module V: Gandhi and Contemporary Issues

Conflict Resolution Techniques of Gandhi-Ecological Challenges and Gandhian solutions-Gandhian Ethics-An Analysis

Learning Outcomes

1. To understand the life of Gandhi
2. To understand the role of Gandhi in Indian national movement
3. To analyse the origin and significance of Satyagraha
4. To understand the eleven vows of Gandhi which he followed through-out his life.

5. To examine the significance of constructive programs today

Course Outcomes

After the successful completion of the course the students will be able to;

1. Understand the life of Gandhi
2. Appreciate the role of Gandhian non-violence and Satyagraha in India's freedom struggle.
3. Critically examine the philosophy of Gandhi on Education, Sarvodaya, and Satyagraha
4. Analyse the contemporary significance of Gandhian constructive programmes and eleven vows
5. Examine the possible solutions for some of the contemporary challenges like environmental issues, moral degradation and ethical dilemmas.

References

1. Gandhi, M K. (1941). *Constructive Programme*. Ahmadabad: Navjivan Publishing House
2. Gandhi, M. K. (1948). *The Story of My Experiments with Truth*. Ahmadabad: Navjivan Publishing House
3. Gandhi, M K. (1968). *Satyagraha in South Africa*. Ahmadabad: Navjivan Publishing House.
4. Khoshoo, T N (1995). *Mahatma Gandhi: An Apostle of Applied Human Ecology*. New Delhi: TERI
5. Kripalani, J.B. (1970). *Gandhi: His Life and Thought*. New Delhi: Publications Division.
6. Narayan, Rajdeva (2011). *Ecological Perceptions in Gandhism and Marxism*. Muzaffarpur: NISLS
7. Pandey, J. (1998). *Gandhi and 21st Century*. New Delhi: Concept.
8. Weber, Thomas (2007). *Gandhi as Disciple and Mentor*. New Delhi: CUP

DOSL1041: Community Services - Volunteer

L	T	P	S	J	C
0	0	0	0	2	2*

This course recognizes student participation in Community service activities organized by various student organizations and other Government and non-government organizations that exist for providing service to communities. These activities allow students to develop empathy, citizenship behavior and community values.

Course Objectives

- To help students develop empathy and citizenship behavior
- Enable students to develop an altruistic attitude and community development sensibility
- Allow exploration of community service activities and reflect about these experiences
- Learn to work in small and large teams for achieving community objectives

List of Community Service Activities

1. Community Health Services
2. Swachh Bharat Abhiyan and other Cleanliness drives
3. Tree Plantation and similar environmental conservation initiatives
4. Rain water harvesting awareness and implementation
5. Fundraising and visits to Orphanages, Old-age homes, etc.
6. Health and disease awareness programs
7. Working with NGOs
8. Disaster mitigation and management training and relief work
9. Rural Upliftment projects
10. Campus awareness and action projects (cleanliness, anti-ragging, blood donation, etc)
11. Community investigations and surveys for development research
12. Educational support for underprivileged (remedial classes, coaching, training, etc)
13. Service camps
14. Advocacy and information literacy initiatives
15. Other activities serving local communities

List of Activities

1. Participation in various community service activities
2. Weekly reflection paper
3. Portfolio (on social media using an instagram account)
4. Two learning papers (one per semester)

Text Books

1. Soul of a citizen: living with conviction in Challenging times (author: Paul Rogat Loeb)
2. Community Services intervention: Vera Lloyd

References

1. A path appears: Transforming lives, creating opportunities (Nicholas Kristof and Sheryl WuDunn)
2. The story of My Experiments with Truth (author: M. K. Gandhi)

Course Outcomes

- Experience of volunteering in a variety of Community service activities
- Gaining empathy for lesser privileged sections of society by experience
- Understanding the process of generating community awareness
- Understanding Disaster management and relief through training and experience
- Developing environmental and sustainability awareness

DOSL1051: Community Services - Mobilizer

L	T	P	S	J	C
0	0	0	0	2	2*

This course recognizes student leadership in mobilizing community service activities as members of various student organizations or other Government and non-government organizations that exist for providing service to communities. These activities allow students to develop leadership, management skills, empathy, citizenship behavior and community values.

Course Objectives

- To help students understand leadership in a community environment
- Enable students to develop an altruistic attitude and community development sensibility
- Allow deep understanding of community service through practical experience
- Learn to lead small and large teams for achieving community objectives

List of Community Service Activities

1. Community Health Services
2. Swachh Bharat Abhiyan and other Cleanliness drives
3. Tree Plantation and similar environmental conservation initiatives
4. Rain water harvesting awareness and implementation
5. Fundraising and visits to Orphanages, Old-age homes, etc.
6. Health and disease awareness programs
7. Working with NGOs
8. Disaster mitigation and management training and relief work
9. Rural Upliftment projects
10. Campus awareness and action projects (cleanliness, anti-ragging, blood donation, etc)
11. Community investigations and surveys for development research
12. Educational support for underprivileged (remedial classes, coaching, training, etc)
13. Service camps
14. Advocacy and information literacy initiatives
15. Other activities serving local communities

List of Activities

1. Organizing and leading teams in various community service activities
2. Fortnightly reflection paper
3. Portfolio (on social media using an instagram account)
4. Two learning papers (one per semester)

Text Books

1. Soul of a citizen: living with conviction in Challenging times (author: Paul Rogat Loeb)
2. Community Services intervention: Vera Lloyd

References

1. A path appears: Transforming lives, creating opportunities (Nicholas Kristof and Sheryl WuDunn)
2. The story of My Experiments with Truth (author: M. K. Gandhi)
3. List of student run and other Government and non-government community service organizations

Course Outcomes

- Experience of mobilizing and executing Community service activities
- Providing opportunities for community service volunteering for other fellow students
- Understanding the process of mobilizing cash, kind and volunteer support
- Building leadership and management skills
- Building empathy and citizenship behavior

ENVS1001: Environmental Studies

L	T	P	S	J	C
3	0	0	0	0	3*

The course enables the students to adapt eco-centric thinking and actions rather than human-centric thinking on natural resources, their utilization and conservation. The course also focuses on the importance of ecosystems, biodiversity and their degradation led to pollution. This course helps in finding solutions through application of control measures to combat pollution and legal measures to achieve sustainable development.

Course Objectives

1. To impart knowledge on natural resources and its associated problems.
2. To familiarize learners about ecosystem, biodiversity, and their conservation.
3. To introduce learners about environment pollution.
4. To acquaint learners on different social issues such as conservation of water, green building concept.
5. To make learners understand about the present population scenario, its impacts and role of informational technology on environment and human health.
6. To make learners understand about the importance of field visit.

Course Outcomes

After the completion of the course student will be able to

1. List different natural resources and their uses
2. Summarize the structure and function of terrestrial and aquatic ecosystems.
3. Identify causes, effects, and control measures of pollution (air, water & soil).
4. Function of green building concept.
5. Adapt value education

UNIT – I **Multidisciplinary nature of environmental studies & Natural Resources:**

No of Hours:
10

Multidisciplinary nature of environmental studies Definition, scope and importance. Need for public awareness. Natural resources and associated problems. Uses and over exploitation of Forest resources, Water resources, Mineral resources, Food resources, Energy resources. Role of an individual in conservation of natural resources.

Activity:

1. Planting tree saplings
2. Identification of water leakage in house and institute-Rectify or report
3. Observing any one day of a week as Car/bike/vehicle free day.

UNIT – II **Ecosystem and biodiversity**

No of Hours:
10

Ecosystem: Structure components of ecosystem: Biotic and Abiotic components. Functional components of an ecosystem: Food chains, Food webs, Ecological pyramids, Energy flow in the ecosystem (10% law), Ecological succession.

Biodiversity: Definition, Biogeographical classification of India, Values of biodiversity: consumptive use, productive use, social, ethical, aesthetic. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching, man wildlife conflicts. Conservation of biodiversity: In – situ and Ex-situ

Activity”

1. Visit to Zoological Park-Noting different ecosystem
2. Biodiversity register- Flora and fauna in the campus

**UNIT – Environmental Pollution
III**

No of Hours:
10

Definition Causes, effects, and control measures of: -Air pollution. Water pollution. Soil pollution. Marine pollution. Noise pollution. Nuclear hazards. Solid waste Management: Causes, effects, and control measures. Role of an individual in prevention of pollution. Pollution case studies.

Activity

1. Visit to treatment plant and documentation.
2. Documentation of segregation of solid waste-Dry and Wet

Learning Outcomes:

After completion of this unit, the student will be able to

UNIT – IV Social Issues and the Environment

No of Hours:
10

From Unsustainable to Sustainable development Urban problems related to energy. Water conservation, rainwater harvesting, watershed management. Environmental ethics: Issues and possible solutions. Green building concept.

Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies.

Activity:

1. Observing zero hour at individual level-documentation.
2. Eco friendly idols.
3. Rainwater harvesting-creating storage pits in nearby area.

**UNIT – V Human Population and the Environment and Environment Protection
Act and Field work**

No of Hours:
10

Population growth, variation among nations. Environment and human health. HIV/AIDS, Human rights. Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health. Environment Legislation. Air (Prevention and Control of Pollution) Act. Water (Prevention and Control of Pollution) Act. Wildlife Protection Act. Environmental Protection Act, Issues involved in enforcement of environmental legislation.

Activity:

1. Visit to a local polluted site-industry/agriculture
2. Identifying diseases due to inappropriate environmental conditions

Text Book(s)

1. Erach Bharucha. Textbook of environmental studies for undergraduates courses-Universities Press, India Private Limited. 2019.
2. Kaushik A and Kaushik C.P. Perspectives in Environmental Studies. New Age International Publishers Edition-VI. 2018.
3. Dave D Katewa S.S. Textbook of Environmental Studies, 2nd Edition. Cengage Learning India. 2012.

Additional Reading

1. Benny Joseph. Textbook of Environmental Studies 3rd edition, McGraw Hill Publishing company limited. 2017.

Reference Book(s):

1. McKinney M.L., Schoch R.M., Yonavjak L. Mincy G. Environmental Science: Systems and Solutions. Jones and Bartlett Publishers. 6th Edition. 2017.
2. Botkin D.B. Environmental Science: Earth as a Living Planet. John Wiley and Sons. 5th edition. 2005.

Journal(s):

1. <https://www.tandfonline.com/loi/genv20>
2. <https://library.lclark.edu/envs/corejournals>

Website(s):

<https://www.ugc.ac.in/oldpdf/modelcurriculum/env.pdf>
[From Climate Science to Action | Coursera](#)

	Programme Objectives (POs)												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2												2		
CO2		2				1							2		
CO3			1						1					1	
CO4				2							2				1
CO5	1													1	
CO6					2							1			1

1-Low, 2-Medium and 3-High Correlation

MFST1001: Health & Wellbeing

L	T	P	S	J	C
0	0	2	0	0	1*

The course provides the students a better understanding of the role of a proper diet in maintenance of human health. This course emphasizes the composition of the food, and will help to understand how to exercise, the role of sports and physical fitness in development of a good health. The course also focuses on the importance of emotional well-being and mindfulness. This course helps in teaching the role of yoga in maintenance of physical balance.

Course Objectives

- To provide an understanding of the relationship between food and nutrition
- To emphasize the role of exercise, sports and physical fitness in obtaining a good health
- To explain about the mindfulness and emotional well being
- To teach the role of yoga and meditation in maintaining the body balance

UNIT-I

Understand the relationship between Food and Nutrition and how food composition affects nutritional characteristics. Knowledge about regulatory principles in determining diets and recommended daily allowances. Understand how to create personalised diet/nutrition plans.

UNIT-II

Understand how exercise, activity and sports helps in developing good health. Experiential exposure to the role of proper, specific nutritional interventions along with structured activities on developing proper physical health. Practical exercises and assignments in sports and exercise regimes.

UNIT-III

Introduction to emotional wellbeing and mindfulness. Teaching of mindfulness practices to reduce stress, increase relaxation and improve mental wellbeing.

UNIT-IV

Introduction to Yoga theory and how Yoga helps in maintaining balance in the body. Practice of Yoga and meditation to improve overall emotional and physical balance. Practical yoga exercises and meditation techniques

Course outcomes:

By the end of the course, student will

- Learn the role of nutrition and diet in maintaining a good health
- Will understand how the exercise, sports and physical activities will improve health
- Will learn mindfulness practices for reducing stress
- Will know the importance of yoga and meditation

CLAD2001: Preparation for Campus Placement-1

(Soft Skills 5A)

L	T	P	S	J	C
0	0	2	0	0	1

Course Description:

The course addresses all relevant areas related to campus placements and readies them to ace their upcoming/ ongoing recruitment drives. Specifically, it focuses on students' career preparedness, interview skills, test preparedness, etc.

Course Objectives:

Prepare the students for their upcoming/ ongoing campus recruitment drives.

1. Career Preparedness: Resume & Cover Letter Writing, Interview Skills: Elevator Pitch, Making the First Impression, Being Other-Oriented, Being Positive and Curious, communicating with Confidence and Poise, Frequently Asked Questions & How to Answer Them, Pitfalls to Avoid, Etc. Etiquette: Hygiene, Courtesy, Culture differences, Workplace, use of cell phone, Profanity, Slang, Protocol.
2. Verbal Ability: Practising Reading Comprehension, Error Detection, Sentence Completion, MCQs, FIBs, Para jumbles, Cloze Test, Critical Reasoning.
3. Quantitative Aptitude: Number Systems, Algebra, Geometry, Data Handling, Data Sufficiency, Word Problems
4. Reasoning: Logical and Verbal Reasoning

Course Outcomes:

1. Write a power resume and covering letter
2. Answer interview questions with confidence and poise
3. Exhibit appropriate social mannerisms in interviews
4. Solve placement test questions on verbal ability, quantitative aptitude and reasoning

References:

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

CLAD2011: Preparation for Higher Education (GRE/ GMAT)-1 (Soft Skills 5B)

L	T	P	S	J	C
0	0	2	0	0	1

Course Description:

1. The course offers a special track for students who aspire to go abroad in pursuit of their higher education for which a GRE/ GMAT score is a prerequisite. It covers all four topical areas of these tests and includes fully solved mock tests as well.

Course Objectives:

1. Prepare the students to solve questions from all four broad areas of GRE/ GMAT
 2. Orient the students for GRE/ GMAT through mock tests
-
1. Verbal Reasoning: Reading Comprehension, Sentence Equivalence, Text Completion, Sentence Correction, Critical Reasoning
 2. Quantitative Reasoning: Arithmetic, Algebra, Geometry, Data Analysis
 3. Analytical Writing Assessment: Issue/ Argument
 4. Integrated Reasoning

Course Outcomes:

1. Solve questions from all four broad areas of GRE/ GMAT
2. Practice answering several mock tests

References:

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

CLAD2021: Preparation for CAT/ MAT - 1 (Soft Skills 5C)

L	T	P	S	J	C
0	0	2	0	0	1

Course Description:

The course offers a special track for UG students who aspire to go for higher education in business management in India for which cracking CAT/ MAT/ other related test is mandatory. It covers all four topical areas of these tests and includes fully solved mock tests as well.

Course Objectives:

1. Prepare the students to solve questions from all four relevant areas of CAT/ XAT/ MAT, etc.
 2. Orient the students for CAT/ XAT, etc. through mock tests
-
1. Quantitative Ability: Arithmetic, Algebra, Geometry, Mensuration, Calculus, Trigonometry
 2. Data Interpretation: Data Interpretation and Data Sufficiency
 3. Logical Reasoning: Data Management, Deductions, Verbal Reasoning and Non-Verbal Reasoning
 4. Verbal Ability: Critical Reasoning, Sentence Correction, Para Completion, Para Jumbles, Reading Comprehension

Course Outcomes:

1. Solve questions from all four relevant areas of CAT/ MAT as listed above
2. Practice test-cracking techniques through relevant mock tests

References:

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay

2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

CLAD2031: Preparation for Campus Placement-2

(Soft Skills 6A)

L	T	P	S	J	C
0	0	2	0	0	1

Course Description:

This course builds on the previous course and focuses on all four major areas of campus placements, including career preparedness, mock interviews, verbal ability, quantitative aptitude and logical reasoning.

Course Objectives:

1. To comprehensively prepare all eligible and aspiring students for landing their dream jobs.
 2. To sharpen the test-taking skills in all four major areas of all campus drives
-
1. Career Preparedness II: Mock Interviews, Feedback and Placement Readiness
 2. Verbal Ability II: Practising Reading Comprehension, Error Detection, Sentence Completion, MCQs, FIBs, Para jumbles, Cloze Test, Critical Reasoning
 3. Quantitative Aptitude II: Number Systems, Algebra, Geometry, Data Handling, Data Sufficiency, Word Problems
 4. Reasoning II: Logical and Verbal Reasoning

Course Outcomes:

1. Demonstrate career preparedness and confidence in tackling campus interviews
2. Solve placement test questions of a higher difficulty level in verbal ability, quantitative aptitude and logical reasoning.
3. Practice test-taking skills by solving relevant questions accurately and within time.

References:

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay

2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

CLAD2041: Preparation for Higher Education (GRE/ GMAT)-2

(Soft Skills 6B)

L	T	P	S	J	C
0	0	2	0	0	1

Course Description:

1. The course offers a special track for students who aspire to go abroad in pursuit of their higher education for which a GRE/ GMAT score is a prerequisite. It covers all four topical areas of these tests at a higher difficulty-level and includes fully solved mock tests as well.

Course Objectives:

1. Prepare the students to solve higher level questions from all four broad areas of GRE/ GMAT
 2. Orient the students for GRE/ GMAT through mock tests
-
1. Verbal Reasoning II: Reading Comprehension, Sentence Equivalence, Text Completion, Sentence Correction, Critical Reasoning
 2. Quantitative Reasoning II: Arithmetic, Algebra, Geometry, Data Analysis
 3. Analytical Writing Assessment II: Issue/ Argument
 4. Integrated Reasoning II

Course Outcomes:

1. Solve higher level questions from all four broad areas of GRE/ GMAT
2. Practice answering several mock tests

References:

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

CLAD2051: Preparation for CAT/ MAT - 2 (Soft Skills 6C)

L	T	P	S	J	C
0	0	2	0	0	1

Course Description:

The course offers a special track for UG students who aspire to go for higher education in business management in India for which cracking CAT/ MAT/ other related test is mandatory. It covers all four topical areas of these tests at a higher level of difficulty and includes fully solved mock tests as well.

Course Objectives:

1. Prepare the students to solve all types of questions from all four relevant areas of CAT/ XAT/ MAT, etc.
1. Quantitative Ability II: Arithmetic, Algebra, Geometry, Mensuration, Calculus, Trigonometry
2. Data Interpretation II: Data Interpretation and Data Sufficiency
3. Logical Reasoning II: Data Management, Deductions, Verbal Reasoning and Non-Verbal Reasoning
4. Verbal Ability II: Critical Reasoning, Sentence Correction, Para Completion, Para Jumbles, Reading Comprehension

Course Outcomes:

1. Solve higher difficulty level questions from all four relevant areas of CAT/ MAT as listed above
2. Practice test-cracking techniques through relevant mock tests

References:

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

FINA3001: Personal Financial Planning

L	T	P	S	J	C
0	0	2	0	0	1*

Course Overview

Personal Financial Planning is one of the most significant factors in our lives. It is essential that funds are available as and when required at various stages of life. Unavailability of funds at critical stages of our life leads to financial distress and leads to many medical and non-medical problems. There are certain planned and unplanned events in our life. On the one hand, education of our children, their marriage, our retirement etc. are some of the planned events of our life, but at the same time, some medical urgency, accident or death of an earning member might be some unplanned events. Many of these events are beyond our control, but the availability of funds can be planned to avoid any financial distress. In other words, we cannot stop the rain but can plan for an umbrella.

