Name of Institute: Institute of Sciences, Humanities & Liberal Studies(ISHLS)
Name of Faculty: Dr. Madhuresh Makavana

Course code: MCH0323
Course name: Advanced Chromatographic Techniques
Pre-requisites: B.Sc. (Chemistry)
Credit points:

L	T	P	C
4	0	0	4

Offered Semester: II

Course Coordinator (weeks XX - XX)
Full Name: Dr. Madhuresh Makavana
Department with siting location: Department of Chemistry
Class-9 (EDC Cell) ,4th Floor , Bhanwar Building
Telephone: EXT : 3404
Email: madhureshmakavana.gd@indusuni.ac.in
Consultation times: 4:15 pm to 5:00 pm (Monday to Friday)

Course Lecturer (weeks xx - XX)
Full Name: Dr. Madhuresh Makavana
Department with siting location: Department of Chemistry
Class-9 (EDC Cell) ,4th Floor , Bhanwar Building
Telephone: EXT : 3404
Email: madhureshmakavana.gd@indusuni.ac.in
Consultation times: 4:15 pm to 5:00 pm (Monday to Friday)

Students will be contacted throughout the Session via Mail with important information relating to this Course.

Course Outcomes (CO)

By participating in and understanding all facets of this Course a student will:

1. To explain the theory and principle of various kinds of chromatographic techniques. [BT-2]
2. Describes the types and materials of column. [BT-2]
3. Explains the types of mobile phase and eluation. [BT-2]

4. Categorize the types, basic components and properties of ion chromatography, supercritical fluid chromatography and capillary electrochromatgraphy. [BT-4]
5. Evaluate qualitative and quantitative analysis of various samples with HPLC. [BT-5]
6. Illustrate the types, features and application areas of detectors. [BT-4]

Course Outline
(Key in topics to be dealt)

- Liquid Chromatography
- Gas Chromatography
- Ion Exchange Chromatography & Electrophoresis
- Specialized Liquid Chromatographic Techniques

Method of delivery
(Face to face lectures, , Active Learning Techniques)
Face to Face Lecture

Study time
(How many hours per week including class attendance)
04 hours per week

CO-PO Mapping (PO: Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1										
CO2										
CO3										
CO4										
CO5										
CO6										

Blooms Taxonomy and Knowledge retention (For reference)
(Blooms taxonomy has been given for reference)

