Lecture Policy

5.310 Laboratory Chemistry has three components:

1) the safety lectures and safety quiz
2) the experiments carried out in the laboratory and associated quizzes/ reports
3) the classroom lectures and two 50 minutes lecture quizzes.

Classroom lectures are given at 10:00 on Tuesday and Thursday mornings as shown in the Lecture Schedule.

No graphing or other calculators with extensive memory will be permitted for the lecture quizzes. Please see the course website for the list of acceptable calculators.

The purpose of the lecture component is to provide the background and theoretical understanding necessary to execute and understand the experiments. Lectures will cover the chemistry involved in the experiments, the theoretical background of various techniques and procedures used in the experiments and the instrumental methods of analysis used throughout the semester. Error analysis and use of the computer to perform the more elaborate calculations will also be covered.

A list of **required readings** is provided in direct support of the lecture material. It will prove most valuable to students to look over the readings prior to the associated lectures. These readings will be found in the course textbook and in books on reserve in the library or in the reading room (4-449).

It is expected that students will attend **all** of the lectures scheduled for the course. Lecture attendance may be considered in the case of borderline grades.

Topics for the Lecture Quizzes:

Lecture Quiz Part I:

Separations:
- Recrystallization
- Distillation (simple, fractional, vacuum)
- Sublimation
- Chromatographic methods
  - Thin Layer chromatography
  - Column chromatography
  - Gas-liquid chromatography

Identification and quantification of material:
- Melting point

Equivalent weight
UV-VIS Spectroscopy
Infrared Spectroscopy
Refractometry
Polarimetry

Lecture Quiz Part II:

Error Analysis

Synthesis and derivatization
Tosyl derivative
Ferrocene and Acetylation
Semicarbazone derivative

Kinetics

Potentiometric Titration

5.310 Required Reading:

Required text: MHSM Mohrig, Hammond, Schatz and Morrill ***Techniques in Organic Chemistry***
(Freeman ISBN 0-7167-6638-8, 2003)

The following texts are available on reserve in the library (O.R.), in the Reading Room 4-449 (R.R.), in the chemistry stockroom (C.S.). (Note the same topics may be found in other editions)

SWH Skoog West and Holler ***Fundementals of Analytical Chemistry*** 7th ed. (6th ed.)
S&L Skoog and Leary, ***Principles of Instrumental Analysis*** 4th ed
Oxtoby Oxtoby et. al. ***Principles of Modern Chemistry*** 5th edition
Atkins Atkins and Jones ***Chemical Principles: The Quest for Insight*** 2nd ed.

SFH J. I. **S**teinfeld, , J. S. **F**rancisco, and W. L. **H**ase, ***Chemical Kinetics and Dynamics***, 2nd ed. Prentice-Hall, Upper Saddle River, N.J., 1999.

Lecture/Topic	**Reading**
Lecture #1 Introduction/ Unkmown Amino Acid	Lab Manual: Sections I, II, III and Experiment 1 (Unknown Amino Acid) MHSM Ch. 1 Safety pp.2-15 MHSM Ch. 2 Laboratory Glassware pp.16-23 MHSM Ch. 3 Laboratory Notebook pp.23-27 MHSM Ch. 4 Using Handbooks and On-line Databases pp.27-31 MHSM Ch. 5 Measuring Mass and Volume pp.32-40 MHSM Ch. 6.2 Heating ... pp.42-43 (hot plates), pp.46-47 water baths MHSM Ch. 6.3 Cooling methods p.47 SWH Balances pp. 780-791 (pp. 797-806) SWH Handling Chemicals p. 779 (p. 795) **optional**-JWZ Buchner funnels and filtration Ch. 13 pp. 94-98
Lecture #2 Unknown Amino Acid	MHSM Ch. 8.5 Pasteur filter pipets pp.65-66 MHSM Ch. 9 Recrystallization pp.78-89 MHSM Ch. 10 Melting Points and Melting Point Ranges pp.93-103 MHSM Ch. 3.2 Calculation of Percent Yield pp. 26-27 SWH Burets pp. 798-805 (pp.820-825) (omit sections on pipets for now) Atkins Ch. 10 Acid and Bases Ch. 11 Aqueous Equilibria especially Titrations (p.590-603)
Lecture #3 Error Analysis	SWH Ch. 2 Errors in Chemical Analysis and Ch. 3 Statistical Evaluation of Data **OR** S&L Appendix 1 Evaluation of Analytical Data
Lecture #4 UV-VIS spectroscopy	Review: Oxtoby Ch 17.1 General Aspects of Molecular Spectroscopy Oxtoby Ch 17.3 Excited Electronic States [Oxtoby Ch 18.5 The Spectrochemical Series...] **OR** Atkins Ch3.13 Orbitals in Polyatomic Molecules p. 152-156 Major Techniques 2 Ulraviolet and Visible Spectroscopy p 168-169 Ch.16 The Electronic Structures of Complexes p. 889-900 Read: SWH Ch. 22 Spectroscopic Methods of Analysis pp. 497-519 (pp. 508-528) SWH Ch. 24 Molecular Absorption Spectroscopy pp. 557-572 (pp. 561-568) **optional** SWH Ch. 23 Instruments for Optical Spectroscopy **OR** S&L Ch. 5 Properties of Electromagnetic... pp.58-61, 72-75 S&L Ch. 7 ...Molecular UV/VIS spectroscopy pp. 123-147 S&L Ch. 8 Application of UV/VIS spectroscopy pp. 150-164 **optional** S&L Ch. 6 Instruments for Optical Spectroscopy