This course looks at the many challenges an individual faces in a complex financial environment and the rising uncertainties of one's life. It focuses on achieving long-term financial comfort of individual and family through goal setting, developing financial and life strategies, acquiring personal financial planning knowledge and managing risk throughout one's life.

Course Objectives:

1. To build students' ability to plan for long-term financial comfort of individual and family through goal setting, developing financial and life strategies.
2. To provide students with knowledge on terms, techniques to evaluate investment avenues.
3. To build the skill set of the student to enable them to file their tax returns.

Course Outcome:

1. Describe the financial planning process and application of time value of money
2. Application of life and non-life insurance products in financial planning
3. Understand the investment avenues and analysis of investment returns
4. Understand the retirement planning and its application
5. Describe and analysis the Tax Planning

Unit 1: Basics of Financial Planning

Financial Planning Meaning, Need, Objectives, Financial Planning Process, Time Value of Money and its application using excel (NP)

Unit 2: Risk and Insurance Management

Need for insurance, Requirement of insurance interest, Role of insurance in personal finance, Steps in insurance planning, Life and Non-life insurance products, Life insurance needs analysis (NP)

Unit 3: Investment Products and Measuring Investment Returns

Investment Products: Small Saving Instruments, Fixed Income Instruments, Alternate

Investments, Direct Equity

Measuring Investment Returns: Understanding Return and its concept, Compounding concept, Real vs Nominal Rate of Return, Tax Adjusted Return, Risk-Adjusted Return (NP)

Unit 4: Retirement Planning

Introduction to the retirement planning process, estimating retirement corpus, Determining the retirement corpus, Retirement Products (NP)

Unit: 5 Tax Planning

Income Tax: Income tax principles: Heads of Incomes, Exemptions and Deductions, Types of Assesses, Rates of Taxation, Obligations for Filing and Reporting, Tax aspects of Investment Products, Wealth Tax

Text Books

1. National Institute of Securities Management (NISM) Module 1 & XA
2. Madhu Sinha, Financial Planning, 2 Edition, McGraw Hill India
3. Simplified Financial Management by Vinay Bhagwat, The Times Group

Reference Books

1. Personal Financial Planning (Wealth Management) by S Murali and K R Subbakrishna, Himalaya Publishing House.
2. Mishra K.C., Doss S, (2009). Basics of Personal Financial Planning 1e. National Insurance Academy, New Delhi: Cengage Learning.
3. Risk Analysis, Insurance and Retirement Planning by Indian Institute of Banking and Finance.

The following is the Program structure for B.Sc. Chemistry program semester wise.

	Credits	Sem1	Sem 2	Sem 3	Sem 4	Sem 5	Sem 6	Theory subjects	Lab papers
University Core	12	3	5	1	1	1	1	5	12
Faculty Core	18	9 +1 (L)	6+2 (L)	-	-	-	-	5	3
Program Core	32	3+1(L)	3+1 (L)	6+2 (L)	3+1 (L)	6+2 (L)	3+1 (L)	8	8
Program Electives	16	-	-	3+1(L)	6	3	3	5	1
Minors	24	-	3+1(L)	6	6+1(L)	3+1(L)	3	7	3
Open Elective	18	-	-	3	3	6	6	6	-
B.Sc.	120	17	21	22	21	22	17	-	-

FACULTY CORE

MATH1081: Mathematics for Science (FC)

Hours per week: 3
Credits: 3

Continuous Evaluation: 70 Marks
Semester End Examination: 30 Marks

Preamble

This course is introduced to learn fundamental topics in mathematics for chemistry students in the undergraduate level such as trigonometry, limits, continuity, differentiation, and integration.

Course objectives:

- To understand trigonometry and their uses in real life problems
- To learn the basic concept and applications of limits
- To identify and estimate the continuity of the function and type of discontinuity
- Ability to differentiate all the functions such as polynomials, trigonometric and logarithmic etc.
- Ability to integrate different types of functions definitely and indefinitely.

Unit-I:

8L

Trigonometry: Measurement of angles, Trigonometric ratios of any angle, signs of the trigonometric ratios of allied angles, trigonometric identities and trigonometric ratios of compound angles.

Learning outcomes:

By the end of this Unit, the student will be able to

- **define** trigonometric ratios of any angle (L1)
- **describe** various trigonometric identities (L1)
- **evaluate** trigonometric ratios of allied angles (L2)
- **choose** appropriate method to solve trigonometric identities (L2)
- **evaluate** trigonometric ratios of compound angles (L2)

Unit-II:

9L

Trigonometry: Trigonometric ratios of multiple and sub multiple angles, Transformations, Inverse trigonometric functions, Hyperbolic functions.

Learning outcomes

By the end of this Unit, the student will be able to

- **illustrate** the concept of trigonometric ratios (L2)
- **evaluate** trigonometric ratios of multiple and sub multiple angles (L2)
- **explain** the concept of transformation in trigonometry (L2)
- **evaluate** problems on trigonometric functions and inverse trigonometric functions (L2)
- **describe** various types of hyperbolic functions (L2)

Unit-III:

8L

Limits: Real numbers, Intervals, Functions, Limit, and One sided limits, Infinite limits, standard limits, indeterminate forms, problems on limits

Continuity- definition and simple illustrations.

Learning outcomes:

By the end of this Unit, the student will be able to

- **explain** the need of limits and continuity in real life problems (L2)
- **apply** various methods to solve limit of a function (L2)
- **evaluate** the one sided limits and infinite limits (L3)
- **explain** various types of standard limits and evaluate problems on limits (L3)
- **describe** various types of discontinuities. (L3)

Unit-IV:

9L

Differentiation: Derivative of a function, Derivative from first principles, Product and Quotient rule for derivatives, Derivatives of some standard functions, Derivatives of trigonometric functions, composite functions, hyperbolic functions Derivatives of inverse trigonometric functions, inverse hyperbolic functions, Implicit differentiation, Logarithmic differentiation, derivatives by trigonometric substitution.

Learning outcomes:

By the end of this Unit, the student will be able to

- **define** derivative of a function (L1)
- **summarize** different types of rules to solve differentiation (L1)
- **evaluate** the derivatives of trigonometric functions (L2)
- **evaluate** the derivatives hyperbolic functions (L2)
- **explain** and evaluate the derivatives of logarithmic functions (L3)

Unit-V:

8L

Indefinite integration: Indefinite integral, methods of integration, integration by substitution, integration of some standard functions, integration by parts, integration of rational functions

Definite integration: Definite integrals, Properties of definite integrals.

Learning outcomes:

By the end of this Unit, the student will be able to

- **explain** various methods of integration (L2)
- **evaluate** the functions using integration by parts (L2)
- **explain** integration of rational functions (L2)
- **explain** difference between definite and indefinite integrals (L3)
- **describe** the properties of definite integrals (L4)

Text Books:

1. A textbook of Intermediate Mathematics: Vol I, V. Venkateswara Rao, N. Krishna Murty, B.V.S.S. Sarma, S.Chand& Co
2. A textbook of Intermediate Mathematics: Vol II, V. Venkateswara Rao, N. Krishna Murty, B.V.S.S. Sarma, S.Chand& Co

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1							1	1	2	2					
CO2							1	2	2	1					
CO3							2	2	1	2					
CO4							2	1	2	2					
CO5							1	2	1	2					

1-Low, 2- Medium and 3- High Correlation

PHYS1051: Physics I (FC)

Hours per week: 3
Credits: 3

Continuous Evaluation: 70 Marks
Semester End Examination: 30 Marks

Unit-I: Measurements

9L

Physical quantities-standards and units-International systems of units-the standard of time-the standard length-the standard mass precession and significant figures. Dimensional Homogeneity and Consistency-Dimensional analysis-Dimensionless groups and their use in chemical engineering-National Standards of Weights-Measurements & their calibration.

Unit-II: Mechanics

8L

Forces and Resolution of Forces-Composition of Coplanar Forces-friction-Centre of Gravity-Simple Lifting Machine-Work and Kinetic Energy Theorem-Conservative and non-conservative forces- Potential Energy-Energy diagram Stable and unstable equilibrium-Work & Potential energy-Work done by non-conservative forces-Law of conservation of Energy.

Unit-III: Wave nature of light and Optical fibers

9L

Introduction-Nature of light-Reflection and refraction-Total internal reflection- Definition and properties of wave front and ray - Huygens principle- Mathematical representation of plane wave-General wave equation-Optical Fibers-Numerical aperture- Acceptance angle-Step and Graded Indices (Concept and definitions only). Single and Multiple mode fibers (Concept and definition Only)-Applications of optical fibers

Unit-IV: Waves-Interference and Diffraction

8L

Division of amplitude and wave front-Young's double slit experiment-Phase change on reflection- Stokes' treatment-Interference in Thin films-parallel and wedge-shaped films-Fringes of equal inclination (Haidinger fringes). Newton's Rings: Measurement of wavelength and refractive index. Diffraction-types of diffraction-Diffraction grating and resolving power.

Unit-V: LASER

8L

Introduction-Absorption-Spontaneous and stimulated emissions-Meta stable state-population inversion-Lasing action-components of laser-Types of laser -Ruby laser -He-Ne laser - Semi conductor laser -Characteristics and applications of laser.

Text Books:

1. Physics-D.Resnick and R.Halliday, Wiley Publishers
2. Text book of Engineering Physics-Dr. M N Avadhanulu&Dr.P G Kshirsagar, S Chand & Co Pvt Ltd, New Delhi
3. Optics-Brijlal Subrahmanyam, S Chand Co
4. Engineering Physics-R.K.Gaur and S.L.Gupta, Dhanpat Rai & Sons, Delhi

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1							2	1	1	2					
CO2							2	2	2	1					

C03							1	1	1	2					
C04							2	2	2	1					
C05							1	2	1	2					

1-Low, 2- Medium and 3- High Correlation

MATH1111: Statistics (FC)

Hours per week: 3
Credits: 3

Continuous Evaluation: 70 Marks
Semester End Examination: 30 Marks

Preamble

This course is an introductory to statistics for undergraduate students in sciences. Statistical methods are important tools which provide the student with both descriptive and analytical methods for dealing with the variability in observed data. It introduces students to cognitive learning in statistics; and develops skills on analyzing the data by using different tests and designing the experiments with several factors.

Course objectives:

- To summarize the data and to obtain its salient features from the vast mass of original data.
- To describe the basic measures of statistics including measures of location, dispersion and linear regression.
- To understand the concepts of Large Samples and Small Samples.

Unit-I:

8L

Statistical Methods: Definition and scope of Statistics, concepts of statistical population and sample. **Data:** quantitative and qualitative, attributes, variables, scales of measurement nominal, ordinal, interval and ratio. Presentation: tabular and graphical, including histogram and ogives.

Learning Outcomes:

At the end of this unit, the student will be able to

- **organize**, manage and present the given data. (L3)
- **analyze** statistical data graphically using frequency distributions and cumulative frequency distributions. (L4)
- **understand** the difference between the levels of measurement: nominal, ordinal, interval, and ratio. (L4)
- **identify** the general elements that characterize a study. (L4)
- **understand** the fundamentals of experimental design. (L5)

Unit-II:

8L

Measures of Central Tendency: Arithmetic mean, Median, Mode, Geometric Mean, Harmonic mean.

Learning Outcomes:

At the end of this unit, the student will be able to

- **analyze** statistical data using measures of central tendency. (L3)
- **understand** the differences between each measure of center. (L5)
- **identify** the symbols and know the formulas for sample and population means. (L5)

Unit-III:

8L

Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, Moments, absolute moments, factorial moments, skewness and kurtosis, Sheppard's corrections

Learning outcomes:

At the end of this unit, the student will be able to

- **calculate** the range and inter-quartile range. (L5)
- **calculate** the standard deviation for a population and a sample, and understand its meaning. (L5)

Unit–IV:**8 L**

Bivariate Data Analysis: Definition, scatter diagram, simple, correlation, rank correlation. Simple linear regression.

Learning outcomes:

At the end of this unit, the student will be able to

- **understand** the concept of bivariate data, correlation and the use of scatter plots to display bivariate data. (L4)
- **understand** when the terms “positive,” “negative” “strong,” and “perfect” apply to correlation between two variables in a scatter plot graph. (L3)
- **calculate** and interpret the correlation between two variables then fitting of regression line. (L4)
- **calculate** the simple linear regression equation for a set of data. (L5)

Unit–V:**10L**

Testing of Hypothesis : Formulation and procedure testing of hypothesis

Test for single mean and difference of means. Confidence interval for parameters in one sample and two sample problems. Student t-distribution (test for single mean, two means), χ^2 - test for goodness of fit, χ^2 - test for independence of attributes.

Learning outcomes:

At the end of this unit, the student will be able to

- **apply** parametric tests in different real life data. (L3)
- **understand** the features of experiments that allow Goodness-of-Fit tests to be used. (L4)
- **run** a Test of Independence to determine whether two variables are independent or not. (L5)

Course Outcomes:

At the end of the course the student will be able to

- analyze statistical data graphically using frequency distributions and cumulative frequency distributions. (L4)
- analyze statistical data using measures of central tendency, dispersion & location. (L3)
- calculate & interpret the correlation between two variables then fitting of regression line. (L4)

Text Books:

1. Feller, W. (2014): An Introduction to Probability theory and application, Wiley.
2. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edition. The World Press, Kolkata.
3. Gupta, S.C. and Kapoor, V.K. (2007): Fundamental of Mathematical Statistics, 11th Edition. (Reprint), Sultan Chand & Sons.

Reference Books:

1. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edition.), Pearson Education, Asia.
2. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edition., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
3. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New D.
4. S. Ross, A First Course in Probability, Pearson Education India, 2002.

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1							2	1	1	2					
CO2							2	1	2	1					
CO3							1	2	1	2					
CO4							1	1	2	2					
CO5							2	2	1	2					

1-Low, 2- Medium and 3- High Correlation

PHYS1061: Physics I Lab (FC)

Hours per week: 2

Credits: 1

Continuous Evaluation: 100 Marks

List of experiments:

1. Determination of thickness of wire by using Screw guage
2. Determination of volume of the cylinder or sphere by using Vernier calipers
3. Radius of curvature of curved surface using Spherometer
4. Determination of time period of Simple pendulum
5. Determination of Numerical aperture/Loss of Optical fiber
6. Determination of wavelength of LASER using grating
7. Determination of wavelength of monochromatic light with Newton's rings
8. Diffraction due to single slit/circular aperture
9. Study of characteristics of LASER

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1							2	1	2	2					
CO2							2	1	2	1					

C03							1	2	1	2					
C04							2	1	2	1					
C05							2	2	1	2					

1-Low, 2- Medium and 3- High Correlation

PHYS1071: Physics II (FC)

Hours per week: 3

Credits: 3

Continuous Evaluation: 70 Marks

Semester End Examination: 30 Marks

Preamble: To Study the general properties of solids and nucleus

Objective: Understanding and examine the solids with properties of crystals, electron theory and different magnetic materials. Interpret the general properties of nuclei and its radioactive properties.

UNIT I

Crystal Structure

Amorphous and Crystalline Materials, Unit Cell, Miller Indices, Reciprocal Lattice, Types of Lattices, Diffraction of X-rays by Crystals, Bragg's Law, Experimental techniques, Laue's method and powder diffraction method.

Learning Outcomes

To illustrate crystalline structures (L2)

Experimental studies of crystals (L3)

UNIT II

Introduction to Free electron and band theory

Free electron theory and its demerits, Bloch theorem and Kronig Penny model, Energy Bands in solids, Energy gaps, Conductors, Semiconductors and insulators, P and N type Semiconductors, P-N Junction diode, Half wave and Full wave rectifiers (qualitative).

Learning Outcomes

Construct model for band theory of solids (L3)

Classify various semiconductors (L2)

UNIT III

Magnetic Materials & Superconductivity

Dia, Para, Ferromagnetic Materials, Classical Langevin Theory of Paramagnetism, Curie-Weiss's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains- Basic concepts of superconductivity Experimental Results, Critical Temperature, Critical magnetic field- Meissner effect. Type I and type II Superconductors- applications of super conductors

Learning Outcomes

Classification of magnetic materials and explain related theories (L2)

Outline superconductors (L2)

Unit IV

General Properties of Nuclei

Basic ideas of nucleus -size, mass, charge density (matter energy), binding energy, angular momentum, parity, magnetic moment, electric moments, semi-empirical mass formula.

Liquid drop model-Shell model- Collective model (qualitative), Magic numbers.

Learning Outcomes

To outline various properties of nuclei (L2)

To classify various Models of Nucleus (L4)

UNIT V

Radioactivity decay

Alpha decay: basics of α -decay processes, Gamow's theory of α -decay, Geiger Nuttal law, β -decay, Energy kinematics for β -decay, positron emission, electron capture, neutrino hypothesis. Detectors of nuclear Radiation -Ionization chamber, Proportional counter, GM Counter, scintillation counter.

Learning Outcomes

To outline various properties of and theories of radioactive radiation (L2)
Experimental studies of detectors of radiation (L3)

Course Outcomes

- To illustrate crystalline structures and experimental studies of crystals (L2)
- Construct model for band theory of solids (L3)
- Classify various semiconductors (L2)
- Classification of magnetic materials and explain related theories (L2 and L3)
- Outline superconductors (L2)
- To outline properties of nuclei and related models (L2 and L4)
- To outline properties, theories and experiments of radioactive radiation (L2 and L3)

Text Books:

- Elements of Solid State Physics, J.P. Srivastava, Prentice Hall of India Pvt., Ltd.
- Unified Physics, Vol.4., S.L. Gupta & Sanjeev Gupta, Jai Prakash Nath & Co. Meerut.

Reference Books:

- Concepts of Modern Physics, Arthur Beiser Tata McGraw Hill Edition.
- Nuclear Physics, Irving kaplan, Narosa publishing House.
- Introduction to Solid State Physics, C. Kittel, John Wiley & Sons.
- Solid State Physics, A.J. Dekker, McMillan India.
- Physics of Magnetism Sushin Chikazumi, Stanley H. Charap, Krieger Pub Co (June 1978)
- Nuclear Physics, D.C. Tayal, Himalaya Publishing House.

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1							2	3	2	2					
CO2							3	2	2	1					
CO3							1	2	2	3					
CO4							2	1	3	1					
CO5							1	3	2	2					

1-Low, 2- Medium and 3- High Correlation

CSCI1011: Programming with C (FC)

Hours per week: 3
Credits: 3

Continuous Evaluation: 70 Marks
Semester End Examination: 30 Marks

Preamble:

C is a general purpose programming language. It is basis for Java and C++. This course deals with the same objects that are manipulated by computers: single characters, numbers and memory addresses. Any other type of object is created, by the programmer, by combining those objects (e.g., character strings, arrays, records, fields, etc.).

Course Objectives:

- To understand the difference between different datatypes
- To learn the basic concept, applications of control statements
- To identify and practice the functions and program structures
- Ability to process arrays, multi-dimensional arrays and character arrays.
- To understand the concept of pointers and functions.
- To understand the concept of structures and unions

UNIT- I

Datatypes, operators and some statements, Identifiers and keywords, constants, Coperators, Type conversion. Writing a program in C: Variable declaration, statements, simple C programs, simple input statement, simple output statement, feature of study.

Control statements: conditional expressions, If statement, If-else statement, switch statement, Loop statements, for loop, while loop, do-while loop, Breaking, control statements, Break statement, continue statement, Goto statement.

