

### 1.5.2 INSTRUMENTAL ANALYSIS II

Program	BSc in Chemistry					
Module Name	Instrumental Analysis					
Module Number	05					
Module code	Chem-M2051					
Course Title	Instrumental Analysis II					
Course Code	Chem2052					
Pre-requisite	Chem2051					
Module coordinator name and address	TBA					
Instructor(s) name and address	TBA					
Lecture days, Hours & room	TBA					
Cr.Hrs/ECTS	3/5					
Work load	Lecture	Tutorial	Lab.	Home study	Assessment	Total
	48	16	-----	66	5	135
Target group	2 <sup>nd</sup> year chemistry students					
Semester	Semester II					
Mode of delivery	Semester based					
Status of the course	Core Compulsory					

#### Course Description

Introduction to the subject matter; analytical methods based on the interaction of electromagnetic radiation with matter; atomic absorption and emission spectroscopy; instrumentation for spectroscopy; ultraviolet and visible spectroscopy; infrared; nuclear magnetic resonance; fluorescence; phosphorescence.

#### Learning Outcomes

By the end of this course students should be able to:

- Describe the theory behind techniques of spectrochemical analysis.
- Describe different types of analysis for the estimation of the concentration of an unknown solution
- Identify different parts of selected instruments, draw block diagrams for different instruments and describe their respective functions.
- Define Possible terms used in the analysis such as resolution, spectroscopy, absorption and emission of EMR;
- Describe the underlying principles of spectral analysis.
- Discuss the qualitative and quantitative applications of different spectral analysis
- Elucidate structure of compounds from spectra by using data from joint spectroscopic techniques;

## Course Outline and Schedule

Week	Contents	Teaching methodology	Students activity	Readings
1 <sup>st</sup> - 3 <sup>rd</sup>	<b>1. Introduction to Spectroscopy</b> <ul style="list-style-type: none"> <li>• Electromagnetic Radiation and its interaction with matter</li> <li>• Electromagnetic radiation and its quantum mechanical property</li> <li>• Absorption and Emission of Radiation</li> <li>• The electromagnetic spectrum</li> </ul> <b>2. Absorption Laws (Quantitative Analysis)</b> <ul style="list-style-type: none"> <li>➤ Lambert-Beer's Law</li> <li>➤ Deviation from Beer's Law</li> <li>➤ Errors associated with Beer's Law</li> </ul>	<ul style="list-style-type: none"> <li>• Lecture</li> <li>• Asking questions</li> <li>• Reading assignment</li> </ul>	<ul style="list-style-type: none"> <li>• Active participation in discussion</li> <li>• Listen to a lecture</li> <li>• Take notes on the lesson treated</li> <li>• Ask questions on unclear ideas</li> </ul>	Skoog/ Leary Skoog/ West, Gray D. Christian,
	<b>Quiz 1 (5%)</b>			
4 <sup>th</sup>	<b>3. Instruments for optical spectroscopy</b> <ul style="list-style-type: none"> <li>• Components of optical instruments <ul style="list-style-type: none"> <li>➤ Source of Radiation</li> <li>➤ Wave-length selectors</li> <li>➤ Sample containers</li> <li>➤ Radiation Detectors</li> <li>➤ Read out detectors and signal amplification systems</li> </ul> </li> <li>• Optical systems used in spectroscopy: Single beam versus double beam.</li> </ul>	<ul style="list-style-type: none"> <li>• Lecture</li> <li>• Asking questions</li> <li>• Reading assignment</li> </ul>	<ul style="list-style-type: none"> <li>• Active participation in discussion</li> <li>• Listen to a lecture</li> <li>• Take notes on the lesson treated</li> <li>• Ask questions on unclear ideas</li> </ul>	Skoog/ Leary Skoog/ West, Gray D. Christian,
	<b>Surprise test 1 (5%)</b>			