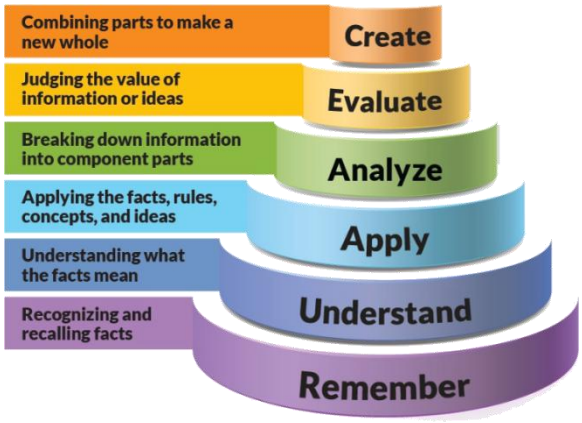

Figure 1: Blooms Taxonomy

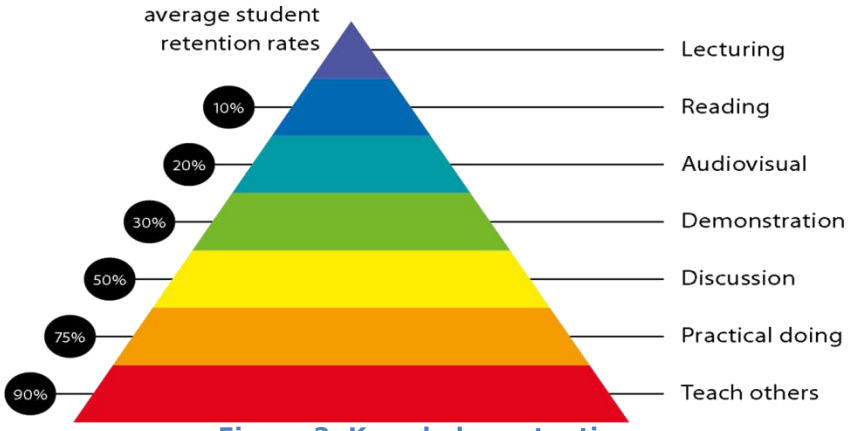

Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of _____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness:-** Student's will gain knowledge about chemistry subject in the both areas i.e. theory as well as practical's. Professionally students will know how chemistry is important in our daily life as well as to build up any industry. Students will be having knowledge/ awareness

	about chemicals' such as how to use them and how hazardous they are for the environment.
Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing:-** Student's will be able identify the problems happening in the society as well as in the industry such as Photochemistry, uses of Aromatic heterocyclic compounds and their reactions, Organic waste coming from the industries etc. with this basic information they will be having ability to gather the possible solutions.
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills:** Organic Chemistry education provides students with the tools to solve many problems based on Chemistry. This means that students should be able to apply the scientific method: define a problem clearly, develop testable hypotheses, design and execute experiments, analyse data using appropriate statistical methods, and draw appropriate conclusions. Students should be able to integrate knowledge across chemical sub disciplines and apply this knowledge to solve problems. In the laboratory, in addition to the characteristics described above, students should understand the fundamental uncertainties in experimental measurements.
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication:-** Students should be able to retrieve specific information from the chemical literature, critically evaluate technical articles, and manage many types of chemical information. Students should able to develop proficiency with electronic searching of appropriate technical databases, including structure-based searching
	6 Oral communication:- Students should orally able to use communication technology such as

	computerized presentations as well as software for word processing, chemical-structure drawing, writing review article on any related topic, poster preparation and research paper presentation to any conferences.
	7 Teamwork:- Students should be able to Solve scientific problems often involves working in disciplinary and multidisciplinary teams. This is especially true in industry and increasingly in academic settings. Students should learn to work productively with a diverse group of peers in classroom and laboratory activities. Students should be able to lead portions of an activity or be effective followers, as dictated by the situation. Peer- and self-assessment is often an effective way to evaluate student contributions to group activities.
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact:** With this course students will know/ aware/ learn about the sustainable use of the organic reagents while performing the laboratory experiments. Students will be able to understand various photochemical reactions happening in the environment and their participation in global warming. So they will be having capabilities/ knowledge how to tackled/ deal with different types of organic pollutants coming from the organic laboratory and industry.

Lecture/tutorial times

(Give lecture times in the format below)_M.Sc. Chemistry _SEM-2

Example:

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the Course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for mid and end semester examinations.

Reference Books:

1. Quantitative Chemical Analysis, Daniel C. Harris, 5 th Edition, W.H. Freeman and
Company, New York, 2007.
2. Analytical Chemistry, Gary D. Christian, 6 th Edition, John Wiley and Sons Inc. New
Jersey.
3. Chiral Separation Techniques: A Practical Approach, 2 nd edition, edited by Ganapathy Subramanian, Wiley-VCH, 2001.
4. Chiral Separations by Chromatography, Satinder Ahuja, American Chemical Society,
2000.
5. Chiral Chromatography, Thomas E. Beesley, T.E. Beesley, R.P.W. Scott, John Wiley
and Sons, 1999.
6. A Practical handbook of preparative HPLC by Donald Wellings, Elsevier, 2006.
7. Ion-pair chromatography: Theory and Biological and Pharmaceutical Applications
(Chromatographic Science), Milton Hearn (editor), Marcel and Dekker Inc., 1985.
8. Advances in Electrophoresis (Volume 2) by Andreas Chrembach, Michael J. Dunn,
Bertold J. Radola, Wiley-VCH, 1989.
9. High Performance Capillary Electrophoresis: An Introduction, David N. Heiger. Hewlett Packard GmbH, 1992.
10. High-speed counter current chromatography, Yoichiro Ito and Walter D. Conway,
John Wiley and Sons, 1995.
11. Practical Aspects of Gas Chromatography/Mass Spectroscopy, Gordon M. Message,
John Wiley & Sons, 1984.
12. Modern Practice of Gas Chromatography, Robert L. Grob and Eugene F. Barry, 3 rd

