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# INSTRUMENTAL METHODS I: CHROMATOGRAPHY

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## CHEM 4010/6010 On-Lecture CRN: 53455 and 53456 Professor Name: Shahab A. Shamsi Summer 2021

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### Course Description

Welcome to CHM 4010/6010. Instrumental Methods Part I: Chromatography. We're going to have a great time this semester exploring fundamental theory and real world applications of chemical separations using modern instrumental methods such as gas chromatography (GC) and liquid chromatography (HPLC).

My name is **Shahab A. Shamsi**, and I'll be your professor. You can call me Shamsi (not necessarily Dr. Shamsi). I've been teaching this course for more than twenty-two years and at least once a year. I always enjoy teaching chromatography because this is my "*bread and butter*," which means this is the research area where I am professionally trained. I obtain my Ph.D. at the Miami Valley, Oxford, OH, where there is a big industry to make columns. I have practice chromatography in my laboratory research at GSU since 1998.

I hope that when the students finish this course, they will at least develop some appreciation and perhaps working knowledge of how one can analyze a sample using an array of separation techniques available to analytical chemists in the industry. Teaching this full-semester course and modifying this from year to year has helped me improve my own perspective of chemical separations. Now, this online teaching will add a new dimension to teaching chromatography. During this course, I promise to make my class students begin to imagine how chemical separations can be done. This course has helped many students find jobs in pharmaceutical, environmental, agricultural, and many research areas in medical and other health-related fields of graduate studies.

As I mentioned earlier, I am a trained chromatographer who has practiced this research and teaching technique in the past twenty-eight years since I

published my first paper in 1992. I have published more than 100 peer-reviewed publications on analytical chemistry, chromatography, and electrophoresis, the two commonly used modern analytical chemistry techniques. Our laboratory has developed many applications for the analysis of various types of samples necessary in many fields. Students take this course as a valuable experience and have developed skills in the laboratory section that has helped them find jobs after graduation.

I'm looking forward to working with all of you this semester. Please do note that this syllabus reflects a plan for the summer semester. **Deviations may become necessary as the semester progresses.**

## Course Goals:

**Goal 1:** \*Learn effective strategies on how to measure and calculate the separation parameters for a mixture of chemical compounds, perform qualitative and quantitative analysis

**Goal 2:** \*Learn principles of how different parts of analytical (gas or liquid chromatographic) instruments works to allow complete qualitative and quantitative analysis of mixtures of chemical compounds

**Goal 3:** \*Learn to apply goal 1 and goal 2 to develop a chromatographic method(s) to achieve a particular separation and analysis of the real-world sample for a mixture of chemical compounds

## Course Outcomes

### Learning Outcome 1

When asked to calculate and measure the separation parameters for a mixture of chemical compounds and perform qualitative and quantitative analysis, the student will be able to:

- Choose the school approved laboratory manuals, tutorials and homework problems, and Kaltura online lectures to measure numerical separation parameters using a set of equations and graphs (aka. chromatogram for this course)
- Develop a fundamental understanding of chemical separations, which will involve learning to read a chromatogram and evaluate how to

improve the analytical separation of chemical compounds (displayed as chromatographic peaks) in a chromatogram.

### **Learning Outcome 2**

When asked to learn to understand different parts and working function of a gas or liquid chromatographic instruments, the student will be able to:

- Watch and listen to Kaltura online lectures, choose the school approved laboratory online short lab videos and animations, problem-solving assignments read textbook discussions to understand the working principles of chromatographic instruments capable of performing chemical separations using a gas or a liquid chromatography

### **Learning Outcome 3**

When asked to develop a chromatographic method(s) to achieve a particular separation and analysis of the real-world sample, the student will be able to:

- Watch and listen to Kaltura online lectures on analysis of real-world samples delivered by the instructor, evaluate case studies and apply to the analysis of samples using the cumulative knowledge and learning achieved under goal 1 and goal 2.