5 <sup>th</sup> & 6 <sup>th</sup>	<b>4. Atomic Absorption and emission spectroscopy</b> <ul style="list-style-type: none"><li>Principles</li><li>Instrumentation</li><li>Analytical Applications</li></ul>	<ul style="list-style-type: none"><li>Lecture</li><li>Oral questions</li><li>Reading assignment</li></ul>	<ul style="list-style-type: none"><li>Active participation in discussion</li><li>Listen to a lecture</li><li>Take notes on the lesson treated</li><li>Ask questions on unclear ideas</li></ul>	Skoog/Leary Skoog/West, Gray D. Christian,
	Assignment 1 (5%)			
7 <sup>th</sup>	<b>5. Ultraviolet and Visible (UV-Vis) Spectroscopy</b> <ul style="list-style-type: none"><li>Introduction</li><li>Basic Principles</li><li>Absorption characteristics of some chromophores</li><li>Instrumentation</li><li>Application</li></ul>	<ul style="list-style-type: none"><li>Lecture</li><li>Asking questions</li><li>Reading assignment</li></ul>	<ul style="list-style-type: none"><li>Active participation in discussion</li><li>Listen to a lecture</li><li>Take notes on the lesson treated</li><li>Ask questions on unclear ideas</li></ul>	Skoog/Leary Skoog/West, Gray D. Christian,
	Quiz 2 (5%)			
8 <sup>th</sup> & 9 <sup>th</sup>	<b>6. Infrared Spectroscopy</b> <ul style="list-style-type: none"><li>Introduction</li><li>Energy levels in vibrating and rotating molecules</li><li>Characteristic vibrational frequencies</li><li>Factors affecting group frequencies</li><li>Instrumentation</li><li>Interpretation of some spectra</li></ul>	<ul style="list-style-type: none"><li>Lecture</li><li>Oral questions</li><li>Reading assignment</li></ul>	<ul style="list-style-type: none"><li>Active participation in discussion</li><li>Listen to a lecture</li><li>Take notes on the lesson treated</li><li>Ask questions on unclear ideas</li></ul>	Skoog/Leary Skoog/West, Gray D. Christian
	Assignment 2 (5%)			
10 <sup>th</sup> & 12 <sup>th</sup>	<b>7. Nuclear Magnetic Resonance Spectroscopy (NMR)</b> <ul style="list-style-type: none"><li>Basic principle of NMR</li><li>NMR spectrometers</li><li>Proton NMR</li><li>C–13 NMR</li><li>Interpretation of NMR spectra</li></ul>	<ul style="list-style-type: none"><li>Lecture</li><li>Asking questions</li><li>Reading assignment</li></ul>	<ul style="list-style-type: none"><li>Active participation in discussion</li><li>Listen to a lecture</li><li>Take notes on the lesson treated</li><li>Ask questions on unclear ideas</li></ul>	Skoog/Leary Skoog/West, Gray D. Christian
	Assignment 3 (5%)			

12 <sup>th</sup>	<b>8. Mass spectroscopy (MS)</b> <ul style="list-style-type: none"> <li>Basic Principle of MS.</li> <li>MS spectrometers</li> <li>Interpretation of MS spectra.</li> </ul>	<ul style="list-style-type: none"> <li>Lecture</li> <li>Asking questions</li> <li>Reading assignment</li> </ul>	<ul style="list-style-type: none"> <li>Active participation in discussion</li> <li>Listen to a lecture</li> <li>Take notes on the lesson treated</li> <li>Ask questions on unclear ideas</li> </ul>	Skoog/ Leary Skoog/ West, Gray D. Christian,
13 <sup>th</sup> - 15 <sup>th</sup>	<b>9. Structure elucidations by joint application of different spectroscopic methods: UV, IR, NMR and MS.</b>	<ul style="list-style-type: none"> <li>Demonstration</li> <li>Asking questions</li> <li>Class work</li> <li>assignment</li> </ul>	<ul style="list-style-type: none"> <li>Active participation in discussion</li> <li>Listen to a lecture</li> <li>Take notes on the lesson treated</li> <li>Ask questions on unclear ideas</li> </ul>	Skoog/ Leary Skoog/ West, Gray D. Christian,
<b>Assignment and Presentation (20%)</b>				

### Mode of Assessment

Assessment Breakdown	%
continuous assessment (not more than 10% for each)	<b>50</b>
End of Semester Examination	<b>50</b>

### Course Policy

Beside the university's policy on course delivery and evaluation, students are expected to actively participate in learning process by obeying the following course policies:

- Coming class on time (punctuality)
- Attend all class sessions
- Be prepared to learn and actively participate during class discussion
- Do all assignments, group works, project works, and presentations on time
- All students are expected to complete their own work to the best of their ability and cheating is strictly forbidden
- Do not miss quizzes, assignments, and exams unless you are forced due to health and other reasonable problems
- Cite all sources consulted to any extent (including material from the internet), whether or not assigned and whether or not quoted directly. It is strictly forbidden to take others work and present as own.
- Make-up class shall be conducted if classes are missed due to national holidays and/or when unpredicted conditions result in class dismissal

## Reference

1. D.A. Skoog and J.J. Leary, Principles of Instrumental Analysis, 4<sup>th</sup> Ed. Saunders College Publishing, 1992.
2. J.W. Robinson, Undergraduate Instrumental Analysis, 5<sup>th</sup> ed, Marcel Dekkers Inc. 1995
3. D.A. F. Rouessac and A. Rouessac, Chemical Analysis; Modern Instrumentation Methods and Techniques, 6<sup>th</sup> Edition, John Willey & sons Ltd, 2007
4. C.N. Banwell and E.M. McCash, Fundamentals of Molecular Spectroscopy, McGraw Hill, 1994.
5. R.M. Silverstein, G.C. Bassler and T.C. Morrill, Spectrometric Identification of Organic Compounds, 5<sup>th</sup> ed., John Willey and sons, 1991.
6. J. Hollas, Modern Spectroscopy, 3<sup>rd</sup> Ed. John Willey and sons, 1996.
7. L.D. Field, S. Sternhell and S. Kalman, Organic structure from spectra, 2<sup>nd</sup> ed., John Willey and sons, 1995.
8. D.H. Williams and I. Fleming, Spectroscopic method in organic chemistry, 5<sup>th</sup> ed. McGraw Hill, 1995.
9. H. Gunter, NMR Spectroscopy, 2<sup>nd</sup> ed., John Willey and sons, 1995.
10. J.R. Chapman, Organic Mass Spectrometry, 2<sup>nd</sup> ed.; John Willey and Sons, 1993.