Learning Outcomes:

By the end of this Unit, the student will be able to

- List the data types, operators and some statements in C
- Describe the basic concepts of control statements
- Explain the concepts of Loop statements

UNIT- II

Functions and Program structures: Introduction, Defining a function, Return statement, Types of functions, Actual and formal arguments, Local Global variables, Automatic variables, register variables, static variables, External variables, Recursive functions.

By the end of this Unit, the student will be able to

- Describe the basic concepts of functions
- Explain different types of functions used in C
- Explain difference between Local and Global variables
- Explain the concept of recursive functions

UNIT-III

Arrays: Array Notation, Array declaration, Array initialization, Processing with arrays, Arrays and functions, Multidimensional array, Character array.

By the end of this Unit, the student will be able to

- Describe the basic concepts of arrays
- Explain different types of arrays and functions
- Explain multidimensional arrays and character arrays

UNIT-IV

Pointers: Pointer declaration, Pointer operator, address operator, pointer expressions, pointer arithmetic, pointers and functions, call by value. Call by reference, pointers and arrays, pointer and one dimensional array, pointer and multidimensional array, pointer and strings, array of pointers, pointer stop inters.

By the end of this Unit, the student will be able to

- Describe the basic concepts of pointers
- Explain different types of pointers and functions
- Explain the concept of pointer and strings and also pointerstopointers

UNIT-V

Structures, Unions: Declaration of structure, Initializing a structure, Functions and structures, Arrays of structures, arrays with in a structure, structure with in a structure, Flow charts and structures, Unions.

By the end of this Unit, the student will be able to

- Describe the basic concepts of structures and unions
- Explain different types of functions and structures
- Explain the concept of arrays of structures, structures with in a structure and flow charts and structures

Textbook:

1. Programming in C by D. Ravi Chandran, New Age international Publishers, 2006.

Reference Books

1. Let Us C by Yashwant Kanetkar, 13th Edition, Publications, 2012.
2. Programming in ANSIC by E. Balaguruswamy, 6th Edition, McGraw Hill Education, 2012.
3. Programming in C by Smarajit Ghosh, Prentice Hall India Pvt. Ltd (2004).

Course Learning Outcomes:

On successful completion of this course, students will be able to

- Describe the basic concepts of control statements in C
- Explain the concepts of Loop statements in C
- Explain difference between Local and Global variables
- Explain the concept of recursive functions
- Explain multidimensional arrays and character arrays

- Explain different types of pointers and functions
- Explain the concept of pointer and strings and also pointer stop pointers
- Explain different types of functions and structures in C
- Explain the concept of arrays of structures, structures with in a structure and flow charts and structures in C

•	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1							1	3	2	2					
CO2							3	2	2	1					
CO3							2	2	3	3					
CO4							2	1	3	1					
CO5							1	3	3	2					

1-Low, 2- Medium and 3- High Correlation

CSCI1021: Programming with C Lab (FC)

Hours per week: 2

Credits: 1

Continuous Evaluation: 100 Marks

1. Program to convert a given decimal number to octal number
2. Program to solve quadratic equation using switch case structure
3. Program to check a given integer is a palindrome
4. Program to check a given integer is a prime number
5. Sorting of numbers
6. Multiplication of two matrices
7. Inverse of a matrix
8. Finding norm of a matrix using function
9. Program to check a given string is a palindrome or not
10. Using pointers copying a string to another string
11. Using pointers and functions sorting of number
12. Computer binomial coefficients using recursive function for factorial

Course Outcomes:

- Able to solve problems using switch case structure
- Differentiate the sorting of numbers using different methods
- Explain looping structure to create a matrix
- Identify the differences in matrix multiplication and to find inverse of a matrix

- Examine the working of Control structures in C programs
- Able to develop and implement pointers
- Able to develop applications with the help of pointers and functions
- Understand various types of subroutine programs and apply in applications

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1							2	3	2	2					
CO2							3	2	2	1					
CO3							1	2	3	3					
CO4							2	1	3	1					
CO5							1	3	3	2					

1-Low, 2- Medium and 3- High Correlation

PHYS 1081: Physics II Lab (FC)

Hours per week: 2

Credits: 1

Continuous Evaluation: 100 Marks

Preamble: To perform experimental studies related to solids state and radioactive sources.

Objective: To develop and explain properties related to solids state and radioactive sources.

List of Experiments:

Ultrasonic Interferometer
 Rigidity modulus-Internal friction
 B-H Curve- Determination of Curie temperature
 Thermo EMF
 Dielectric Constant
 Plateau Characteristics
 Intensity variation of radiation
 Absorption Coefficient of material
 Statistical Aspects of Radiation
 Beta back scattering factor
 Gamma ray Spectrometer Energy resolution characteristics

Course Outcomes:

- Learn the ground state properties of a nucleus.
- Learn about the process of radioactivity, the radioactive decay law, the emission of alpha, beta and gamma rays.
- Learn the basic aspects of measurements

- Learn about the detectors of nuclear radiations.
- Gain knowledge on the how to measure properties of radiation

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1							2	3	2	2					
CO2							3	2	2	1					
CO3							1	2	3	3					
CO4							2	1	3	1					
CO5							1	3	3	2					

1-Low, 2- Medium and 3- High Correlation

Program Core

CHEM1061: Inorganic Chemistry I

Hours per week: 3

Credits: 3

Continuous Evaluation: 70 Marks

Semester End Examination: 30 Marks

Preamble

This course enables the students to gain knowledge in chemistry, starts with dealing of the nucleus (proton, electron, etc.), theories, and wave functions, in further it gives the information regarding the periodic classification, bonding nature, bond types (sigma and pi), bond order, and different types of the interactions. The knowledge gained in this course will be helpful in different chemical reactions (bond cleavage and bond breaking).

Course objectives

- To study the atom, proton, electron, and element properties
- To know the importance of wave functions
- To impart knowledge of the bonding nature in molecules
- To emphasize the importance of the electron filling and bond order
- To study the different types of chemical bonding

Unit-I: Atomic structure

9L

Bohr's theory, its limitations, and the atomic spectrum of the hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, the significance of ψ and ψ^2 . Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for the hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d, and f orbitals. Contour boundary and probability diagrams.

Learning outcomes:

By the end of this Unit, the student will be able to

- **describe** the atomic theories (L1)
- **recognize** quantum numbers and their significance (L1)
- **discuss** the radial, nodal planes, and wave functions (L2)
- **sketch** the shape of the different orbitals (L2)

Unit-II: Periodicity of s, p, d, f - block elements

8L

s, p, d, and f-block elements, the long form of the periodic table. A detailed discussion of the following properties of the elements, with reference to s, p, d, and f-block.

(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in the periodic table. (b) Atomic radii (van der Waals) (c) Ionic and crystal radii. (d) Covalent radii (octahedral and tetrahedral) (e) Ionization enthalpy, Successive ionization enthalpies, and factors affecting ionization energy. Applications of ionization enthalpy. Electronegativity, Pauling's/Mulliken's/ electronegativity scales.

Learning outcomes:

By the end of this Unit, the student will be able to

- **describe** the periodic table and its classification to groups and periods (L1)
- **illustrate** the electronic configuration of the s,p-block elements (L1)

- **calculate** the effective nuclear charge by Slater rule (L2)
- **explain** enthalpy and electronegativity (L2)

Unit-III: Chemical bonding-1

8L

Ionic bond: General characteristics, types of ions, size effects, radius ratio rule, and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Born-Haber cycle and its application, Solvation energy. **Covalent bond:** Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule.

Learning outcomes:

By the end of this Unit, the student will be able to

- **describe** the ion packing in crystal (L2)
- **apply** Born-Haber cycle to calculate lattice energy (L2)
- **compare** theories of covalent bonding (L3)
- **explain** the geometry and shape of molecule by Bent's rule (L3)

Unit-IV: Chemical bonding-2

9L

Molecular Orbital Theory (MOT), molecular orbital diagrams of diatomic and simple polyatomic molecules N_2 , O_2 , C_2 , B_2 , F_2 , CO , NO , and their ions; HCl , BeF_2 , (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

Learning outcomes:

By the end of this Unit, the student will be able to

- **draw** the molecular orbital diagrams of homo and simple hetero molecules (L1)
- **calculate** bond order (L1)
- **explain** the shapes of simple molecules and ions using VSEPR theory (L2)
- **calculate** percentage ionic character (L3)

Unit-V: Chemical bonding-3

8L

Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids. **Weak Chemical Forces:** van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment).

Learning outcomes:

By the end of this Unit, the student will be able to

- **classify** solids as conductors and insulators (L2)
- **describe** band theories (L3)
- **compare** the different types of interactions (L4)
- **explain** theories of hydrogen bonding (L2)

Course outcomes

- **understand** about the particles which are in the nucleus of atom/element (L1)
- **comprehend** the idea of the periodic table classification and its order (L2)
- **differentiate** between crystal and powder and its arrangement in crystal, product formation through many steps (sublimation, ionization enthalpy, etc.) (L3)
- **explain** the chemical bonding and bond order in homo and hetero molecules (L4)
- **describe** the conductors, insulators, and different types of interactions (L5)

Text Books:

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Atkins, P.W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.
3. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.

(g)	Program Objectives(POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEM1071: Inorganic Chemistry-I Lab (MAC)

Hours per week: 2

Credits: 1

Continuous Evaluation: 100 Marks

Preamble

In this course, we projected to teach and demonstrate the usage of the apparatus, and preparation of the different concentrated solutions. It continues, there are two different types of the experiments with acid-base titrations and oxidation-reduction titrimetric.

Course objectives

- Demonstration about the usage of the chemical apparatus which are in laboratory experiments
- Gives idea about the acid-base terms, its reactions and indicators
- Oxidation and reduction terms (oxidizing agent, reducing agent) and indicators.

(A) Titrimetric Analysis

- (i) Calibration and use of apparatus
- (ii) Preparation of solutions of different Molarity/Normality of titrants

(B) Acid-Base Titrations

- (i) Estimation of carbonate and hydroxide present together in mixture.
- (ii) Estimation of carbonate and bicarbonate present together in a mixture.

(C) Oxidation-Reduction Titrimetry

- (i) Estimation of Fe(II) and oxalic acid using standardized KMnO_4 solution.
- (ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
- (iii) Estimation of Fe(II) with $\text{K}_2\text{Cr}_2\text{O}_7$ using internal **external** (diphenylamine, anthranilic acid) and external indicator.

Course outcomes

- **understand** the basics of laboratory practices (L1)
- **understand** about the usage of the chemical apparatus (L2)
- **know** about the acid-base reactions and usage of specific indicator in particular pH range (L3)
- **get** the idea about the terms of oxidation and reduction reactions. (L4)
- **master** the pertaining laboratory skills in inorganic chemistry (L4)

Text Books

Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009

CHEM 1081: Physical Chemistry I

Hours per week: 3
Credits: 3

Continuous Evaluation: 70 Marks
Semester End Examination: 30 Marks

Preamble

The difference in the physical and chemical properties of the three states of matter: solid, liquid and gas, can be understood in terms of atomic hypothesis as rightly pointed out by Richard Feynman: "I believe it is the atomic hypothesis that all things are made of atoms — little particles that move around in perpetual motion, attracting each other when they are a little distance apart, but repelling upon being squeezed into one another." This hypothesis forms the preamble of this beginners course in Physical Chemistry.

Course objectives:

- To introduce different states of matter as a mere interplay of interatomic interactions.
- To illustrate different theories to model the behaviour of gas particles
- To rationalize the properties of liquids like vapour pressure, surface tension and viscosity in terms of associated interatomic interactions
- To provide insights into properties of amorphous and crystalline solids and theories behind crystal X-ray diffraction.
- To demonstrate how different types of acids, bases and salts interact in solutions in terms of equilibrium between the substance and its constituent ions and consequences of these interactions

Unit-I: Gaseous state:

9L

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, relation between mean free path and coefficient of viscosity, Variation of viscosity with temperature and pressure, Molecular velocities (average, root mean square and most probable) and average kinetic energy.

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z , and its variation with pressure for different gases. Causes of deviation from ideal behavior.

Vander Waals equation of state

Learning outcomes:

By the end of this Unit, the student will be able to

- **understand** the kinetic theory of gases, its applications and limitations (L2)
- **understand** the concepts of mean free path and viscosity (L2)
- **compare** and contrast behavior of ideal and real gases (L2)

Unit-II: Liquid state

Qualitative treatment of the structure of the liquid state; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Temperature variation of viscosity of liquids. Qualitative discussion of structure of water (in the ice form).

Learning outcomes:

By the end of this Unit, the student will be able to

- **understand** the properties of liquids such as vapour pressure, surface tension and viscosity (L2)
- **interpret** different properties of liquids in terms of atomic hypothesis (L3)

Unit-III: Solid state

8L

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's equation.

Learning outcomes:

By the end of this Unit, the student will be able to

- **understand** laws of crystallography (L2)
- **understand** different symmetry elements and operations present in various crystal systems (L2)
- **interpret** X-ray diffraction in terms of Bragg's equation (L3)

Unit-IV: Ionic equilibria-1

9L

Strong, moderate, and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant, and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions- derivation of Henderson equation and its applications; and applications of buffers in analytical chemistry.

Learning outcomes:

By the end of this Unit, the student will be able to

- **understand** difference between strong and weak electrolytes in terms of degree of ionization (L2)
- **understand** and apply the concepts of common ion effect and salt hydrolysis (L2)
- **acquire** knowledge of buffers, Henderson equation and their applications (L2)

Unit-V: Ionic equilibria-2

8L

Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid-base titration curves (calculation of pH at various stages). Theory of acid-base indicators; selection of indicators and their limitations.

Learning outcomes:

By the end of this Unit, the student will be able to

- **understand** the concept of solubility product and its application (L2)
- **understand** the role of acid-base indicators and theories describing their action (L2)
- **acquire** Knowledge on pH metry (L2)

Course outcomes:

- **understand** differences in properties of the three states of matter in terms of atomic hypothesis (L1)
- **gain** knowledge of kinetic theory of gases and differences between the behavior of ideal and real gases (L2)
- **gain** insights into different physical properties of liquids (L3)
- **appreciate** the symmetry in crystalline solids and understand the usefulness of crystal X-ray diffraction (L4)
- **gain** insights into ionic interactions in solutions and their role in solubility and conductance (L4)

Text Books:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 10th Ed., Oxford University Press (2014).
2. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).

	Program Objectives(POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEM1091: Physical Chemistry-I Lab (MAC Lab)

Hours per week: 2 Credits: 1 Continuous Evaluation: 100 marks

Preamble

This lab course complements the theory course in States of Matter and Ionic equilibrium. It is concerned with the measurement of physical properties of liquids such as surface tension and viscosity, and the instrumental technique of pH metry.

Course objectives:

- To illustrate the concepts of surface tension and viscosity
- To provide hands-on experience in determining surface tension and viscosity of a given liquid using simple techniques
- To provide hands-on experience in performing pH metry involving strong and weak acids and bases

1. Surface tension measurements.

Determination of the surface tension by drop number method.

2. Viscosity measurement using Ostwald's viscometer.

Determination of viscosity of aqueous solutions of (i) ethanol and (ii) sugar at room temperature.

3. pH metry

- a. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium Acetate, and their mixtures.
- b. Preparation of buffer solutions of different pH
 - i. Sodium acetate-acetic acid
 - ii. Ammonium chloride-ammonium hydroxide
- c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.

Course outcomes:

By the end of this lab course, the student will be able to

- **understand** physical properties of liquids (L2)
- **understand** the applications of pH metric titrations (L2)
- **obtain** hands-on experience in measuring surface tension and viscosity, and I
- performing pH metry. (L3)

Text Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

4.	Program Objectives(POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEM2001: Organic chemistry – I (MAC)

Hours per week: 3
Credits: 3

Continuous Evaluation: 70 Marks
Semester End Examination: 30 Marks

Preamble

Organic chemistry is the chemistry of the compounds of carbon and these compounds constitute a major role in the survival of mankind. The importance and existence of millions of carbon compounds has necessitated the emergence of this branch of chemistry. It includes the study of the structure, composition, nomenclature, properties (physical, chemical, etc.), reactions, and synthesis of the library of organic compounds. This course was intended to create a knowledge in basics of organic chemistry and their applications in the study of simple hydrocarbons.

Course objectives

- To explain the importance of organic chemistry, how it is different from other branches of chemistry
- To make the students understand the structural features of the organic compounds and their classification
- To discuss the nomenclature rules laid by IUPAC
- To introduce the basic concepts encountered in organic chemistry – bond breaking, reagents, electronic effects, reaction intermediates, and types of organic reactions
- To create a 3-dimensional visualization of organic molecules and talk about their structural and stereoisomerism. Biological importance of stereoisomers
- Application of the knowledge to synthesize basic organic molecules and to study their properties
- To introduce the chemistry of aromatic compounds and their reactivity

Unit-I: Basics of organic chemistry

9L

Organic compounds: Classification, nomenclature and hybridization.

Electronic displacements: Inductive, electromeric, resonance, mesomeric, hyperconjugation effect and their applications; dipole moment, bond fission (homolytic and heterolytic) with suitable examples; curly arrow rules; reactive intermediates—carbocation, carbanion, Free radical and carbene; organic reagents – electrophile and nucleophile; nucleophilicity and basicity.

Introduction to types of organic reactions and their mechanism – Addition, elimination and Substitution reactions (only basics)

Learning outcomes

By the end of this Unit, the student will be able to

- **find out** the differences in structural aspects among various hydrocarbons (L1)
- **name** the organic compounds (L1)
- **point out** and recognize the various reagents, attacking species, intermediates encountered in organic reactions (L2)
- **predict** the basic mechanism of an organic reaction (L2)

Unit-II: Stereochemistry

9L

Classification: Configurational and conformational isomers; representation of three dimensional molecules – Wedge, Fischer, Newmann and Sawhorse Projection formulae and their interconversions; **Optical isomerism:** Optical isomers, optical activity, specific

Rotation, chirality – Conditions for optical activity, molecules with one or two chiral centers– enantiomers, diastereoisomers and meso compounds, racemization and resolution (Basic only); relative and absolute configuration – D/L and R/S designations; geometrical isomerism – Cis & Trans and E/Z notations.

Learning outcomes:

By the end of this Unit, the student will be able to

- **write** the 3-D projection of organic molecules (L1)
- **differentiate** between configuration and conformation (L1)
- **talk about** the optical activity of compounds and the criteria conditions (L2)
- **give** E/Z; D/L and R/S designation configuration to chiral molecules (L2)
- **outline** the difference between enantiomers, diastereomers and, meso compounds (L3)

Unit-III: Chemistry of aliphatic hydrocarbons-1

8L

Carbon-Carbon sigma bonds:

Chemistry of alkanes: Formation of alkanes – Wurtz Reaction, Corey-House synthesis, Kolbe's electrolysis, Hydrogenation of alkenes & alkynes Properties of alkanes: Physical, chemical – Free radical halogenation, oxidation, isomerization and aromatization.

Conformational analysis of alkanes: Factors affecting stability of conformational isomers, Conformation analysis of ethane, propane & n-butane – Eclipsed, Staggered, Gauche and Anti conformations.

Conformational analysis of cycloalkanes: Baeyer strain theory, energy diagrams of cyclohexane: chair, boat and twist boat conformations and their relative stabilities.

Learning outcomes:

By the end of this Unit, the student will be able to

- **write** the preparation methods of alkanes (L2)
- **give** reasons for the changes observed in physical properties (L2)
- **outline** the chemical properties of alkanes (L2)
- **explain** the different conformations observed for alkanes and cycloalkanes and their stabilities (L3)

Unit-IV: Chemistry of aliphatic hydrocarbons-2, Carbon-Carbon pi bonds:

8L

Formation of alkenes – By elimination reactions (From alcohols, alkyl halide), Mechanism of E1, E2, E1cb reactions, Saytzeff and Hofmann eliminations, hydrogenation of alkyne and Kolbe's electrolysis.