### **Course Benefits**

Your new skills should help you in the following ways:

- Find technician job in an industrial setting for analysis and development of standard operating protocols for chemical separations
- Prepare you for a career in pharmacy school and the pharmaceutical industry where a basic understanding and measurement of a pharmaceutical drug is needed
- Prepare you for career to graduate school and medical school where measurement of analytical instrument learned in this course is applied.

**Assessments for CHM 4010 only**

Evaluation Format	Goal in Category	Points and/or % of Grade
Exam 1 Quiz 1 and Quiz 2	Goal 1	150 pts or 15 % of the Grade 10 pts/quiz, total 20 pts or 3 % of the Grade
Exam 2 Quiz 3 and 4	Goal 2	150 pts or 15 % of the Grade 10 pts/quiz, total 20 pts or 3 % of the Grade
Exam 3 Quiz 5 and 6	Goal 2	100 pts or 10 % of the Grade 10 pts/quiz, total 20 pts or 4 % of the Grade
Final Exam	Goal 3	150 Points or 15% of the Grade
Discussion Board	Goal 1, Goal 2 and Goal 3	40 pts or 4% of the course All bonus points
Laboratory Reports Note books	Goal 1 and Goal 2	300 pts or 30% of the grade
Homeworks	Goal 1, Goal 2 and Goal 3	50 pts or 5% of the grade

**Assessments for CHM 6010 only**

Evaluation Format	Goal in Category	Points and/or % of Grade
Exam 1 Quiz 1 and Quiz 2	Goal 1	150 pts or 15% of the Grade 15 pts/quiz, total 20 pts or 3 % of the Grade
Exam 2 Quiz 3 and 4	Goal 2	150 pts or 15 % of the Grade 15 pts/quiz, total 20 pts or 3 % of the Grade
Exam 3 Quiz 5 and 6	Goal 2	100 pts or 10 % of the Grade 20 pts/quiz, total 20 pts or 4 % of the Grade
Literature Project	Goal 3	50 pts or 5% of the grade
Final Exam	Goal 3	150 Points or 15% of the Grade
Discussion Board	Goal 1, Goal 2 and Goal 3	40 pts or 4% of the course All bonus points

Laboratory Reports Note books	Goal 1 and Goal 2	250 pts or 25% of the grade
Homeworks	Goal 1, Goal 2 and Goal 3	50 pts or 5% of the grade

## On-Line Exams Requirement and Academic Honesty Policy

All students enrolled in the course will need to use to use Lockdown Browser with Respondus Web Monitor for all course Exams, and the Final Exam. Students will need a webcam-enabled device capable of installing this Lockdown Browser. Students who need such a device may request one from CETL using the following link:

<https://cetl.gsu.edu/resources/resources-for-learning-remotely/internet-options/>

\*Please note that sharing information/cheating via group messaging apps such as GroupMe or Slack is a violation of the Academic Honesty Policy. A close review of the evidence will sometimes reveal sufficient evidence to implicate all individuals responsible. Other examples include examining the uploaded material (some study sites such as Chegg.com are willing to provide these details upon request).

## Grade Breakdown

This is how (**Chemistry**) awards grades for courses:

<b>Grade A+</b>	<b>95-100</b>
<b>Grade A</b>	90-94
<b>Grade A-</b>	85-89
<b>Grade B+</b>	80-84
<b>Grade B</b>	75-79
<b>Grade B-</b>	70-74
<b>Grade C+</b>	65-69
<b>Grade C</b>	60-64
<b>Grade C-</b>	55-59
<b>Grade D</b>	50-54

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## COURSE HELP

NOTE THAT THIS IS AN ONLINE COURSE. HERE ARE A FEW TIPS TO GET YOU STARTED:

### HOW DO I CONTACT YOU?

I PREFER TO BE CONTACTED IN THE FOLLOWING WAY(S):

### REQUEST TO SET-UP WEB-EX MEETING:

Please send me an Email to set-up an appointment

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**GSU EMAIL:** [sshamsi@gsu.edu](mailto:sshamsi@gsu.edu); **Cell:** 678-761-0507

### How Do I Access My Course?

You can login to your course via i-College. If you need more help, you can review the Welcome to i-College help-guide. If you have problems accessing your course, please contact Help Desk at [help@gsu.edu](mailto:help@gsu.edu) or 1-855-772-0423 (Service available: 24/7)

### What Are The Required and Optional Materials?

The following resources are required for this course:

Title: Chromatography Principles and Instrumentation.