edition, Wiley-Interscience, 1995.
13. Basic Gas Chromatography, Harold M. McNair, James M. Miller, John Wiley and
Sons, 2008.
14. Analytical Gas Chromatography, Walter Jennings, Eric Mittlefehldt and Philip Stremple, Second edition, Elsevier Science, 1997.
15. Modern HPLC for Practicing Scientists, Michael W. Dong, Wiley Interscience, 2006.

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

Example:

- **CIE (60 Marks)**

1. Mid Sem Exam = 40 Marks
2. Assignment = 10 Marks (2 assignment)
3.Presentation = 05 Marks
3. Attendance = 05 Marks(bonus for student having >80% attendance)

CIE Total = 60 Marks

- ESE (40 Marks)

1. ESE exam = 40 Marks

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in mid semester or end semester will be considered for supplementary assessment in the respective components (i.e mid semester or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (mid semester or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Practical Work Report/Laboratory Report:

A report on the practical work is due the subsequent week after completion of the class by each group.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

Plagiarism - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment)

.

Course schedule (subject to change)

(Mention quiz, assignment submission, breaks etc as well in the table under the Teaching Learning Activity Column)

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Weeks 1	Liquid Chromatography: Principle, theory and applications of high-performance liquid chromatography (HPLC),	1,2,3&5	
	Weeks 2	Ion-pair chromatography (UPLC), High chromatography, Performance thin Ultra layer Performance liquid chromatography, ion chromatography,	1,2,3&5	
	Week 3	Preparative chromatography, Chiral chromatography, Size/Molecular- exclusion/Gel permeation chromatography and affinity chromatography	1,2,3&5	
	Week 4	Gas Chromatography: Principle & theory, types of GC columns: packed and capillary Columns.	1,2,3&6	
	Week 5	Stationary phases-the key to different separations, temperature programming and carrier gas, sample injection,	1,2,3&6	
	Week 6	Types of detectors: thermal conductivity, flame ionization, electron capture and flame photometric and flame thermionic detectors, head space gas chromatography, pyrolysis gas chromatography,	1,2,3&6	

		application in pharmaceutical analysis.		
	Week 7	Ion Exchange Chromatography & Electrophoresis: Ion Exchangers principle, Commercial grade Ion-exchangers (cation and anion), key parameter of ion-exchanger such as swelling, selectivity, capacity etc.	1,2,3&4	
	Week 8	Applications of IEC, Applications of Ion Exchange Chromatography	1,2,3&4	
	Week 9	Principles and concepts of electrophoresis, electrophoretic support media (starch, poly acrylamide and agarose gels), impact of experimental conditions on electro phoretic separations Electrophoretic mobility, Electro-osmosis,	1,2,3&4	
	Week 10	Application of capillary zone electrophoresis, micellar electrokinetic electrophoresis, capillary electro chromatography and capillary gel electrophoresis, Isoelectric focusing.	1,2,3&4	
	Week 11	Specialized Liquid Chromatographic Techniques: Principle, theory and applications of Hydrophilic interaction liquid chromatography (HILIC).	1,2,34&6	
	Week 12	Principle, theory and applications of Supercritical fluid chromatography (SFC), Principle, separation process (hydrodynamic approach)	1,2,34&6	
	Week 13	Instrumentation and applications of counter current chromatography, ice chromatography (retention	1,2,34&6	

		mechanism on water-ice particles),		
	Week 14	superheated water chromatography-green approach for the future (stationary phases and detection systems) and flash chromatography (selection of sorbent and solvent system).	1,2,34&6	
	Week 15			