Properties of alkenes: Physical, chemical properties - Electrophilic additions following Markownikoff/Anti-Markovnikoff rules & mechanisms, oxymercuration-demercuration, hydroboration, ozonolysis, reduction, oxidation - syn and anti-hydroxylation.

Conjugated dienes – 1,2-and 1,4-addition reactions and Diels-Alder reaction; allylic and benzylic bromination mechanism with NBS.

Formation of alkynes: From Vicinal dihalide, CaC_2 , Kolbe's Electrolysis

Properties of alkynes: Physical, Chemical properties - Acidity, Electrophilic (X_2 , HX and HOX) and Nucleophilic (H_2O) additions, Hydroboration, oxidation, ozonolysis, polymerization, Alkylation of terminal alkynes.

Learning outcomes

By the end of this Unit, the student will be able to

- **write** the preparation methods of alkenes and alkynes (L2)
- **explain** Saytzeff & Hofmann eliminations; Markownikoff/anti-Markovnikoff rules (L2)

- **outline** the chemical properties of alkenes & alkynes (L2)
- **predict** the changes in physical properties with change in structure (L3)

Unit-V: Aromatic hydrocarbons

8L

Aromaticity: Hückel's rule, aromatic character of arenes, benzenoid and non-benzenoid compounds. Electrophilic aromatic substitution – halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanisms. Directing effects of the groups– Ortho-para directing and meta directing groups.

Learning outcomes:

By the end of this Unit, the student will be able to

- **explain** the Hückel's rule of aromaticity, anti-aromaticity and non-aromaticity (L2)
- **write** the mechanism of electrophilic aromatic substitution (L3)
- **predict** the directing effects of the groups on the aromatic ring and outcome of the reaction (L4)
- **write** the reaction conversions (L4)

Course outcomes

- **find out** the differences in structural aspects among various hydrocarbons and name the organic compounds (L1)
- **point out** and recognize the various reagents, attacking species, intermediates encountered in organic reactions and predict the basic mechanism of an organic reaction (L1)
- **write** the 3-D projection of organic molecules and differentiate between configuration and conformation (L2)
- **talk** about the optical activity of compounds and the criteria conditions and give E/Z; D/L and R/S designation configuration to chiral molecules (L3)
- **explain** the different conformations observed for alkanes and cycloalkanes and their stabilities. Explain the Hückel rule of aromaticity and Write the mechanism of electrophilic aromatic substitution (L4)

Text Books:

1. A Textbook of Organic Chemistry: Book by R.K. Bansal, SBN: 9788122420258
Publisher: New Age International Year of publishing: 2007.
2. Agarwal, O.P. Unified Chemistry, Vol I, II, & III, Jai Prakashnath Publications, Fiftieth Edition, 2016.
3. Bahl, A & Bahl, B.S. A textbook of Organic Chemistry, S. Chand & Company Pvt.Ltd. 2014.
4. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
6. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
7. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEM2011: Organic chemistry - I Lab (MAC Lab)

Hours per week: 2

Credits: 1

Continuous Evaluation: 100 marks

Preamble

The courses in the theoretical sessions should be well supported by practical classes. The laboratory practices give us the knowledge of how to deal with the chemicals and the realistic way of performing a reaction or operating an analytical instrument. Practicality has always been a driving force for innovation. In this course, we intended to teach and demonstrate a few practicals related to determination of physical characteristics of chemicals and also, make the students self-capable of carrying out the experiments.

Course objectives

- To explain about the solubility of the compounds and how the information can be used to purify solid compounds by the process of recrystallization
 - To illustrate the method to determine melting point of organic compounds and explaining its importance
 - Training the students how to determine boiling point of organic compounds
 - To address the concept of chromatography and train the students in performing TLC
1. Checking the calibration of the thermometer
 2. Purification of organic compounds by crystallization using the following solvents:
 - a. Water
 - b. Alcohol
 - c. Alcohol-Water
 3. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus).
 4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
 5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)
 6. Chromatography
 - a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography

- b. Separation of a mixture of two sugars by ascending paper chromatography
- c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

Text Books:

1. Vogel's textbook of Organic Analysis, Longmann Publishers
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).

Course outcomes

By the end of this course, the student will be able to

- **get** the essence of an organic chemistry lab (L1)
- **learn** the DO's and DONT's in laboratory (L1)
- **make** proper handling of the lab chemicals (L1)
- **crystallize** a solid compound from a solution (L2)
- **find out** the melting point and boiling point of solid and liquids respectively (L2)
- **make** TLC plates using Silica gel and use them in TLC technique (L2)

1-Low, 2- Medium and 3- High Correlation

CHEM2021: Inorganic Chemistry II (MAC)

Hours per week: 3
Credits: 3

Continuous Evaluation: 70 Marks
Semester End Examination: 30 Marks

Preamble

This course enables the students to gain knowledge in periodic table classification with more focus on s-block, p-block elements and its relevant compounds followed by the discussion of the acid-bases, noble gases and inorganic polymers. The knowledge gained in this course will be helpful to know the difference between strong and weak acidic, basic nature and bonding nature in s-and p-block elements of different compounds.

Course objectives

- To study the theories which describe the acid and bases
- Periodic table classification with s-and p-block elements
- To impart knowledge of the p-block elements and its compounds
- To study the inert gases and its compounds with preparation and bonding features
- To study the different types of the inorganic polymers

Unit-I:

9L

Acids and Bases: Bronsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle,

Learning outcomes

By the end of this Unit, the student will be able to

- **understand** about the theories which describes of acid & bases (L2)
- **get** the idea about the reactions between acids and bases (L2)
- **understand** about the compound formation through HSAB concept and its applications (L2)

Unit-II:

8L

Chemistry of s and p Block Elements: Inert pair effect, relative stability of different oxidation states, diagonal relationship and anomalous behavior of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate.

Learning outcomes

By the end of this Unit, the student will be able to

- **know** the classification of periodic table with s & p-block elements (L1)
- **understand** about the diagonal relationship (L2)
- **know** the differences between allotropy and catenation (L2)
- **understand** about the covalent and interstitial hydrides and beryllium compounds (L2)

Unit-III:

8L

Chemistry of p-block compounds

Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids

of sulphur, interhalogen compounds.

Learning outcomes:

By the end of this Unit, the student will be able to

- **understand** about the general electronic configuration of p-block element (L2)
- **get** the idea about the each p-block elements and its compounds (L2)
- **know** the different types oxides and oxoacids (L2)

Unit-IV:

8L

Noble Gases: Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF₂, XeF₄ and XeF₆; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF₂).

Learning outcomes:

By the end of this Unit, the student will be able to

- **understand** why do we noble gases called as inert gases (L2)
- **get** the idea about the clathrates (L3)
- **know** the xenon compounds and its hybridization (L4)

Unit-V:

Inorganic Polymers

9L

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates, and phosphagens, and polysulfides.

Learning outcomes

By the end of this Unit, the student will be able to

- **know** the differences between inorganic and organic polymers (L3)
- **get** the idea about the structural aspects of inorganic polymers and its applications (L4)

Course outcomes

- **understand** about the theories which are describes about acid & bases (L1)
- **get** the idea of the periodic table classification of s & p-block elements, allotropy terms (L2)
- **bonding** nature in p-block elements its reactivity and synthesis (L3)
- **know** the information about the noble gases and its hybridization (L4)
- **different** types of inorganic polymers and its applications (L4)

Text Books:

1. Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
2. Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.

	Program Objectives(POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2

CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEM2031: Inorganic Chemistry - II Lab (MAC Lab)

Hours per week: 2

Credits: 1

Continuous Evaluation: 100 marks

Preamble

In this course, there are two category experiments which describe the iodo and iodimetric titrations, followed by the different types of inorganic complex preparations. We were projected to teach and demonstrate the structural aspects and hybridization and chemical reactions involved in each experiment.

Course objectives

- The differences between iodo and iodimetric titrations
- Different types of inorganic complexes preparations
- Color aspect of copper and differences between mono and double salt

(A) Iodo/Iodimetric Titrations

- Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically).
- Estimation of available chlorine in bleaching powder iodometrically.

(B) Inorganic preparations

- Cuprous Chloride, Cu_2Cl_2
- Preparation of Manganese (III) phosphate, $MnPO_4 \cdot H_2O$
- Preparation of Aluminum potassium sulphate $KAl(SO_4)_2 \cdot 12H_2O$ (Potash alum) or Chrome alum.

Course outcomes

- **understand** the differences between iodo and iodimetric titrations (L2)
- **know** about the preparation methods of inorganic complexes preparation (L3)
- **get** the idea about the electronic configuration and color exhibition of copper and differences between mono and double salt (L4)

Text Books:

- Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEM2041: Physical Chemistry II (MAC)

Hours per week: 3
Credits: 3

Continuous Evaluation: 70 Marks
Semester End Examination: 30 Marks

Preamble

Thermodynamics describes macroscopic behavior of a system in a time-invariant state in terms of bulk properties such as pressure, volume, temperature and chemical potential. It is also concerned with the potential functions obtained by combining these properties and their relation to spontaneity of physical and chemical processes.

Course objectives:

- To demonstrate the laws of thermodynamics through real-life examples and applications
- To generate an intuitive understanding among the students for the concept of entropy and its relevance in design of a heat engine
- To demonstrate how thermodynamics dictates the feasibility of physical transformations and chemical reactions
- To provide insights into the concept of chemical equilibrium and factors influencing equilibrium
- To introduce the idea that solute particles in dilute solutions behave essentially like gas particles and discuss properties associated with such solutions

Unit-I:

9L

Chemical thermodynamics -1

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.

First law: Concept of heat, q , work, w , internal energy, U , and statement of first law; enthalpy, H , relation between heat capacities(ideal) under isothermal and adiabatic conditions.

Learning outcomes:

By the end of this Unit, the student will be able to

- **understand** the terminology of thermodynamics (L2)
- **understand** the concepts of heat, work, internal energy, and heat capacity (L2)
- **develop** an intuition for zeroth and first laws of thermodynamics (L3)

Unit-II: Chemical Thermodynamics -2

8L

Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules and ions, calculation of bond energy, bond dissociation energy, and resonance energy from thermochemical data.

Second Law: Concept of entropy; Carnot cycle, statement of the second law of thermodynamics; Calculation of entropy change for reversible and irreversible processes.

Learning outcomes:

By the end of this Unit, the student will be able to

- **understand** the second law of thermodynamics and its implications (L2)
- **appreciate** the usefulness of concept of entropy (L3)
- **acquire** knowledge of thermochemical methods and their applications (L3)

Unit-III: Chemical Thermodynamics -3

8L

Third Law: Statement of the third law, concept of residual entropy, calculation of absolute entropy of molecules. Free Energy Functions: Gibbs free energy and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Gibbs-Helmholtz equation; Maxwell relations;

Learning outcomes:

By the end of this Unit, the student will be able to

- **understand** the necessity of third law of thermodynamics (L2)
- **appreciate** the usefulness of free energy functions and their connection to spontaneity of a process (L3)
- **acquire knowledge** of Maxwell relations and Gibbs-Helmholtz equation and understand their significance (L3)

Unit-IV: Chemical Equilibrium

9L

Criteria of thermodynamic equilibrium, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Thermodynamic derivation of relations between the various equilibrium constants K_p , K_c and K_x . Le Chatelier principle and application to the synthesis of NH_3 (Haber's process) and SO_3 (Contact process).

Learning outcomes:

By the end of this Unit, the student will be able to

- **understand** the concept of chemical equilibrium (L2)
- **appreciate** the influence of thermodynamic properties on chemical equilibrium (L3)
- **gain** knowledge of the relation between equilibrium constant and Gibbs free energy and its implications for chemical reactions (L2)

Unit-V: Solutions and Colligative Properties

8L

Dilute solutions; lowering of vapor pressure, Raoult's and Henry's Laws and their applications. Derive relations between the four colligative properties [(i) relative lowering of vapor pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure and amount of solute.

Learning outcomes:

By the end of this Unit, the student will be able to

- **understand** the analogy between solute particles in dilute solutions and gas particles (L2)
- **explain** the concepts of vapor pressure and its relation to boiling point (L2)
- **describe** different colligative properties and their applications (L2)

Course outcomes:

By the end of this course, the student will be able to

- **acquaint** with terminologies employed in thermodynamics (L1)
- **understand** the laws of thermodynamics and the concept of entropy (L2)
- **gain** knowledge of thermodynamic potentials and criteria of spontaneity (L3)
- **explain** how equilibrium can be influenced by changing thermodynamic variables (L3)
- **write** colligative properties and their applications (L4)

Text Books

1. Peter, A. & Paula, J. de. Physical Chemistry 10th Ed., Oxford University Press (2014).
2. McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi (2004).
3. Levine, I.N. Physical Chemistry 6th Ed., Tata McGraw Hill (2010).
4. Metz, C.R. 2000 solved problems in chemistry, Schaum Series (2006).

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	2	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	2	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEM2051: Physical chemistry - II Lab (MAC Lab)

Hours per week: 2

Credits: 1

Continuous Evaluation: 100 marks

Preamble

This lab course in thermochemistry complements the SCY-104 theory course in chemical thermodynamics and its applications. It is concerned with an industrially important technique known as calorimetry that involves measuring heat changes in physical processes and chemical reactions

Course objectives

- To encourage students to make a home-made coffee cup calorimeter using thermal insulators such as thermocoal
 - To illustrate the concepts of enthalpy of neutralization, enthalpy of ionization, enthalpy of solution, enthalpy of hydration and basicity of an acid
 - To provide hands-on experience in measuring heat changes of physical transformations and chemical reactions by means of calorimetry
1. Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
 2. Calculation of the enthalpy of ionization of ethanoic acid.
 3. Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.
 4. Determination of basicity/proticity of a polyprotic acid by the thermochemical method in

- terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.
5. Determination of enthalpy of hydration of copper sulphate.

Course outcomes

- **understand** the terminology of thermochemistry (L2)
- **understand** the principles of calorimetry (L2)
- **obtain** hands-on experience in making a coffee cup calorimeter and performing calorimetry (L3)

Text Books

1. Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Athawale, V. D. & Mathur, P. Experimental Physical Chemistry New Age International: New Delhi (2001).

	Program Objectives(POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	2	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEM3001: Organic Chemistry – II (MAC)

Hours per week: 3
Credits: 3

Continuous Evaluation: 70 Marks
Semester End Examination: 30 Marks

Preamble

Knowing the basic definition of organic chemistry and the mechanisms involved, it is quite important to know about the different organic compounds encountered in biological systems. This course was aimed at teaching the students more compounds with versatile functional groups. More importantly hydroxy compounds, carbonyl compounds and carboxylic acids. These compounds have diverse applications in the manufacturing of a plethora of organic compounds.

Course objectives

- To discuss the preparation methods, physical and chemical properties of aliphatic and aromatic halogen compounds
- To explain the preparation methods, physical and chemical properties of aliphatic and aromatic alcohols and introduce the compounds having ether functional group
- Illustrate the preparation methods and properties of carbonyl compounds. Nucleophilic additions, oxidation, reductions and addition reactions
- Outline the acidity of carboxylic acids, preparation methods and properties and extend it to carboxylic acid derivatives and introduce the chemistry of sulphur compounds, their importance, preparation and properties
- Emphasize more on clear mechanistic explanation of all the reactions and developing application skills pertaining to prediction of the reaction outcome; introducing and interconverting functional groups

Unit-I: Chemistry of Halogenated Hydrocarbons

9L

Alkyl halides: Methods of preparation–Preparation of $\text{CH}_3\text{Cl}/\text{CHCl}_3/\text{C}_2\text{H}_5\text{Cl}/\text{ClCH}_2\text{CH}_2\text{Cl}$ from alkanes & alkenes, alcohols and Hunsdiecker reaction; Chemical Properties – S_N^1 , S_N^2 and S_N^i mechanisms with stereo-chemical aspects; Nucleophilic substitution vs elimination; Preparation of Grignard reagent.

Aryl halides: Preparation – From benzene, Sandmeyer reaction, Gattermann reaction; Chemical properties: Electrophilic aromatic substitutions – nitration, sulphonation and Friedel-Crafts alkylation; Nucleophilic substitution reaction with an example, Coupling reactions – Ullmann reaction, Wurtz-Fittig; Benzyne mechanism.

Relative reactivity of alkyl, vinyl, allyl, aryl and benzyl halides towards nucleophilic substitution reactions.

Learning outcomes:

By the end of this Unit, the student will be able to

- **write** the preparations of substituted halogen compounds (L1)
- **predict** the course of the reaction and the factors affecting it (L2)
- **find** out the difference between substitution vs elimination (L2)
- **analyze** the reactions of aryl halides towards electrophilic and nucleophilic reactions (L2)
- **explain** about relative reactivity of alkyl, vinyl, allyl, aryl and benzyl halides towards nucleophilic substitution reactions. (L2)

Unit-II: Alcohols, Phenols, Ethers and Epoxides

8L

Alcohols: Preparation from – Alkyl halide hydrolysis, Hydration of alkenes, Hydroboration-oxidation of alkenes, RMgX to carbonyls; Properties and relative reactivity of 1° , 2° and 3°

alcohols – Dehydration, Dehydrogenation, Grignard reagents, Oxidation; Distinguish test between 1°, 2° and 3° alcohols; Hydrogen bonding.

Preparation of Glycol: From 1,2-dichloroethane, alkene; Physical and chemical properties – Reaction with Na, PCl₅, PI₃, oxidation with HIO₄, dehydration and Pinacol-Pinacolone rearrangement.

Phenols: Preparation – Dow method, Cumene, Benzenediazonium salt; Properties – Acidity, Reimer-Tiemann reaction, Kolbe's-Schmidt reaction, Phthalic anhydride, Zn dust, oxidation; Effect of substituents on acidity.

Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and LiAlH₄.

Learning outcomes:

By the end of this Unit, the student will be able to

- **explain** the preparations of alkyl and aryl alcohols, ethers (L2)
- **distinguish** between 1°, 2° and 3° alcohols (L2)
- **write** the products for the reactions like oxidation, dehydration, and dehydrogenation (L3)
- **illustrate** the preparation and reactions of polyhydroxy compounds, ethers, and epoxides (L3)

Unit III: Carbonyl Compounds

8L

Aldehydes and ketones:

Preparation – Oxidation of alcohols and alkenes, dehydrogenation of alcohols, hydration of alkynes;

Properties – Nucleophilic additions: HCN, NaHSO₃, RMgX; Nucleophilic addition-elimination reactions with ammonia derivatives: NH₂OH, Hydrazine, 2,4-dinitrophenylhydrazine and semicarbazide; reduction with LiAlH₄, NaBH₄, Clemensen & Wolf-Kishner; Oxidation with PCC, PDC; Mechanisms of Aldol, Perkin, Benzoin condensation, Cannizzaro, Wittig reaction, Beckmann rearrangements, haloform reaction and Baeyer-Villiger oxidation.

Addition reactions of unsaturated carbonyl compounds: Michael addition.

Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

Learning outcomes:

By the end of this Unit, the student will be able to

- **write** the IUPAC names of the carbonyl compounds and talk about preparation methods from alcohols, alkenes, alkynes (L1)
- **explain** nucleophilic addition-elimination, oxidation, reduction reactions (L2)
- **illustrate** the important reactions such as Aldol, Perkin, Benzoin condensation, Cannizzaro, Wittig reaction, Beckmann rearrangements, haloform reaction and Baeyer-Villiger oxidation (L2)
- **depict** the 1,4 addition reactions of unsaturated carbonyl compounds (L2)
- **explain** the keto-enol tautomerism and their role in the reactivity of active methylene compounds (L2)

Unit-IV: Carboxylic Acids

8L

Methods of Preparation – From 1° alcohols /aldehydes, Hydrolysis of nitriles, RMgX with CO₂; Properties – Reaction with NH₃, SOCl₂, dehydration, HVZ reaction; Acidity, Effects of substituent on Acidity; Typical reactions of dicarboxylic acids, hydroxy acids, and unsaturated acids: succinic/phthalic, lactic, tartaric, maleic and fumaric acid.