Written by Mark F. Vitha

Publisher: Wiley

ISBN: 978-1-119-27088-1

<https://www.wiley.com/en-us/Chromatography%3A+Principles+and+Instrumentation-p-9781119270881>

This textbook is available at the University Bookstore:

<https://www.bkstr.com/georgiastatestore/shop/textbooks-and-course-materials>

Lecture Notes (All notes will be provided via i-college website).

### Are There Any Required Meetings?

This course is not completely on-line. Please see schedule for set-up Web-ex meeting and homework problem solving.

## Are There Any Additional Fees?

This course has **no** additional fees:

## How Do I Succeed in this Course?

If this is your first time taking an online course, you should refer to GSU's [online student success guide](#). I also have specific tips for this course located in the Welcome To The Course Module once you login to the course.

## Course Schedule

Although this is an online course, we do have a set schedule (see below). Please note that deviations may become necessary as the semester progresses. You'll want to refer to the schedule below frequently as we work together. I've designed this iCollege course in such a way to help us all stay on track, including (**Module Dates, Due Dates Attached To Grade Items, Announcements, etc**). If this is your first time taking an online course, you'll want to review the [Online Time Management Essentials](#) guide. Please note that deviations may become necessary as the semester progresses.

This course is divided into **Six** Modules. You'll have **(1-2)** weeks to complete each Module. For detailed information about what's required for each Module, visit iCollege and check out the Module Introductions on the content section. While you're working, I'll also be working hard to give you quality feedback and grade your assessments by the dates indicated below.

## Time Needed to Spend on the Course

So, how much time do you need to spend working on this course? Because this is a 3-Credit Hour course GSU recommends that you spend around **3 hours or more per week** interacting with readings, watching videos, and other sorts of content and **then 3 hour per credit hour per week** completing activities, assessments and lab report writings.

## Schedule of Prerecorded On-Line Kaltura Lectures and Synchronous Web-ex meetings

### Module I: The Basic Theory of Chromatography

<u>Date</u>	<u>Suggested Reading/Watching</u>	<u>Sub-Topic</u>
Jun 7	Textbook Chapter 1 Kaltura On-line Lecture <b>Video 1-3</b>	Introduction, History and Type of Chromatography, Plate Theory of Chromatography, Calculation of Zone Spreading, Calculation of Theoretical Plates, Short Comings of Plate Theory
Jun 9	Chapter 1, Lect Notes Kaltura On-Line Lecture <b>Video 4-6</b>	Introduction to Chromatographic Parameters, (Retention, Capacity Factor, Resolution, Symmetry and Peak Capacity), Factors Affecting Resolution
Jun 14	Lecture Notes Kaltura On-Line Lecture <b>Video 7-10</b>	Rate Theory of Chromatography, Van Deemter Equation, Factors Affecting the Van Deemter Plot and Equation

### Module II: Qualitative and Quantitative Analysis in Chromatography

Jun 16	Chapter 2, Lect Notes Kaltura On-Line Lecture <b>Video 11-13</b>	Qualitative Methods, Kovat Retention Index; Quantitation Methods in Chromatography; Temperature Effects in Chromatography
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**June 17-18 (Thursday-Friday) Exam I ( Module I and II, 150 pts /15% of the Grade) (Maximum 3 hr allocation); Multiple choice, problem solving**