Learning outcomes:

By the end of this Unit, the student will be able to

- **write** the preparation methods of carboxylic acids (L1)
- **comment** on physical properties and compare the acidities of alcohols and carboxylic acids (L1)
- **talk about reactions** of carboxylic acids, dicarboxylic acids, hydroxy acids and unsaturated acids and illustrate the decarboxylation reactions (L2)
- **compare** the structural features of maleic and fumaric acid and their reactivity towards bromine water and alkaline KMnO_4 (L2)

Unit-V: Carboxylic Acids Derivatives**8L**

Typical Preparation methods and reactions: For acid chlorides, anhydrides, esters, amides; Comparative study of nucleophilic substitution at acyl group; Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann- bromamide degradation, and Curtius rearrangement.

Sulphur containing compounds: Preparation and reactions of thiols, thioethers and sulphonic acids.

Learning outcomes:

By the end of this Unit, the student will be able to

- **predict** the difference in properties (physical and chemical) between carboxylic acids and their derivatives (L2)
- **write** the preparation methods of various carboxylic acid derivatives (L2)
- **outline** the mechanism of acidic and alkaline hydrolysis of esters (L3)
- **write** explanatory notes on important named reactions (L4)
- **describe** the preparation and reactions of Sulphur compounds (L3)

Course outcomes

By the end of this course, the student will be able to

- **write** the preparations and reactions of substituted halogen compounds, alcohols, carbonyl compounds, Sulphur compounds, carboxylic acids and their derivatives (L2)
- **find out** the difference between substitution vs elimination of halogen compounds (L2)
- **explain** about relative reactivity of alkyl, vinyl, allyl, aryl and benzyl halides towards nucleophilic substitution reactions. (L3)
- **distinguish** between 1° , 2° and 3° alcohols and depict the 1,4 addition reactions of unsaturated carbonyl compounds (L3)
- **explain** the keto-enol tautomerism and their role in the reactivity of active methylene compounds and comment on physical properties and compare the acidities of alcohols and carboxylic acids (L4)
- **predict** the difference in properties (physical and chemical) between carboxylic acids and their derivatives and outline the mechanism of acidic and alkaline hydrolysis of esters (L4)

Text Books:

1. Agarwal, O.P. Unified Chemistry, Vol I, II, & III, Jai Prakashnath Publications, Fiftieth Edition, 2016.
2. Bahl, A & Bahl, B.S. A textbook of Organic Chemistry, S. Chand & Company Pvt.Ltd. 2014.
3. Agarwal, O.P. Unified Chemistry, Vol I, II, & III, Jai Prakashnath Publications, Fiftieth Edition, 2016.
4. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd.

- (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
 - McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEM3011: Organic Chemistry - II Lab (MAC Lab)

Hours per week: 2

Credits: 1

Continuous Evaluation: 100 marks

Preamble

The laboratory real time experience showcases the theoretical explanations given for various organic compounds. This course was intended to explain the typical reactions shown by a few classes of compounds and to demonstrate them. Also, make the students understand the safer ways to perform a reaction by illustrating the preparations of a few organic compounds.

Course objectives

- To explain the qualitative analysis of few organic compounds
 - To demonstrate the standard protocols for the preparation of organic compounds
 - To make the students be able to practice the protocols in a safer manner
- Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.
 - Organic preparations:
 - Acetylation of one of the following compounds: amines (aniline) and phenols (salicylic acid) by any one method:
 - Using conventional methods.
 - Using green approach
 - Benzoylation of amines (aniline) and phenols (β -naphthol) by Schotten-Baumann reaction.
 - Oxidation of ethanol/ isopropanol (Iodoform reaction).
 - Bromination of any one of the following:

- (a). Acetanilide by conventional methods
 (b). Acetanilide using green approach (Bromate-bromide method)
- v. Nitration of any one of the following:
 (a). Acetanilide/nitrobenzene by conventional method
 (b). Salicylic acid by green approach (using ceric ammonium nitrate).
- vi. Selective reduction of meta dinitrobenzene to m-nitroaniline.
- vii. Reduction of p-nitrobenzaldehyde by sodium borohydride.
- viii. Hydrolysis of amides and esters.
- ix. Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.
- x. S-Benzylisothiuronium salt of one each of water soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).
- xi. Aldol condensation using either conventional or green method.
- xii. Benzil-Benzilic acid rearrangement.

The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization, melting point and TLC.

At least 6-8 experiments to be performed under S. No 2.

Text Books:

1. Vogel's textbook of Organic Analysis, Longmann Publishers
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
3. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
4. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

Course outcomes

By the end of this Course, the student will be able to

- **know** about the changes happen while doing a reaction (L2)
- **safe** handle the reagents and chemicals (L3)
- **carry out** a reaction following the standard protocols and achieving the desired product (L3)

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEM3021: Analytical Chemistry (MAC)

Hours per week: 3
Credits: 3

Continuous Evaluation: 70 Marks
Semester End Examination: 30 Marks

Preamble

This course enables the students to apply the various statistical tools in the analysis and acquire the basic principles of atomic, molecular techniques, Electro-analytical methods and separation methods and their applications. The knowledge gained in this course can be applied to the latest developments in technology.

Course objectives

- To familiarize the students with various types of basic statistical tools.
- To study about the basic principles of atomic, molecular techniques and separation methods.
- To emphasize the importance of UV Vis spectroscopy and atomic spectroscopy in quantitative determination of Metal ions.
- To impart knowledge on the basic concepts of pH metry and conductometry.
- To compare the different separation methods like chromatography and solvent extraction.

Unit-I:

8L

Evaluation of analytical data: errors, accuracy and precision. Types of errors and Methods for minimization of errors. Significant figures

Statistical test of data: F, Q and t test, rejection of data, and confidence intervals.

Learning outcomes:

After the completion of the Unit I, the student will be able to

- **list out** different types of errors in chemical analysis. (L1)
- **explain** the different types of errors in chemical analysis (L1)
- **compare** the accuracy and precision. (L2)
- **illustrate** the type of errors in Chemical Analysis. (L2)
- **application** of different statistical tools in chemical analysis. (L3)

Unit-II:

9L

UV-Visible spectrophotometry: Interaction of radiation with matter. fundamental laws of spectroscopy: Beer-Lambert's law and its validity.: source of radiation, wavelength dispersion: monochromator: gratings, prisms, interference filters. Detection of signal: photocells, photomultipliers, diode arrays. Schematic diagrams of Single and Double Beam instruments. applications in the quantitative determination of cations (Fe^{2+} , Ni^{2+} , Cr^{6+}) and anions (PO_4^{3-} , NO_3^- and NO_2^-).

Learning outcomes:

After the completion of the Unit II, the student will be able to

- **list out** the different part of the instrumentation of UV Vis Spectrophotometry (L1)
- **illustrate** the procedure for the determination of various anions and cations (L2)
- **explain** the importance of double beam UV Vis Spectrophotometry. (L2)
- **assess** the differences between single beam and double beam spectrophotometry (L2)

Unit-III:**8L**

Flame Emission and Flame Absorption Spectrometry: Basic principle and instrumentation: source of excitation, atomization, nebulizer, types of burner, monochromator and detector. Interferences: Physical, Chemical and spectral. Quantitative estimation of metal ions in water samples by Flame emission and Flame absorption spectroscopy.

Learning outcomes:

After the completion of the Unit III, the student will be able to

- **state** the principle of AAS and AES. (L1)
- **explain** the basic principle and working of AAS and AES (L2)
- **compare** the functioning the AAS and AES (L2)
- **identify** the significance of each part of AAS and AES Instruments. (L3)
- **apply** the knowledge of this concept in the analysis of samples. (L3)

Unit-IV:**8L**

Electroanalytical methods: Basic principle, Instrumentation and applications of pH metric, potentiometric and conductometric titrations.

Learning outcomes:

After the completion of the Unit IV, the students will be able to

- **state** the principles of pH metry, potentiometry and conductometry (L1)
- **explain** the working of pH meter, potentiometer and conductivity bridge. (L2)
- **identify** the suitable electrodes for pH meter, potentiometer and conductivity bridge (L3)
- **apply** the knowledge of these instruments in various types of chemical analysis. (L3)

Unit-V:**9L****Separation techniques**

Solvent extraction: Principle of solvent extraction and efficiency of the technique. Technique of extraction: batch, continuous and counter current extractions. Solvent extraction systems: Metal chelates and ion association systems.

Chromatography: Principle and classification of the technique. Mechanism of separation: adsorption and partition. Development of chromatograms: frontal, elution and displacement methods.

Learning outcomes:

After the completion of Unit V, the students will be able to

- **explain** the process of chromatography and solvent extraction techniques (L3)
- **identify** a suitable method for the separation of mixture of components. (L3)
- **distinguish** between mechanism of different chromatographic and solvent extraction methods. (L4)
- **compare** various types of solvent extraction and chromatographic methods (L4)

Course outcomes

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

- **list** various types of statistical tools and the instruments for chemical analysis. (L1)
- **explain** the role of various parts of instrumentation of atomic and molecular techniques (L2)
- **identify** suitable analytical technique for chemical analysis. (L3)
- **distinguish** atomic and molecular techniques. (L4)

Text Books:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
2. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
3. Harris, D.C.: Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
4. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.
5. Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEM3031: Analytical Chemistry Lab (MAC Lab)

Hours per week: 2

Credits: 1

Continuous Evaluation: 100 marks

Preamble

This lab course is platform for the application of knowledge acquired in Analytical methods in Chemistry theory course by providing a hands-on experience in performing the experiments of chromatography, solvent extraction and spectrophotometry

Course objectives

- To demonstrate the separation of metal ions, pigments and other active ingredients of plant extract through chromatographic techniques.
- To demonstrate the basic difference in performing the paper and TLC chromatographic techniques.
- To demonstrate the calibration and use of pH meter and flame photometry in analysis of soil, cool drinks and shampoos.
- To explain the characterization of different compounds through UV-Vis and IR spectroscopies and use of Spectrophotometry in quantitative analysis.
- To demonstrate the quality of water by doing DO, BOD and COD experiments.

I. Separation Techniques

- Chromatography:
 1. Separation of mixtures

- i. Paper chromatographic separation of Fe^{3+} , Al^{3+} , and Cr^{3+} .
- ii. Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values.
- iii. Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their R_f values.
- iv. Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

II. Solvent Extractions

2. To separate a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+} -DMG complex in chloroform, and determine its concentration by spectrophotometry.
3. Solvent extraction of zirconium with amberlite LA-1, separation from a mixture of iron and gallium.
4. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.
5. Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.
6. Analysis of soil:
Determination of pH of soil.
Total soluble salt
Estimation of calcium, magnesium, phosphate, nitrate
7. Ion exchange:
(i) Determination of exchange capacity of cation exchange resins and anion exchange resins.
(ii) Separation of metal ions from their binary mixture.
(iii) Separation of amino acids from organic acids by ion exchange chromatography.

III. Spectrophotometry

1. Determination of pK_a values of indicator using spectrophotometry.
2. Structural characterization of compounds by infrared spectroscopy.
3. Determination of dissolved oxygen in water.
4. Determination of chemical oxygen demand (COD).
5. Determination of Biological oxygen demand (BOD).
6. Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method.

Course outcomes

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

- **apply** the correct chromatographic method for the analysis of metal ions, pigments and other plant extracts. (L2)
- **use** of UV Vis spectrophotometry in quantification of different analytical species and are able to identify carbonyl groups through IR. (L2)
- **use** of pH meter and flame photometry in finding the quality of soil as well as cool drinks, shampoo and soaps. (L2)
- **find** the quality of water by application of DO, BOD and COD experiments. (L3)

Text Books:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

- Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
- Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
- Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.
- Skoog, D.A., Holler, F.J. and Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Edition.

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2-Medium and 3-High Correlation

CHEM3041: Green Chemistry (MAC)

Hours per week: 3
Credits: 3

Continuous Evaluation: 70 Marks
Semester End Examination: 30 Marks

Preamble

This course enables the students to gain knowledge on various green synthetic process towards sustainable development. These methods include Ionic liquids, Phase transfer catalyst, Supercritical CO₂, Use of Microwave and Ultrasonic irradiation in synthesis along with Green analytical techniques. The knowledge gained in this course can be applied to the latest developments in the scale up process.

Course objectives

- To familiarize the students with Green Chemistry and its twelve principles
- To design the green synthetic method by choosing appropriate starting materials etc.
- To emphasize the importance of Ionic liquids and its applications in organic reactions.
- To impart knowledge of PTC in organic synthesis.
- To explain the importance of Supercritical CO₂ in extraction and various process
- To expose the student's about the microwave activation and ultrasound-assisted reactions.
- To enable them with Green Analytical Techniques

Unit-I:

Introduction to green chemistry

9L

Green chemistry - Introduction - need for green chemistry - goals of green chemistry - Anastas' twelve principles of green chemistry - Designing a green synthesis (tools) - choice of starting materials, solvents, catalysts, reagents, processes with suitable examples.

Learning outcomes:

After the completion of the Unit I, the student will be able to

- **explain** the need for green chemistry. (L1)
- **list** the goals of green chemistry. (L1)
- **understand** Anastas' twelve principles of green chemistry (L2)
- **illustrate** to design green synthesis methods. (L2)

Unit-II:

8L

Ionic liquids - synthesis, physical properties of ionic liquids - applications in alkylation, epoxidation, Friedel-Crafts reaction - Diels-Alder reactions – Knoevenagel condensations and Wittig reactions.

Phase Transfer Catalyst (PTC) - Definition - advantages, types of PTC reactions - synthesis of PTC, applications of PTC in organic synthesis - Michael reaction - alkylation of aldehydes and ketones. Wittig, generation of dihalocarbene, elimination reaction

Learning outcomes:

After the completion of the Unit II, the student will be able to

- **list out** the synthesis, physical properties of ionic liquids. (L1)
- **explain** the significance of ionic liquids in alkylation, epoxidation. (L2)
- **illustrate** the use of ionic liquids in Friedel-Crafts / Diels-Alder / Wittig reactions – and Knoevenagel condensations. (L3)
- **compare** the advantages, types of PTC reactions. (L2)

- **apply** the knowledge of PTC in organic synthesis - Michael reaction - alkylation of aldehydes/ ketones and Wittig, generation of dihalocarbene, elimination reaction. (L3)

Unit-III: 8L

Supercritical CO₂- phase diagram - uses in extracting natural products, dry cleaning, bromination, Kolbe-Schmidt synthesis - Friedel-Crafts reaction. Dimethyl carbonate as a methylating agent in green synthesis

Learning outcomes:

After the completion of the Unit III, the student will be able to

- **explain** Supercritical CO₂ with a phase diagram. (L2)
- **illustrate** the uses of CO₂ in various processes in extracting natural products, dry cleaning, bromination,. (L2)
- **apply** the knowledge of this in Kolbe-Schmidt synthesis - Friedel-Crafts reaction. (L3)
- **illustrate** the use of Dimethyl carbonate as a methylating agent in green synthesis (L3)

Unit-IV: 9L

Microwave and ultrasound assisted reactions

Microwave activation - advantages of microwave exposure - Microwave assisted reactions, condensation reactions - oxidation, reduction reactions, multicomponent reactions.

Sonochemistry - use of ultrasound in organic synthesis (alternate source of energy) - saponification - substitution, addition, oxidation reactions, reductions.

Learning outcomes:

After the completion of Unit IV, the students will be able to

- **explain** the Microwave activation and ultrasound-assisted reactions. (L2)
- **list out** advantages of microwave exposure to the various reactions (L2)
- **illustrate** the use of ultrasound in organic synthesis (L3)
- **apply** the knowledge of sonochemistry in organic reactions. (L3)

Unit-V: 8L

Green Analytical Techniques

Micelle mediated extraction- Cloud point extraction and adsorptive micellar flocculation methods. Solid Phase Microextraction (SPME)

Learning outcomes:

After the completion of the Unit V, the students will be able to

- **explain** the concepts of Micelle mediated extraction. (L3)
- **compare** Cloud point extraction. (L3)
- **illustrate** adsorptive micellar flocculation methods. (L4)
- **compare** Solid Phase Micro Extraction. (L4)

Course outcomes

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

- **list** various types of Green synthetic and analytical methods. (L1)
- **understand** the importance of Ionic liquids and PTC along with their applications in organic Synthesis. (L2)
- **explain** Supercritical CO₂ and its applications in various process. (L2)
- **compare** the Microwave assisted synthesis and Ultrasonic synthesis. (L3)
- **distinguish between various** Green analytical techniques. (L4)

Text books:

1. Paul T. Anastas and John C. Warner, "Green Chemistry", Oxford University Press, Indian Edition, 2008.
2. V. K. Ahluwalia and M. Kidwai, "New Trends in Chemistry", Anamaya Publishers, 2nd Edition, 2007.
3. V. Kumar, "An Introduction to Green Chemistry", Vishal Publishers, 1st Edition, 2007.
4. V. K. Ahluwalia and R. S. Varma, "Green Solvents", Narosa Publishing, 1st Edition, 2009.
5. V.K.Ahluwalia and Renu Aggarwal, "Organic Synthetic Special Techniques", Narosa, 2nd Edition, 2009.
6. V. K. Ahluwalia, "Green Chemistry - Environmentally Benign Reactions", Ane books, India, 2006.
7. Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker (2001).

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
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CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEM3051: Green Chemistry Lab (MAC Lab)

Hours per week: 2

Credits: 1

Continuous Evaluation: 100 marks

1. Safer starting materials

Preparation and characterization of nanoparticles of gold using tea leaves.

2. Using renewable resources

Preparation of biodiesel from vegetable waste cooking oil.

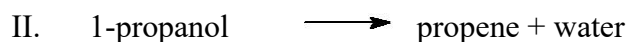
3. Avoiding waste

Principle of atom economy.

Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.

Preparation of propene by two methods can be studied

- I. Triethylamine ion + $\text{OH}^- \rightarrow$ propene + trimethylpropene + water $\text{H}_2\text{SO}_4/\square$



Other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy.

4. Use of enzymes as catalysts

Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.

5. Alternative Green solvents

Extraction of D-limonene from orange peel using liquid CO₂ prepared from dry ice.

Mechanochemical solvent free synthesis of azomethines

6. Alternative sources of energy

Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).

Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Text Books:

1. Anastas, P.T & Warner, J.C. Green Chemistry: Theory and Practice, Oxford University Press (1998).
2. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi. Bangalore CISBN 978-93-81141-55-7 (2013).
3. Cann, M.C. & Connelly, M. E. Real world cases in Green Chemistry, American Chemical Society (2008).

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

Program Electives

CHEM2061: Concepts of Medicinal Chemistry (PE)

Hours per week: 3

Credits: 3

Continuous Evaluation: 70 Marks

Semester End Examination: 30 Marks

Preamble

This course enables the students to gain knowledge on various chemical processes and its calculations includes: Material balances with and without Chemical reactions and energy balances and also on various aspects related to Fuels and its combustion processes. The knowledge gained in this course can be applied to the latest developments in technology.

Course objectives

- To familiarize the students with various types of chemical calculations.
- To study about the material balances without chemical reactions.
- To emphasize the importance of material balances with chemical reactions.
- To impart knowledge on the various concepts of energy balanced techniques.
- To compare different types of fuels.
- To expose the students to the latest combustion techniques of fuel.