### Module III: Principles and Instrumentation in Gas Chromatography

June 21	Chapter 5, Lect Notes Kaltura On-Line Lecture <b>Video 14-16</b>	Principles and Instrumentation in Gas Chromatography, Choice of Mobile Phases and GC Injectors
June 23	Lect Notes, Kaltura On-Line <b>Video 17-18</b>	Choice of Stationary Phases in Gas Chromatography,



<b>June 28</b>	<b>Video 19</b> Lecture Notes Kaltura On-Line Lecture <b>Video 20</b>	Detector Properties Types of GC detectors, Working Principle of GC detector
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#### Module IV: Principles and Instrumentation in Liquid Chromatography

<b>June 30</b>	Chapter 6, Lecture Notes Kaltura On-Line Lecture <b>Video 21</b>	Thin Layer Chromatography (TLC)
<b>July 5</b>	Chapter 6, Lecture Notes Kaltura On-Line Lecture	Instrumentation in HPLC Pump, Injector, Column and Detector
<b>July 7</b>	<b>Video -22-26</b>	HPLC Detectors (Contd)

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**July 8/ July 9 (Thursday/Friday) Exam II (Module III and IV) 150 pts /15% of the Grade) (Maximum 3 hrs allocation); Multiple choice, problem solving**

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#### Module V: Modes of High Performance Liquid Chromatography

<u>Date</u>	<u>Suggested Readings/Watching</u>	<u>Sub-Topic</u>
<b>July 12</b>	Chapter 6, Lecture Notes Kaltura On-Line Lecture <b>Video 27</b>	Normal Phase and Reversed Phase HPLC Methodology (Role of Mobile Phase)
<b>July 14</b>	Chapter 6, Lecture Notes Kaltura On-Line Lecture <b>Video 28-29</b>	Normal Phase and Reversed Phase HPLC Methodology (Role of Stationary Phase), Gradient Elution in HPLC
<b>July 19</b>	Chapter 6, Lecture Notes Kaltura On-Line Lecture <b>Video 30</b>	Size Exclusion Chromatography
<b>July 21</b>	Chapter 6, Lecture Notes Kaltura On-Line Lecture <b>Video 31-33</b>	Ion Exchange HPLC and Ion Chromatography

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**July 22-23 (Thursday/Friday) Exam III (Module V) 100 pts /10% of the Grade) (Maximum 3 hr allocation); Multiple choice, problem solving**

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<b>July 26</b>	Lecture Notes Kaltura On-Line Lecture	Sample Analysis Analysis of Real World Samples
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**\*July 28/29 ( Final Exam 150 pts (Maximum 3 hrs allocation, Short answers on Free Response Questions.**

**Final exam window:** Exam open on  
07/28/21 at 8:00 A.M

Exam closed on  
07/29/21 at 11: 59 P.M

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## Course Policies

Please review the policies as outlined below. You'll have an opportunity to voice your opinion on these policies and other content and issue about the course when we reach evaluation points during the semester.

### Attendance and Participation Policy

For online courses, it is important to identify what counts as participation and/or attendance. I believe that comment, questions and rebuttals on Kaltura Lectures is a must through Discussion Board and is considered as your attendance and participation in the course. For this, please write your questions down as you listen and watch the lecture and post on the board. I promise to answer them within 24-48 hrs. Please note that if you ask questions past two weeks of the lecture posted on the Kaltura gallery it might take more time to get answered. So stay on schedule when listening and watching the video lectures posted on the Kaltura Gallery.

### Policies on Home Work Problems

Assigned homework problems will also be given during the course of the semester; Homework problem sets will need to be turned in through assignment section of the i-college, and will be e-graded. Please make a pdf copy when turning in your assignment as one file. Homeworks can be discussed on the electronic discussion board or you can talk to the instructor about the homework before submitting. It should be noted that questions similar to homework problems may be asked in the exam. Hence, it should be reviewed carefully.

**\*There will be penalty for 2%/day. Homework, which is more than 4 days late will not be accepted under any circumstances unless there is legitimate reason for late submission (see the possible reasons below).**

**Policy on Quizzes:** Will be given throughout the semester at the end of the class. They are mandatory and will contribute to your overall grade of the semester.