Unit-I:

9L

Drug structure and biological activity: Pharmaceutically important functional groups- alcohols, carboxylic acid, amines, sulfonamides and carbonyl compounds. Basic reactions for drug molecule synthesis: Aldol, Diels-Alder, Claisen, Grignard, Michael, and Mannich reactions

Learning outcomes

After the completion of the Unit I, the student will be able to

- **find out** the differences in structural aspects among various functional groups (L1)
- **name** the drug organic reactions (L1)
- **compare** the relationship between drug molecule and simple organic molecule. (L2)
- **illustrate** the basic mechanism of an organic reaction (L2)

Unit-II:

8L

Chemistry of drug metabolism- absorption distribution, drug metabolism and excretion site specificity, stability, prolong release, minimum toxicity, patient acceptance.

Learning outcomes:

After the completion of the Unit II, the student will be able to

- **write** the various absorption distributions of drug metabolism (L1)
- **outline** the distribution properties. (L2)
- **predict** the stability, toxicity and life of drug. (L2)
- **explain** the different drug operations. (L2)

Unit-III:

8L

Vitamines: Structure, physiological role and uses of Vitamins A , Vitamin D Thiamine (B1) and Pyridoxine (B6).

Learning outcomes:

After the completion of the Unit III, the student will be able to

- **know** the structures Vitamines. (L2)
- **explain** the different aspects of Vitamines. (L2)
- **describe** the preparation and its uses of Vitamins. (L2)
- **understand** the physiological role of Vitamins. (L3)

Unit-IV:**8L**

Chemistry of selected drugs- Synthesis and basic concept of action for the following drugs

- (i) Anticancer: 5-Fluorouracil
- (ii) Antimalarials :Chloroguanide
- (ii) Anti-inflammatory: Diclofenac Sodium
- (iii) Sedatives: Phenobarbital

Learning outcomes:

After the completion of the Unit IV, the students will be able to

- **know** the chemistry of selected drugs. (L2)
- **know** their chemistry mode of action (L2)
- **prepare** the drug process and reaction mechanism. (L3)
- **use** drugs via chemistry of metabolism. (L3)

Unit-V:**9L**

Chemistry of selected drugs- Synthesis and basic concept of action for the following drugs

- (i) Antiulcers and antacids: Omeprazole
- (ii) Antiviral: Acyclovir
- (iii) Antihistaminic: Cinnarizine
- (iv) Antiasthmatic agents: Salbutamol

Learning outcomes:

After the completion of Unit V, the students will be able to

- **know** the chemistry of selected drugs and their mode of action. (L3)
- **synthesize** different medicinal drug processes and reaction mechanisms. (L3)
- **use** medicinal drugs via chemical metabolism. (L4)
- **compare** varieties of medicinal drugs (L4)

Course outcomes

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

- **describe** the lead Drug discovery and Design (L2)
- **explain** the Drug structure and biological activity (L3)
- **understand** the structure, physiological role and uses of Vitamins (L3)
- **mention** some Anticancer, Anti-malarials, Anti-inflammatory, Sedatives agents (L4)
- **give** some Anti-ulcers and antacids, Antiviral, Antihistaminic, Anti-asthmatic agents (L4)

Text books:

1. Medicinal Chemistry, A. Burger, Vol. I-III, Wiley Interscience Publications, New York, 1995.
2. Medicinal Chemistry, A. Kar, Wiley Eastern Ltd., New Delhi, 1993.
3. The Organic Chemistry of Drug design and Drug action, Richard B. Silverman; II Ed.;

Elsevier Academic Press, 2004

4. Medicinal Chemistry; Rama Rao Nadendla; PharmaMed Press, 2013

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEM2071: Concepts of Medicinal Chemistry lab (PE Lab)

Hours per week: 2

Credits: 1

Continuous Evaluation: 100 marks

- (1) Assay of Ibuprofen by alkalimetry.
- (2) Assay of Diclofenac by alkalimetry.
- (3) Assay of Analgin by iodimetry
- (4) Assay of Lidocaine HCl by nonaqueous titrimetry
- (5) Assay of Metronidazole by nonaqueous titrimetry
- (6) Preparation of Benzimidazole from O-phenylene diamine
- (7) Preparation of Benzotriazole from O-phenylene diamine
- (8) Preparation of Para amino salicylic acid from p-nitro salicylic acid
- (9) Preparation of Chlorbutol
- (10) Preparation of Benzil from benzoin
- (11) Preparation of Phenytoin from benzyl
- (12) Preparation of Benzocaine from p-amino benzoic acid
- (13) Preparation of 7-hydroxy, 4-methyl coumarin
- (14) Preparation of paracetamol
- (15) Preparation of Aspirin

At least 8-10 of the above (Assay:3-4 and Preparations:5-6)

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	2	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2

CO3	2	1	2	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEM2081: Fundamentals of Instrumental Methods of Analysis (PE)

Hours per week: 3
Credits: 3

Continuous Evaluation: 70 Marks
Semester End Examination: 30 Marks

Preamble

This course enables the students to choose correct analytical tools for the characterization as well as quantification of different analytical species and acquire the basic principles of atomic, molecular techniques, Radio-analytical methods and advanced separation methods and their applications. The knowledge gained in this course can be applied to the latest developments in technology.

Course Objectives

- To familiarize the students with various types of basic and advanced analytical techniques.
- To study about the basic principles of atomic, molecular techniques and advanced separation methods.
- To emphasize the importance of IR spectroscopy, Fluorimetry, thermal methods of analysis and advanced atomic spectroscopy in both qualitative and quantitative analysis of compounds.
- To impart knowledge on the basic concepts of advanced characterization techniques like HPLC, GC and ICPOES.

Unit-I:

9L

Spectro fluorimetry: Theory of fluorescence, phosphorescence, instrumentation, application with reference to thiamine (B1) and riboflavin (B2) **Infrared spectroscopy** - Interactions with molecules, source of excitation, separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection). Qualitative interpretation of spectrum.

Learning outcomes

After the completion of Unit I, the student will be able to

- **list** out different parts of the Fluorimeter and IR Spectrometer. (L1)
- **explain the** working of Fluorimeter and IR Spectrometer (L1)
- **compare** the different types of IR spectrometer (L2)
- **application** of IR and spectrofluorometer in the chemical analysis. (L3)

Unit-II:

8L

Mass spectroscopy: Principle and Instrumentation: Ionization methods: Electron impact ionization, chemical ionization, electrical discharge, laser desorption, fast atom bombardment. Separation of ions on basis of mass to charge ratio: Magnetic sector analyzer, Time of flight and quadrupole analyzer, Detector.

NMR spectroscopy: Principle, Instrumentation, Factors affecting chemical shift, spin-spin coupling, Applications.

Learning outcomes:

After the completion of the Unit II, the student will be able to

- **list** out the different part of the instrumentation of NMR and Mass Spectrometers (L1)
- **illustrate** the procedure for the identification of unknown compounds (L2)
- **identify** the significance of each part of NMR and Mass spectrometers. (L3)

- **apply** the knowledge of this concept in the analysis of samples. (L3)

Unit-III: 8L

High performance liquid chromatography: Theory and instrumentation: pumps, column, detectors-UV detector, refractive index detector, Fluorescence detector, photodiode array detector, applications.

Gas liquid chromatography: Theory and instrumentation: columns (packed and capillary columns), detector: thermal conductivity detector, flame ionization detector, electron capture detector, nitrogen-phosphorus detector, photo ionization detector and applications.

Learning outcomes:

After the completion of the Unit III, the student will be able to

- **explain** the importance of each components of HPLC and GC instruments (L3)
- **identify** suitable methods for the separation of mixture of components. (L3)
- **distinguish** between mechanisms of different chromatographic methods. (L4)
- **compare** various types detectors of both HPLC and GC (L4)

Unit-IV: 8L

Induced Couple Plasma Optical Emission Spectroscopy: source of Excitation: plasma. Nebulizer, Wavelength separation and resolution, Detection of radiation. matrix effects, chemical & spectral interferences.

Thermal methods of analysis: Thermogravimetry (TG): Basic principle and Instrumentation. Thermogram of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ and $\text{CaC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$

Learning outcomes:

After the completion of the Unit IV, the students will be able to

- **state** the principle of ICPOES and TGA (L1)
- **explain** the importance and working of different components of ICPOES and TGA (L2)
- **classify** the different types of interferences involved in ICPOES (L2)
- **identify** the significance of each part of TGA instrument. (L3)
- **apply** the knowledge of both TGA and ICPOES in the analysis of samples. (L3)

Unit-V: 9L

Radiochemical Methods: Detection and measurement of radioactivity. Applications of tracer technique: Isotope dilution analysis and applications. Neutron activation analysis and applications. Radio Carbon dating technique

X-ray Fluorescence spectroscopy (surface analysis): Theory, instrumentation: x-ray tube, Energy dispersive and wavelength dispersive spectrometers, matrix effect and general applications.

Learning outcomes:

After the completion of the Unit V, the students will be able to

- **explain** the working of various radiochemical and ESCA techniques (L3)
- **identify** suitable method for the analysis of mixture of components. (L3)
- **distinguish** between mechanism of EDX and WDX (L4)

Course outcomes

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

- **list** various types of analytical techniques for chemical analysis. (L1)

- **explain** the role of various parts of instruments used in IR spectroscopy, Fluorimetry, thermal methods of analysis and advanced atomic spectroscopy. (L2)
- **identify** suitable analytical technique for chemical analysis. (L3)
- **distinguish** atomic and molecular techniques. (L4)

Text Books:

1. D.A. Skoog, F.J. Holler & S. Crouch (ISBN 0-495-01201-7) Principles of Instrumental Analysis, Cengage Learning India Edition, 2007.
2. Willard, Merritt, Dean, Settle, Instrumental Methods of Analysis, 7th ed, IBH Book House, New Delhi.
3. Atkins, P.W & Paula, J.D. Physical Chemistry, 10th Ed., Oxford University Press (2014).
4. Kakkar, R. Atomic and Molecular Spectroscopy: Concepts and Applications. Cambridge University Press, 2015.
5. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
6. Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006).
7. Smith, B.C. Infrared Spectral Interpretations: A Systematic Approach. CRC Press, 1998.
8. Moore, W.J., Physical Chemistry Orient Blackswan, 1999.

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	2	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	1	2	1	2
CO3	2	1	3	1	2	2	1	2	2	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2-Medium and 3-High Correlation

CHEM2091: Fundamentals of Instrumental Methods of Analysis Lab (PE Lab)

Hours per week: 2

Credits: 1

Continuous Evaluation: 100 marks

Preamble

This lab course is platform for the application of knowledge acquired in Analytical methods in Chemistry theory course by providing a hands-on experience in performing the experiments of chromatography, solvent extraction and spectrophotometry

Course objectives

- To demonstrate the separation of metal ions, pigments and other active ingredient of plant extract through chromatographic techniques.

- To demonstrate the basic difference in performing the the paper and TLC chromatographic techniques.
- To demonstrate the calibration and use of pH meter and flame photometry in analysis of soil, cool drinks and shampoos.
- To explain the characterization of different compounds through UV-Vis and IR spectroscopies and use of Spectrophotometry in quantitative analysis.
- To demonstrate the quality of water by doing DO, BOD and COD experiments.

I. Separation Techniques: Chromatography:

Separation of mixtures

- (i) Paper chromatographic separation of Fe^{3+} , Al^{3+} , and Cr^{3+} .
- (ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values.
- (iii) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their R_f values.
- (iv) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

II. Solvent Extractions

- v. To separate a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+} -DMG complex in chloroform, and determine its concentration by spectrophotometry.
- vi. Solvent extraction of zirconium with amberlite LA-1, separation from a mixture of irons and gallium.
Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.
Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.
- vii. Analysis of soil:
 - i. Determination of pH of soil.
 - ii. Total soluble salt
 - iii. Estimation of calcium, magnesium, phosphate, nitrate
- viii. Ion exchange:
 - i. Determination of exchange capacity of cation exchange resins and anion exchange resins.
 - ii. Separation of metal ions from their binary mixture.
 - iii. Separation of amino acids from organic acids by ion exchange chromatography.

III Spectrophotometry

1. Determination of pK_a values of indicator using spectrophotometry.
2. Structural characterization of compounds by infrared spectroscopy.
3. Determination of dissolved oxygen in water.
4. Determination of chemical oxygen demand (COD).
5. Determination of Biological oxygen demand (BOD).
6. Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method.

Course outcomes

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

- **apply** the correct chromatographic method for the analysis of metal ions, pigments and other plant extracts. (L2)
- **use** of UV Vis spectrophotometry in quantification of different analytical species and are able to identify carbonyl groups through IR. (L2)
- **use** of pH meter and flame photometry in finding the quality of soil as well as cool drinks, shampoo and soaps. (L2)
- **find** the quality of water by application of DO, BOD and COD experiments. (L3)

Text Books:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
2. Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.
5. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Edition.

6.	Program Objectives(POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	1	2	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEMXXXX: Pharmaceutics - I (PE)

Hours per week: 3
Credits: 3

Continuous Evaluation: 70 Marks
Semester End Examination: 30 Marks

Preamble

This course is to impart fundamental knowledge on industrial pharmacy. Different Dosage forms design, development, and evaluation studies and the manufacturing process problems and scale-up process.

Course objectives:

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

- Know the basics of different dosage forms and their formulation design
- Understand the manufacturing process by using machinery
- Preparation of various conventional dosage forms and their quality control testing

Unit-I:

8L

Study the following dosage forms, including the definition, types, formulation design, development, scale-up, and testing of Monophasic liquid dosage forms: Mouth Washes, Ear Drops, Nasal Drops, Lotions. Only Definition of Gargles, Throat Paints, Liniments, Enemas and Colloids Biphasic Liquid dosage forms - Suspensions and Emulsions.

Learning outcomes:

By the end of this unit, the student will be able to

- **explain** the definitions of different dosage forms and their classification (L2)
- **prepare** of dosage forms with examples (L3)
- **perform** evaluation tests for different dosage forms (L2)

Unit-II:

9L

Tablets: definition, types, formulation design and development with details functions excipients, manufacturing process and scale-up of unit operations, problems in manufacturing, quality control testing and machinery involved in Preparation of tablets

Tablet coating: introduction, reasons for coating tablets, types of tablet coating, sugar, film ideal characteristics, formulation design and development with details functions of coating component, process details & equipment used in film coating and scale-up of unit operations, defects in the coating.

Learning outcomes:

- By the end of this unit, the student will be able to
- **define** tablets and their classification (L2)
- **formulate** the design of tablets and their manufacturing process by using machinery (L2)
- **explain** the Importance of tablet coating and types (L2)
- **solve** problems in the manufacturing process and quality control tests (L3)

Unit-III:

9L

Capsules: Introduction, sizes of capsules, raw materials required for empty capsules shell manufacturing, properties of Gelatin, the process of Preparation, equipment.

Hard Gelatin Capsule: Formulation design and development with detailed functions of excipients used in capsule preparation, Capsule filling & Machines used in the filling, filling of Powder, Pellet, semi-solid & Liquid into the empty shell.

Soft Gelatin Capsules: Introduction to soft gelatin capsule dosage form, Rationale for the

selection of soft gels as a dosage form, Manufacture of soft gels.

Learning outcomes:

By the end of this unit, the student will be able to

- **define** capsules and their types (L2)
- **perform hard** Gelatin capsules preparation with machines used in filling operation (L3)
- **explain** the importance of soft gelatine capsules and manufacturing process (L2)
- **distinguish** between the Hard gelatine capsules & Soft gelatin capsules. (L2)

Unit-IV:

8L

Semi-solid preparations: Classification - topical formulations and their application, ointment bases, and their application. Unit operations involved in the manufacturing of ointment, cream, paste, lotion, and gel formulations, CQA for ointment, cream, paste, and gel formulations, CPP, and CMA for ointment, cream, paste, and gel manufacturing process.

Learning outcomes:

By the end of this unit, the student will be able to

- **explain** the semi-solid dosage forms and their application (L2)
- **describe** the classification of ointment bases (L2)
- **know** the manufacturing of ointment, cream, paste, lotion, and gel formulations (L2)
- **explain** the importance of CQA, CPP, and CMA for semi-solid dosage forms. (L2)

Unit-V:

8L

Sustained and Controlled Release Dosage Forms: Definition, Types, formulation design of matrix dosage form and pellets and evaluation.

Introduction to labeling & packaging, types of packaging materials, factors that affect the selection of containers, materials used for containers & closures, drug-container considerations, quality control tests for packaging materials.

Learning outcomes:

By the end of this unit, the student will be able to

- **define** Sustained and controlled release dosage forms and their advantages (L2)
- **plan** formulation design of matrix dosage forms (L4)
- **explain** the importance of labeling and packaging of dosage forms (L2)
- **know** the classification of packaging materials and their quality control tests. (L4)

Course outcomes

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

- **define** dosage forms and their applications (L2)
- **distinguish** between mono-phasic and biphasic liquid dosage forms with examples (L2)
- **plan** formulation design of tablets and their manufacturing process (L3)
- **define** capsules and explain the difference between the Hard gelatine capsules & Soft gelatin capsules. (L3)
- **explain** about CQA, CPP, and CMA for semi-solid dosage forms and define Sustained and controlled release dosage forms and their advantages (L4)

Text Books:

1. Leon Lachman, H. A. Lieberman & J. L. Kanig: The Theory and Practice of Industrial

- Pharmacy, 3rd edition, Varghese Publishing House, Bombay, 1991.
2. M. E. Aulton: —Pharmaceutics – The Science of Dosage Form Design, 2nd edition, Churchill Livingstone, 2002.
 3. L. V. Allen, N. G. & Popovich H. C. Ansel: —Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, 8th edition, Lippincott William & Wilkins, USA, 2005.
 4. Rawlins, Ed.: —Remington's The Science and Practice of Pharmacy, 20th edition, Lippincott William & Wilkins, USA, 2000.
 5. Indian Pharmacopoeial Government of India, Ministry of Health & Family Welfare, the Indian Pharmacopoeia Commission, Ghaziabad, 2007
 6. British Pharmacopoeia, Vol. III, 2009.
 7. United States Pharmacopoeial, USP 32 – NF 27, Vol 1 & 2, Asian Edition, 2008. Rawlins, Ed.: —Remington's The Science and Practice of Pharmacy, 20th edition, Lippincott William & Wilkins, USA, 2000.

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEMXXXX Pharmaceuticals – 1 Lab (PE Lab)

Hours per week: 2

Credits: 1

Continuous Evaluation: 100 marks

Preamble

This course is designed to know the Preparation of dosage forms. Different conventional dosage forms formulation and their evaluation studies.

Course objectives:

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

- Know the basics of different dosage forms and their formulation design
 - Understand the manufacturing process by using machinery
 - Preparation of various conventional dosage forms and their quality control testing
1. Preparation & evaluation of granules loaded with Active Pharmaceutical Ingredients.
 2. Preparation & Evaluation of Tablets
 3. Preparation & Evaluation of Film-Coated Tablets
 4. Preparation & Evaluation of Capsules
 5. Preparation and evaluation of semi-solid dosage forms.

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	2	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEM2101: Unit Operations in Chemical Engineering (PE)

Hours per week: 3
Credits: 3

Continuous Evaluation: 70 Marks
Semester End Examination: 30 Marks

Preamble

This course enables the students to gain knowledge on various unit operations in chemical engineering which includes filtration, extraction, leaching, distillation, crystallization, Drying, size separation, blending and reactor studies. The knowledge gained in this course can be applied to the latest operations in chemical industries.

Course objectives

- To familiarize the students with various types of unit operations.
- To study about the filtration, extraction and leaching techniques.
- To impart knowledge on the various concepts of distillation and crystallization.
- To study about the reactor equipments.
- To compare different types of methods and select a suitable method for purification of components.
- To expose the students to common industrial techniques.

Unit-I:

8L

Filtration : Types of filters batch, continuous filtration, Centrifugation-batch, continuous and basket, inverting bag, bottom discharge, micron, and cartridge filters, Factors affecting filtration and selection of filtration equipment. Microfiltration

Extraction and Leaching: Introduction-extract, raffinate, choice of solvent for extraction, single-stage, multistage extraction, Equipment for extraction operation: lipid liquid extractor, factors affecting extraction and leaching, leaching and its applications.

Learning outcomes:

After the completion of the Unit I, the student will be able to

- **list** different filters batch. (L1)
- **explain** the types of filtrations. (L1)
- **compare** the filtration equipment and select one suiting the purpose. (L2)
- **explain** the extraction equipment and technique. (L1)

Unit-II:

9L

Distillation: Binary systems relative volatility, Ideal solutions, Steam distillation, continuous distillation, azeotropic distillation, extractive distillation, batch distillation, flash distillation, distillation under reduced pressure – FEE, ATFE t.

Crystallization : principles, super saturation cooling crystallization, reactive crystallization, seeding, formation of polymorph, type of agitators, factors affecting crystallization classification of crystallizers, equipment – crystallization in batch reactors.

Learning outcomes:

After the completion of the Unit II, the student will be able to

- **list** out the different types of distillation techniques. (L1)
- **illustrate** the procedure for distillation. (L2)
- **illustrate** the procedure for crystallization. (L2)
- **explain** the various factors affecting crystallization. (L2)

- **classify** the crystallizers. (L2)

Unit-III: 8L

Drying: Definition, Applications, the purpose of drying, classification of dryers, drying equipment-Tray dryer, rotary dryers, pneumatic dryer, spray dryer, drum dryer, VTD, FBD, RCVD, RCVD, ATFD, ANFD, Spherical dryer. (Basic theoretical concepts with more practical applications)

Learning outcomes:

After the completion of Unit III, the student will be able to

- **classify** different dryers. (L2)
- **explain** different aspects of drying equipment. (L2)
- **compare** the drying equipment. (L2)
- **apply** the knowledge of this concept in industrial applications. (L3)

Unit-IV: 8L

Size separation/reduction: Grinders –types-circuit, screening-industrial screens, gyratory and vibratory screens-air jet mill, multi mill, Co mill, bantam mill, hammer mill, sifter Mixing-Homogenous, Heterogeneous.

Blending – types of blender octagonal, hexagonal, double cone type.

Learning outcomes:

After the completion of the Unit IV, the students will be able to

- **explain** the size reduction grinders. (L2)
- **compare** the size reduction grinders suiting the purpose (L2)
- **identify** the types of blenders. (L3)
- **apply** the knowledge in chemical plants. (L3)

Unit-V: 9L

Reactor studies: Basic functions of a reactor, autoclave types –batch, CSTR, semi-batch, body construction, types of agitators- Spargers, gas induction turbine, anchor, PBT, propeller

Unit processes and operations: Oxidation, reduction, dehydration, condensation, Hydrolysis hydrogenation, neutralization, Friedel – craft reaction, the basis of pH, evaporation, column chromatography, membrane separation, bromination, chlorination humidification, basics of organic chemistry, absorption, adsorption.

Learning outcomes:

After the completion of the Unit V, the students will be able to

- **explain** the reactor functions. (L3)
- **distinguish** between types of agitators. (L4)
- **identify** different unit processes. (L3)
- **understand** the different unit processes and operations. (L4)

Course outcomes

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

- **list** various types of unit processes and operations. (L1)
- **compare** the different processes and select appropriate method for separation. (L2)
- **explain** the methods of filtration, extraction, leaching, distillation, crystallization, Drying, size separation, blending. (L2)
- **identify** common techniques of in chemical units/plants. (L3)

- **distinguish** between different unit operations.

(L4)

Text Books:

1. Julian C. Smith, Warren L. McCabe, Peter Harriott Unit Operations of Chemical Engineering (English), 7th Edition, Mcgraw Hill Education.
2. Shyamal K Sanyal, Salil K Ghosal, Siddhartha, Introduction to Chemical Engineering (English), 1st Edition, Mcgraw Hill Education

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	3	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEM2111: Industrial Chemicals and the Environment (PE)

Hours per week: 3
Credits: 3

Continuous Evaluation: 70 marks
Module Tests/Sem End Exam: 30 marks

Preamble

This course introduces the student to the basics of chemistry in production of industrial gases, Inorganic chemicals, Environment and composition, ecosystems, Environmental pollution, Environmental problems, waste water treatment techniques, waste management, sources of energy.

Course objectives

- Introduce the production of Industrial gases, Manufacture of Inorganic chemicals.
- Provide the Knowledge of Environment and its segments.
- Describe the various types of environmental pollution .
- Introduce the techniques used for wastewater treatment, waste management.
- Describe the applications of energy resources.

Unit–I: Industrial Gases and Inorganic Chemicals

9L

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

Learning outcomes:

By the end of this Unit, the student will be able to

- **understand** the large-scale production of Industrial gases (L2)
- **summarize** the applications, limitations (L2)
- **define** hazards in handling of the Industrial gases (L2)
- **explain** the process of manufacture of Inorganic chemicals like bleaching powder, borax, hydrogen peroxide etc. (L2)
- **explain** the analysis of Inorganic chemicals (L2)

Unit–II: Environment and its segments

8L

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulfur.

Air Pollution: Major regions of the atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size, and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution. Pollution by SO₂, CO₂, CO, NO_x, H₂S. Methods of estimation of CO, NO_x, Sox, and control procedures.

Learning outcomes:

After completing this unit, the student will be able to

- **understand** the properties. Biogeochemical cycles of carbon, nitrogen and Sulphur (L2)
- **interpret** the chemical and photochemical reactions in major regions of atmosphere (L2)

- **explain** the interrelationship between Photochemical smog and photochemistry. (L2)
- **outline** the environmental effects of Ozone and various air pollutants. (L2)
- **demonstrate** the methods of estimation of air pollutants. (L3)

Unit–III:

8L

Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulfur from coal. Control of particulates. Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.

Learning outcomes:

After completing this unit, the student will be able to

- **outline** the importance of water. (L2)
- **explain** the relationship between the oxides of nitrogen, chlorofluorocarbons and halogens and Ozone layer depletion. (L2)
- **interpret** the relationship between the Greenhouse effect and Global warming. (L3)
- **summarize** the Impacts of water pollution on hydrological and ecosystems. (L2)
- **explain** the Techniques for measuring water pollution. (L2)

Unit–IV:

8L

Water purification methods. Effluent treatment plants (primary, secondary, and tertiary treatment). Industrial effluents from the following industries and their treatment: textile, tannery, dairy, petroleum, and petrochemicals.

Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electrodialysis, ion exchange). Water quality parameters for wastewater, industrial water, and domestic water.

Learning outcomes:

By the end of this Unit, the student will be able to

- **understand** difference between effluent treatment plants primary, secondary and tertiary treatment (L2)
- **explain** the water treatment and purification techniques (reverse osmosis, electro dialysis, ion exchange) (L2)
- **identify** Water quality parameters for wastewater, industrial water and domestic water (L2)

Unit–V: Energy & Environment

9L

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

Learning outcomes:

By the end of this Unit, the student will be able to

- **summarize** the various Renewable and nonrenewable sources of energy such as Coal, petrol and natural gas, tidal geothermal nuclear etc., (L2)
- **acquire** knowledge of nuclear waste disposal. (L2)
- **appreciate** the importance of nuclear disaster management. (L3)

Course outcomes

After studying the course, the student will be able to:

- **explain** the production process of industrial gases. (L1)
- **summarize** application, analysis and hazards in handling the Inorganic chemicals. (L1)
- **identify** different major sources of pollution and Techniques for measuring pollution (L2)
- **apply** the knowledge and principles of chemistry to understand environmental adverse effects (L3)
- **analyze** Industrial effluents from the industries and their treatment: (L4)
- **appreciate** the potential of renewable energy resources and nuclear energy. (L5)

Text Books:

1. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEM2121: Industrial Safety, Chemical Technology & Society (PE)

Hours per week: 3

Credits: 3

Continuous Evaluation: 70 Marks

Semester End Examination: 30 Marks

Preamble

This course enables the students to gain knowledge on various aspects of Industrial safety which pertains to transport, handling and storing of flammable liquids and toxic materials, various separation and purification processes which include distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption. It aims in enabling students to explore societal and technological issues from a chemical perspective. The knowledge gained in this course can be useful for the application in clean technology and the latest developments in industrial safety and hygiene.

Course objectives

- To familiarize the students with various terminology and professionals associated with industrial hygiene.
- To study the classification of toxic agents and to emphasize the importance of industrial safety concerning transport, handling and storing of flammable liquids and toxic materials.
- To familiarize the students with basic purification techniques.

- To impart knowledge on the various scale up operations in chemical industry.
- To emphasize the importance of scientific literacy for better environment and to introduce clean technology.

Unit-I:

8L

Introduction to Industrial Hygiene & Historical views, Definitions and professionals involved in industrial Hygiene work.

Safety and Hygiene aspects related to

- I. Transport, handling & storage of inflammable liquids & gases & toxic materials
- II. Process equipment including piping (fire, static electricity, pressure, temperature etc.) safety aspects at process development & design stage.

Threshold Limit Value (TLV) and Permissible Exposure Limits (PEL) for chemicals, Industrial toxicology and the basics, Classification of toxic agents.

Learning outcomes

After the completion of the Unit I, the student will be able to

- **classify** different toxic materials. (L1)
- **list** professionals involved in industrial Hygiene work. (L1)
- **explain** process equipment and safety aspects at design to process stage. (L2)
- **identify** the measures towards transport, handling & storage of inflammable liquids & gases & toxic materials. (L2)
- **apply** the knowledge in transporting, handling, and storage of different materials. (L3)

Unit-II:

8L

Chemical Technology

Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption. An introduction into the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, emulgators. Scaling up operations in chemical industry. Introduction to clean technology.

Unit-III:

8L

Society

Exploration of societal and technological issues from a chemical perspective. Chemical and scientific literacy as a means to better understand topics like air and water, energy from natural sources (i.e., solar and renewable forms), fossil fuels and nuclear fission, materials like plastics and polymers and their natural analogues, proteins and nucleic acids.

Learning outcomes

After the completion of the Unit I, the student will be able to

- **explain** Scaling up operations in chemical industry. (L2)
- **explain** the scope of different types of equipment needed in chemical technology. (L1)
- **compare** the different purification techniques like distillation, solvent extraction leaching, adsorption etc. (L2)
- **explain** different types of natural resources and societal or technological impact on it in a chemical perspective. (L2)

Course outcomes

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

- **classify** different toxic materials.

- **list** professionals involved in industrial Hygiene work.
- **identify** the measures towards transport, handling & storage of inflammable liquids & gases & toxic materials and **apply** the knowledge in transporting, handling, and storage of different materials.
- **explain** Scaling up operations in chemical industry.
- **compare** the different purification techniques like distillation, solvent extraction leaching, adsorption etc.
- **explain** different types of natural resources and societal or technological impact on it in a chemical perspective.

Text books:

1. A Textbook of Chemical Technology - S. D. Shukla, G. N. Pandey · 1977
2. Industrial Safety and Environment by Prashar, Anupama, New Delhi SK. Kataria & Sons 2009.
3. Industrial Safety and Environment by A K Gupta, New Delhi University Science Press 2012.

Reference Books:

1. John W. Hill, Terry W. McCreary & Doris K. Kolb, Chemistry for changing times 13th Ed, Prentice-Hall (2012).
2. Industrial Safety, Health Environment and Security by Basudev Panda, Bangalore University Science Press 2013.

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEMXXXX Concepts of Organometallic Chemistry & Catalysis

Hours per week: 3
Credits: 3

Continuous Evaluation: 70 marks
Module Tests/Sem End Exam: 30 marks

Preamble

The course would cover various application aspects of organometallic compounds in industrial processes. The course would also highlight the concepts behind these blockbuster industrial processes that have directly impacted our society at large over the last century. Not to mention of the fact that nine Nobel prizes have been attributed to the field for original discoveries over the last century, and which too, along with their far reaching implications, would be covered in this course.

- The main focus of this course is on the synthesis, structure, bonding and properties
- The reactivity of organometallic compounds such as: metal carbonyls, hydrocarbon, and carbocyclic based molecules.
- This course also covers, 18-electron rule (Saturation and Unsaturation), Organometallic reaction (substitution, oxidative-addition, reductive elimination, insertion and de-insertion, and isomerization).
- List the main concepts and applications of organometallic compounds.
- Recall the role of organometallic and metallic complexes in catalysis.

Learning Outcomes:

- By the completion of the course, students will get a good overview of the fundamental principles of organotransition-metal chemistry.
- Have insight into the use of modern methods to characterize organometallic compounds.
- Students will understand fundamental reaction types and mechanisms and how to combine these to understand efficient catalytic processes, know important applications of organometallic homogeneous catalysis in the production of large-scale (bulk) and smaller-scale (fine chemicals) production.

Unit 1: Introduction: Definition and scope of organometallic, homogeneous vs. heterogeneous catalysis; importance of homogeneous catalysis in the synthesis of high value chemicals and Valence electron count 18 and 16 electron complexes.

Unit 2: d-block carbonyls: Coordination modes characterization synthesis reactions carbonyl metallates ligands related to CO.

Unit 3: Metal carbonyls: Synthesis, bonding, Properties and applications of Alkyls, aryls, alkenyls, acyl, alkynyls.

Unit 4: Metal-Carbon multiple bonded compounds: Synthesis, bonding, Properties and applications of Carbenes, carbenes and **Metal-complexes:** Alkenes, d—and polyenes.

Unit 5: Hydroformylation: Cobalt and Rhodium complexes, the role of phosphine ligands in regio selective formation of linear aldehydes. Markovnikov and anti-Markovnikov addition and mechanisms.

References: Required textbooks

1. Inorganic Chemistry; Ajay kumar
2. Inorganic Chemistry By Madan Malik Tuli
3. Principal of inorganic chemistry by puri sharma kalia
4. Lee, J.D. Concise Inorganic Chemistry 9th Ed., John Wiley and sons 2020.
5. Powell, P. Principles of Organometallic Chemistry, Chapman and Hall, 1988.
6. Applied Homogeneous Catalysis with Organometallic Compounds, Vols. 1 & 2, edited by B. Cornils and W.A. Herrmann, VCH, Weinheim, New York, 1996.
7. Organometallics: A concise Introduction, Ch.Elshebroien and A Salzer, VCH, Chapters 12 to 16.

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEM2131: Electrochemistry (PE)

Hours per week: 3

Credits: 3

Continuous Evaluation: 70 Marks

Semester End Examination: 30 Marks

Preamble

Electrochemistry deals with conversion of electrical energy to chemical energy and how free energy change of a spontaneous chemical reaction can be converted into EMF. It is concerned with how EMF measurements enable determination of free energy and equilibrium constants of a chemical reaction.

Course objectives:

- **introduce** Arrhenius theory of strong and weak electrolytes.
- **introduce** the concepts of ionic mobility, transference number and methods for their determination.
- **demonstrate** the applications of conductometric and potentiometric titrations
- **discuss** concept of electrode potential, liquid junction potential and usefulness of electrochemical series
- **discuss** Faraday's laws, Nernst equation and their applications
- **provides** insights into electrical and magnetic properties of molecules

Unit-I: **9L**
Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions.

Learning outcomes:

By the end of this Unit, the student will be able to

- **grasp** terminology of electrochemistry **(L1)**
- **understand** the differences between strong and weak electrolytes **(L2)**
- **apply** Kohlrausch law for calculating equivalent conductance of weak electrolytes at infinite dilution **(L3)**

Unit-II: **8L**
Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) conductometric titrations, and (iii) hydrolysis constants of salts.

Learning outcomes:

By the end of this Unit, the student will be able to

- **understand** the concepts of ionic mobility, ionic velocity, transference number and methods for its determination **(L2)**
- **acquire** Knowledge of applications of conductance measurements **(L2)**

Unit-III: **8L**
Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials. Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells.

Learning outcomes:

By the end of this Unit, the student will be able to

- **understand** Faraday's laws of electrolysis, concepts of electrode potential, oxidation and reduction **(L2)**
- **apply** Nernst equation and electrochemical series for calculation of cell EMF **(L2)**
- **apply** EMF measurements in determining free energy and equilibrium constant of a chemical reaction **(L2)**

Unit-IV: **8L**
Determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).

Learning outcomes:

By the end of this Unit, the student will be able to

- **understand** the difference between concentration cells with and without transference **(L2)**
- **grasp** the concept of liquid junction potential and its implications **(L2)**
- **acquire** knowledge of potentiometric titrations and its applications **(L2)**

Unit-V: **9L**
Basic ideas of electrostatics, Electrostatics of dielectric media, Dipole moment and molecular

polarizabilities and their measurements. Diamagnetism, Para magnetism.

Learning outcomes:

By the end of this Unit, the student will be able to

- **understand** the basics of electrostatics (L2)
- **understand** the concepts of electric dipole moment and polarizability (L2)
- **know** the differences between diamagnetic and paramagnetic substances (L2)
- **grasp** the concept of magnetic susceptibility and method for its measurement (L2)

Course outcomes:

- **acquaintance** with terminology and concepts of electrochemistry
- **insights** into applications of conductometric and potentiometric titrations
- **appreciate** the usefulness of electrochemical series and ability to apply it for determining the direction in which a given reaction proceeds spontaneously
- **insights** into electrical and magnetic properties of molecules

Text Books:

1. Atkins, P.W & Paula, J.D. Physical Chemistry, 10th Ed., Oxford University Press(2014).
2. Rogers, D. W. Concise Physical Chemistry Wiley (2010)

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEM2141: Regulatory Affairs and Quality Assurance (PE)

Hours per week: 3

Credits: 3

Continuous Evaluation: 70 Marks

Semester End Examination: 30 Marks

Preamble

This course is designed to impart the fundamental knowledge on the regulatory requirements for approval of new drugs, and drug products in regulated markets of India & other countries like US, EU, etc. It prepares the students to learn in detail on the regulatory requirements, documentation requirements, and registration procedures for marketing the drug products.

Course objectives:

Upon completion of the subject student shall be able to

- Know about the manufacturing process and facilities
- Know the regulatory authorities and agencies governing the manufacture and sale of pharmaceuticals
- Know different Laws and Acts that regulate pharmaceutical industry
- Understand the approval process and regulatory requirements for drug products

1. Guidelines for Drug Master File: Types
2. Introduction to ICH
3. Abbreviated New Drug Application (ANDA): Hatch – Waxman amendment, patent term restoration, types of ANDA
4. Manufacturing premises
5. Equipment and Raw Materials
6. Manufacture and QC of Dosage Forms
7. Quality audit of Manufacturing process and facilities
8. Quality Control in Laboratory
9. Validation of Analytical Methods
10. Regulatory considerations in Validation
11. Validation
12. Process Validation
13. Globalization & Intellectual Property Rights
14. Drug Approval

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEM2151: Chemical Process Calculations (PE)

Hours per week: 3
Credits: 3

Continuous Evaluation: 70 Marks
Semester End Examination: 30 Marks

Preamble

Chemical Process calculations meets the requirements of B.Sc. Chemistry students. It covers basic concepts of Chemical processes and calculations suitable for academic and industrial applications.