**Please understand that there is no make-up quizzes that will be offered. However, you are allowed to have one drop quiz (with the lowest grade)**

## Exam Policies

### PLEASE READ THE FOLLOWING IMPORTANT POLICIES AND PROCEDURES ABOUT MODULE EXAMS (I, II AND III)

1. **No make-up exam will be given** unless the situation is such that the whole class did poorly in the exam.
2. If a student misses any scheduled exam (**without a legitimate excuse**), he/she will receive a grade zero for that exam.
3. If a student misses any short exam (**with a legitimate excuse**), he/she can either choose to receive a grade zero for that exam or apply the grade to the following exam for the missed exam.

\*Legitimate reasons for excuse are the following:

<b>Cause</b>	<b>Required</b>
Due to illness	illness note from the doctor
Due to business	business note from the supervisor
Death in family	note of death from a family member
Other	On a case by case basis

\* I must be informed **before the exam** to count as an excused absence. If you cannot reach me, send me an email ([sshamsi@gsu.edu](mailto:sshamsi@gsu.edu)) or leave a message on my cell, indicating the time and the day).

**Please note that notifying me after the exam will result in a grade of zero for that exam.**

4. Although I do not expect cheating, the penalty is an **F for the course**. Plagiarism is also considered cheating, therefore, copying large sections of another author's material without paraphrasing and referencing it will result in grade F.
5. I strongly urge to listen and watch Kaltura lectures on the day it is scheduled to be posted. Otherwise, it may be hard to capture in the next weeks (some of the materials discussed in the lecture may not be there in your textbook).
6. Although I will try to maintain the class schedule and student learning objectives, I may need to make adjustments
7. **Final Exam Policy:** Only offered on the date of the exam. Failure to

take the final exam may result in grade “F” for the course. If a student misses Final Exam (with a legitimate excuse), he/she can either choose to receive a grade zero for that exam or choose to receive INC as a semester grade.

## 8. **Laboratory Grading Policy**

The laboratory instructor will grade on laboratory reports. Therefore, student will collect all graded report from the laboratory instructor. Dr. Shamsi may review the lab grading for any issues that students may have. OR Graded lab reports may be requested by students to be reviewed by Dr. Shamsi to improve learning outcomes and final assessment.

## **OTHER POLICIES:**

**Course Withdrawl Policy** The last day to withdraw from the course at the midpoint is July 6, and withdrawl policies should be checked by student from Registrar Office.

## **Course Evaluation and Evolution**

Your constructive assessment of this course plays an indispensable role in shaping education at Georgia State. There will be intrasemester evaluations (after each Exam). In addition, upon completing the course, please take time to fill out the online course evaluation.

## **Academic Honesty**

*“Social sharing tools like GroupMe that some students use to share answers for exams and quizzes are not allowed”*

## **FERPA**

In keeping with USG and university policy, this course website will make every effort to maintain the privacy and accuracy of your personal information. Specifically, unless otherwise noted, it will not actively share

personal information gathered from the site with anyone except university employees whose responsibilities require access to said records. However, some information collected from the site may be subject to the Georgia Open Records Act. This means that while we do not actively share information, in some cases we may be compelled by law to release information gathered from the site. Also, the site will be managed in compliance with the Family Educational Rights and Privacy Act (FERPA), which prohibits the release of education records without student permission.

## Student Voices

This course have helped students find jobs at a very high rate. Learning to understand how separation of chemical works through critical thinking and practical examples given through assessment has helped student prepare for college to career. Just in the past few years, I have received emails from student after graduation suggesting how the practical aspect of the topics learned in this course have helped them find jobs quickly. I noted that students who gets jobs easily are the ones who focused on developing both reading and writing skills, answering critically on the questions how the analysis of chemical compounds can be achieved in the real world samples through active learning with the instructor via discussion board without any embarrassment of not knowing the material.