Course objectives:

- To provide basic knowledge of Chemical processes
- To introduce the concepts of Basic chemical calculations
- To impart knowledge on material balances and energy balances
- To familiarize the concepts involved in the use of fuels and combustion

Unit-I:

8L

Basic chemical calculations: Gram mole, normality, molarity, weight percent, mole percent, volume percent, gases, ideal gas law, gaseous mixtures, Dalton's law, Amagat's law, relationship between partial pressure and mole fraction, average molecular weight of gas mixture, density of gas mixture, Raoult's law, Henry's law, problems.

Learning outcomes:

By the end of Unit I, the student will be able to

- **understand** the concept of molarity, normality, etc., (L2)
- **rationalize** the laws such as Dalton's law, Amagat's law (L3)
- **explain** Raoult's law, Henry's law (L2)

Unit-II:

8L

Material balances without Chemical reactions: Law of conservation of mass, classification of material balance, Material balance without chemical reactions, outline of a procedure for material balance calculations, various operations carried out in industry, bypass operations, material balances of unsteady-state operations, basic problems.

Learning outcomes:

By the end of Unit II, the student will be able to

- **understand** the concept of Material balances (L2)
- **rationalize** classification of material balance (L3)
- **outline** a procedure for material balance calculations (L3)

Unit-III:

8L

Material balance with chemical reactions: Stoichiometric equation, Stoichiometric coefficient, Stoichiometric ratio, Stoichiometric proportion, limiting reactant, excess reactant, percent excess, conversion, yield and selectivity, basic problems.

Learning outcomes:

By the end of Unit III, the student will be able to

- **understand** the concept of Material balance with chemical reactions (L2)
- **rationalize** Stoichiometric equation, Stoichiometric coefficient etc., (L3)

- **explain** yield and selectivity (L2)

Unit-IV: 8L

Energy balances: Forms of energy, general energy balance procedure, sensible heat and heat capacities, relationship between C_p and C_v , enthalpy changes accompanying chemical reactions, heat of reaction, heat of formation, heat of combustion, Hess' law of constant heat summation, enthalpy changes in reaction with different temperatures, adiabatic process, adiabatic reaction, adiabatic reaction temperature, adiabatic flame temperature, phase change operation, latent heat of vaporization, latent heat of condensation, latent heat of fusion, latent heat of sublimation, Heat of solution and mixing, basic problems.

Learning outcomes:

By the end of Unit IV, the student will be able to

- **understand** the concept of Energy balances (L2)
- **rationalize** the enthalpy changes accompanying chemical reactions (L3)
- **explain** heat of solution and mixing (L2)

Unit-V: 8L

Fuels and combustion: Solid fuels, liquid fuels, gaseous fuels, calorific values of fuels, Analysis of fuel, theoretical calorific value, combustion of fuel, basic problems.

Learning outcomes:

By the end of Unit V, the student will be able to

- **understand** the concepts involved in fuels and combustion (L2)
- **find out** calorific values of fuels (L2)
- **explain** combustion of fuels and solve basic problems (L4)

Course outcomes:

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

- **understand** the concept of molarity, normality, etc., (L2)
- **explain** Raoult's law, Henry's law (L2)
- **understand** the concept of Material balances, explain yield and selectivity (L3)
- **apply** the concepts involved in fuels and combustion (L4)

Text books

1. Olaf A Hougen, Kenneth M. Watson and Roland A. Ragatz, Chemical Process Principles Part-I, Material and Energy balances, 2/e, CBS Publishers and Distributors, 2010.
2. K.A. Gavhane, Chemical Process Principles (Stoichiometry), 25/e, Nirali Prakashan, 2009.

Reference Books:

1. K.V. Narayanan and B. Lakshmikutty, Stoichiometry and Process calculations, 2/e, PHI Learning Pvt Ltd. 2017.

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2

CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEM3061: Nano Chemistry (PE)

Hours per week: 3
Credits: 3

Continuous Evaluation: 70 Marks
Semester End Examination: 30 Marks

Course objectives:

At the end of the course students should be able to answer the following

- Describe and explain Nano chemistry.
- Describe Nanomaterials based on their dimensionality.
- Classify nanomaterials based on dimensionality
- Understand the characterization techniques
- Know the synthesis methods of nanomaterials

Unit-I:

Introduction to nanoscience, nanostructure and nanotechnology (basic idea), Overview of nanostructures and nano-materials, classification, (cluster, colloid, nanoparticles, and nanostructures -Spheroid, Wire, Rod, Tube, and Quantum Dot); Calculation of percentage of surface atom and surface to volume ratio of spherical, wire, rod, and disc shapes nanoparticles.

Learning outcomes:

By the end of this unit, the student will be able to

- **explain** the basic idea of nanoscience, nanostructure and nanotechnology (L2)
- **classify** nano-materials based on structures (L2)
- **calculate** percentage of surface atom and surface to volume ratio of different nanoparticles (L3)

Unit-II:

Size dependent properties of nanomaterials (basic idea with few examples only): Quantum confinement, Electrical, Optical (Surface Plasmon resonance), variation in colors (Blue shift & Red shift), Magnetic, thermal and catalytic properties.

Learning outcomes:

By the end of this unit, the student will be able to

- **explain** the basic idea of size dependent properties of nanomaterials (L2)
- **explain** quantum confinement (L2)
- **comment** on magnetic, thermal and catalytic properties of different nanoparticles (L2)

Unit-III:

Synthesis of Nanomaterials: Brief introduction about Top-down and Bottom-up approaches & self-assembly techniques of nanoparticles synthesis, Solvothermal process, Examples of preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires.

Learning outcomes:

By the end of this unit, the student will be able to

- **explain** top-down and bottom-up approaches for Nanomaterial fabrication, and give some examples. (L2)
- **explain** the one dimensional control of nanoarchitecture (L2)
- **comment** on carbon nanotubes and inorganic nanowire (L2)

Unit-IV:

Material characterization techniques (basic idea of use of following instruments in nanomaterial characterization need to be emphasized): Electron microscopic technique, diffraction technique, photoelectron spectroscopy, zeta-potential measurement; Examples of use of nanomaterials in environmental remediation and biology (few practical examples of use of materials can be discussed).

Learning outcomes:

By the end of this unit, the student will be able to

- **explain** the principles of nanomaterial characterization techniques (L2)
- **describe** use of instruments like SEM, TEM, etc in nanomaterial characterization (L2)
- **comment on** use of nanomaterials in environmental remediation and biology (L3)

Course outcomes:

- Explain the importance of reduction in materials dimensionality, and its relationship with materials properties.
- Give examples on size-dependant phenomena.
- Explain top-down and bottom-up approaches for Nanomaterial fabrication, and give some examples.
- Diffraction data analysis (especially X-ray diffraction) for identification of crystal structure of nanomaterials and thin-films
- Understanding working principles and analysis of size, topography and morphology analysis of nanomaterials based on SEM/TEM.

Text Books:

- 1.C. N. R. Rao, A. Muller, A. K. Cheetam, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Willey-VCH Verlag, Germany, 2005.
- 2.G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Imperial College Press, London, 2004
- 3.R. W. Kelsall, I. W. Hameley, M. Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, England, 2005, 113
- 4.Charles P. Poole and Frank J Owens, *Introduction to nano technology*, Wiley Interscience, 2003.

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1	3	3	2	3	2	2	2	3	1	2	2
CO2	1	2	3	3	1	1	3	2	2	1	3	2	2	1	2
CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation

CHEMXXXX: Chemistry of Materials

Hours per week: 3
Credits: 3

Continuous Evaluation: 70 Marks
Semester End Examination: 30 Marks

Preamble

This course is introduced to learn fundamental topics in material chemistry for undergraduate level such as nanomaterials, Porous materials, polymer and energy storage materials.

Course objectives:

- To understand the materials and their uses in real life problems
- To learn the basic concept and applications of materials
- To explain various synthesis and characterization and application of materials
- Ability to implement materials for in day today applications
- To study the different types of Materials

Module - I

9 hrs

Chemistry of Nanomaterials:

Introduction to nanomaterials, nanoparticles, nano cluster, carbon nanotube(CNT) Nano sheets and nanowires. Chemical synthesis of nanomaterials: Sol-Gel method, reverse micellar method, electrolytic methods. **Characterizations:** Principle and applications of X-ray diffraction(XRD), scanning electron microscope(SEM) and transmission microscopy(TEM).

Learning outcomes:

By the end of this Unit, the student will be able to

- Understand types of nanomaterials (L1)
- Characterization of nanomaterials (L2)
- Chemical synthesis methods of nano materials (L4)

Module -II

Microporous and Mesoporous Materials:

9 hrs

Zeolites, metallosilicates, silicalites and related microporous materials: synthesis and characterizations. Mesoporous silica, metal oxides and related functionalized mesoporous materials: synthesis, and characterizations. Covalent organic frameworks, porous organic polymers and related organic porous materials: sensing, adsorption and gas storage applications. Organic-Inorganic hybrid materials, periodic mesoporous metal organic frameworks: H₂ /CO₂ gas storage and catalytic applications.

Learning outcomes:

By the end of this Unit, the student will be able to

- Understand **Microporous and Mesoporous Materials** (L1)
- COFs and MOFs materials Chemical synthesis (L2)
- Uses of materials in day today applications (L4)
- **illustrate** various application (L3)

Module –III

8 hrs

Energy Storage Systems:

Batteries: Primary, Secondary batteries; difference between primary and secondary batteries, chemistries of primary batteries such as Zinc-Carbon, Alkaline and secondary batteries such as Lead acid, Nickel Cadmium, Metal hydrides, lithium ion, lithium phosphate and high temperature batteries-sodium-sulphur. Advantages, disadvantages, limitations and application

each above mentioned batteries. Hydrogen for energy storage. Solar Ponds for energy storage

Learning outcomes:

By the end of this Unit, the student will be able to

- Understand various Energy storage systems (L1)
- COFs and MOFs materials Chemical synthesis (L2)
- Uses of different materials in day today applications (L4)
- **illustrate** various types of storages (L3)

Module –IV

7 hrs

Electrical & Electronic Materials: Intrinsic and Extrinsic Semi conductivity, Dielectric material, Piezo-electric materials.

Magnetic Materials: Introduction, classification of magnetic materials, soft & hard magnetic materials.

Organic Solar Materials: Syntheses of indigo, cyanines, tetrathiafulvalenes dyes, organic sensitizers for DSSC, electron donors and acceptors for organic solar cells.

Learning outcomes:

By the end of this Unit, the student will be able to

- Electronic, magnetic and solar materials (L1)
- Type of material applicable different application (L2)
- Synthesis of materials (L4)
- **illustrate** various types of material applications (L3)

Module -V

Polymeric Materials:

8hrs

Polymerization, factors influencing the properties of polymers, differences between thermoplastic and thermos setting polymers. Preparation and properties of polyethylene, polyvinylchloride and Bakelite. Polymer matrix composite materials: Classification and applications. Polymers as biomaterials and biodegradable polymers. Membranes for plasma separation and Blood oxygenation.

Learning outcomes:

By the end of this Unit, the student will be able to

- Learn about Polymerisation process (L1)
- Different types of polymer (L2)
- Synthesis of polymer materials (L4)
- Various types of polymer material applications (L3)

Course outcomes:

- Acquire knowledge about the various materials used. (L1)
- Understand about Nano materials and porous materials (L2)
- **gain** knowledge on energy storage devices, electronic, magnetic materials and polymers. (L3)
- **gain** insights into different synthesis physical & chemical properties of materials (L4)

Text Books:

1. B.S. Murty, P. Shankar, Baldev Raj, B B Rath, James Murday , Textbook of Nanoscience and Nanotechnology, University Press, 2013.
2. Pascal Van Der Voort, Karen Leus, Els De Canck, Introduction to Porous Materials, Wiley 2019.

3. A.C Anand, J F Kennedy, M.Miraftab, S.Rajendran, Woodhead Medical Textiles and Biomaterials for Healthcare, Publishing Limited 2006.
4. Raghavan V (2007), Materials Science and Engineering - A First Course, Prentice Hall, India
5. James F. Shackelford (1996), Introduction to Materials Science for Engineers, Prentice Hall, India
6. Askeland D.R., & P. P. Fullay (2007), The Science and Engineering of Materials –4th Cengage Learning Publishers

CHEMXXXX Bioorganic and Bioinorganic Chemistry

Hours per week: 3

Credits: 3

Continuous Evaluation: 70 Marks

Semester End Examination: 30 Marks

Unit-1

Carbohydrates: structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and non-reducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides). (Definition, structure, functions, examples only) Carbohydrates as informational molecules, working with carbohydrates (applications of carbohydrate)

Unit-II

Lipids: Classification, saturated and unsaturated fatty acids, structure and properties of fats and oils. General properties and structures of phospholipids, sphingolipids and cholesterol. Biomembranes - Behavior of amphipathic lipids in water. Formation of micelles, bilayers, vesicles, liposomes; Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes. Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. Lipids as signals, cofactors and pigments (preliminary ideas only)

Unit-III

Amino acids: Definition, classification & structures. Physico-chemical properties of amino acids (amphoteric molecules, ionisation, zwitterions, pK values, isoelectric point, Lambert-Beer's law, optical density, absorption spectra), titration of amino acids (glycine, glutamic acid, lysine, histidine), Formol titration of glycine (only reaction and principle), reaction of amino acids: reaction due to amino groups (reaction with mineral acids, alkyl halides, acetyl chloride, acetic anhydride in presence of base, nitrous acid, ninhydrin and fluorescamine), reaction due to carboxylic acid group (reaction with base, alcohol, LiAlH_4 , metal oxide), separation and analysis of amino acids by paper & thin layer chromatography and HPLC.

Unit -IV

Elements of life: essential and beneficial elements, major, trace and ultratrace elements. Basic chemical reactions in the biological systems and the role of metal ions (specially Na^+ , K^+ , Mg^{2+} , Ca^{2+} , $\text{Fe}^{3+/2+}$, $\text{Cu}^{2+/+}$, and Zn^{2+}). Metal ion transport across biological membrane Na^+/K^+ -ion pump. Dioxygen molecule in life. Dioxygen management proteins:

Haemoglobin, Myoglobin, Hemocyanine and Hemerythrin. Toxic metal ions and their effects, chelation therapy (examples only), Pt and Au complexes as drugs (examples only), metal dependent diseases (examples only)

Unit-V

Metalloenzymes -Structure and function –Carbonic anhydrase – Carboxy peptidase -Alkaline phosphatase -Alcohol dehydrogenase. Oxygenases, peroxidases and catalases. Interchangeability of zinc and cobalt in enzymes, Reasons for interchangeability –uniqueness of zinc as a biochemical element.

CHEM3101: Pharmaceutics -II (PE)

Hours per week: 3
Credits: 3

Continuous Evaluation: 70 Marks
Semester End Examination: 30 Marks

Preamble

The course deals with the importance and implementation of the sterilization process in parenteral—dosage form design and development and scale-up of small volume and large volume parenteral. The knowledge gained in this course can be applied to the pharmaceutical industry.

Course objectives

- To familiarize the students with various types of parenteral dosage forms.
- To study the formulation design, development, and evaluation tests for parenteral.
- To emphasize the importance of sterilization methods and their applications.
- To impart knowledge on the aseptic processes and sources for contamination.
- To expose the students to the latest techniques.

Unit-I:

8L

Parenterals: Definition, Types, vehicles, used and quality control tests for parenteral. Formulation design, development, and scale-up of parenterals.

Learning outcomes:

By the end of this unit, the student will be able to

- **define** parenteral and their classification (L2)
- **distinguish** between SVP & LVP with examples (L2)
- **explain** the formulation design of parenteral (L2)
- **evaluation** tests of the parenteral and scale-up process (L3)

Unit-II:

9L

Sterilization and Depyrogenation:

Unit operations in Aseptic manufacturing, Moist heat sterilization and autoclaving cycle, Importance of F and Z value, Sterility Assurance Level (Overkill approach) and D value, Loading pattern and biological indicators, mechanism of sterilization using Dry Heat and FH Value, bacterial endotoxin, De pyrogenation, sterile filtration and filter media, filter integrity testing, and bubble point.

Learning outcomes:

By the end of this unit, the student will be able to

- **explain** sterilization and types (L2)
- **describe** the importance of F, Z, and D values (L2)
- **list** the indicators used in the sterilization process (L2)
- **explain** filter integrity testing and bubble point (L2)

Unit-III: 8L

Aseptic Processing & Interventions: compounding for sterile filtration, aseptic processing, and aseptic interventions, aseptic process simulation and regulatory expectation, lyophilization and freeze-drying, explain the impact of extraneous matter in the final product.

Learning outcomes:

By the end of this unit, the student will be able to

- **define** aseptic processing, aseptic interventions, and aseptic process simulation. (L2)
- **explain** about lyophilization process and its applications (L2)
- **enlist** the regulatory expectations (L2)
- **impact** of extraneous matter in the final product (L3)
- **define** visual inspection and factors (L2)

Unit-IV: 9L

Cleaning and Sanitization: Define and classify microorganisms, the impact of microbial contamination on the sterile product, various sources of microbial contamination, cleanroom behavior and aseptic gowning, cleaning in the aseptic area, decontamination of isolators using VHP, Physical and Chemical means of Disinfection.

Learning outcomes:

By the end of this unit, the student will be able to

- **define** microorganisms and their classification (L2)
- **explain** sources and impact of microbial contamination on sterile products (L2)
- **classify** cleanrooms according to ISO 14644-1 Cleanroom Standards (L2)
- **describe** disinfection importance and their classification (L2)

Unit-V: 8L

Visual Inspection: Personal Qualification as per SOP OPR 012

Environment Monitoring: Personal Qualification as per SOP FT7QC084

Learning outcomes:

By the end of this unit, the student will be able to

- **define** visual inspection (L2)
- **explain** Importance of visual inspections and techniques used for visual inspection (L2)
- **identify** of defects on sterile products and their limitations (L3)
- **define** environmental monitoring (L2)
- **differentiate** between viable & non-viable particulates & their detection techniques (L3)

Course outcomes

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

- **explain** about parenteral dosage form design and their classification (L2)
- **design** the layout of the parenteral unit (L3)
- **describe** sterilization methods and biological indicators (L2)

- **explain** sources and impact of microbial contamination on sterile products (L3)
- **distinguish** between viable and non-viable particulates & their detection techniques (L3)
- **define** visual inspection and identification of defects on sterile products and their limitations (L4)

Text Books:

1. Leon Lachman, H. A. Lieberman & J. L. Kanig: —The Theory and Practice of Industrial Pharmacy, 3rd edition, Varghese Publishing House, Bombay, 1991.
2. M. E. Aulton: —Pharmaceutics – The Science of Dosage Form Design, 2nd edition, Churchill Livingstone, 2002.
3. Rawlins, Ed.: —Remington's The Science and Practice of Pharmacy, 20th edition, Lippincott William & Wilkins, USA, 2000.
4. Indian Pharmacopoeia, Government of India, Ministry of Health & Family Welfare, the Indian Pharmacopoeia Commission, Ghaziabad, 2007
5. British Pharmacopoeia, Vol. III, 2009.
6. United States Pharmacopoeia, USP 32 – NF 27, Vol 1 & 2, Asian Edition, 2008.
7. Carter, Ed.: —Cooper & Gunn's Tutorial Pharmacy, 6th edition., CBS Publishers, 1972.
8. S.J. Carter Ed.: —Cooper & Gunn's Dispensing for Pharmaceutical Students, 12th edition, CBS Publisher, New Delhi, 1987.

	Program Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
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CO3	2	1	3	1	2	2	1	2	3	3	1	2	1	3	2
CO4	1	3	3	2	1	1	2	1	3	1	2	1	1	2	1
CO5	3	2	1	3	3	2	1	3	3	2	1	3	2	1	3

1-Low, 2- Medium and 3- High Correlation