Lecture #5 Infrared Spectroscopy	MHSM Ch. 18 Infrared Spectroscopy pp. 197-219 Oxtoby Ch 17.2 Vibrations and Rotations of Molecules **OR** Atkins Major Technique 1 Infrared Spectroscopy p 100-111 **optional** S&L Ch. 12 Infrared Absorption Spectroscopy
Lecture #6 Ferrocene	Lab Manual: Experiment 2 (Ferrocene) MHSM Ch. 11.4 Fractional distillation pp. 118-121 MHSM Ch 2.2 Greasing ground glass joints pp.18-19 MHSM Ch. 6.2 Heating ... pp.42-43 (heating mantles) MHSM Ch. 7.1 Refluxing a mixture pp.48-50 MHSM Ch. 12 Sublimation pp.133-135 Oxtoby 5.6 Phase Diagrams **OR** Atkins 8.6 Phase Diagrams p 401-403
Lecture #7 Chromatography	MHSM Ch. 15 Thin-Layer Chromatography pp.153-160, Summary p.162 MHSM Ch. 16 Gas-Liquid Chromatography pp. 163-177 MHSM Ch. 17 Liquid chromatography pp. 178-189 Oxtoby 9.8 Distribution of a Single Species between Immiscible Phases: Extraction and Separation Processes **OR** Atkins Major Technique 4 Chromatogrphy p 456-459
Lecture #8 Essential Oils	Lab Manual: Experiment 3 (Essential Oils) MHSM Ch. 11 Boiling Points and Distillation pp.104-129 Oxtoby 6.6 Mixtures and Distillation **OR** Atkins 8.17 Vapor Pressure Lowering p 427-429 Binary Liquid Mixtures p. 438-442 MHSM Ch. 13 Refractometry pp. 136-140 MHSM Ch. 14 Optical Activity and Polarimetry pp. 140-147 Atkins Box 16.2 and Figure 16.28 Optical activity, Plane polarized light p 886-887
Lecture #9, 10 Potentiometric I, II	Lab Manual: Experiment 5 (Potentiometric Titration) Oxtoby Ch. 10 Acid-Base Equilibria-especially 10.6 Acid-Base Titration Curves and 10.7 Polyprotic Acids **OR** Atkins Aqueous Equilibria especially Polytropic Titrations p 604-609 Oxtoby Ch. 12 Electrochemistry-especially 12.3 Concentration Effects and the Nernst Equation (pH meters) **OR** Atkins Ch. 12 Electrohemistry especially 12.10 The Nernst Equation (p. 662-664) 12.11 Ion-Selective electrodes (p.664-665) Additional readings from SWH as listed in the laboratory manual

Lecture #11,12 Kinetics I, II	Lab Manual: Experiment 4 (Kinetics) Definition of the Rate of a Chemical Reaction **SFH** pp 1 –3 Order and Molecularity of a Reaction **SFH** pp 3 –6 Second order Reactions **SFH** pp 8 –9 Reaction Mechanisms **SFH** pp 17 –18 Effects of Ionic Strength on Reactions Between Ions: **SFH** pp 133 –136. Pipets and Burets **SWH** pp. 820-825 Experiment #29 **Sime, R**. J. *Physical Chemistry: Methods, Techniques, and Experiments*, Saunders College Publishing: Philadelphia, PE, 1990; pp 628-640 (available in Room 4-449). **SWH** Pipets and Burets pp. 798-805 (pp.820-825)

5.310 Required Videos from the MIT Digital Laboratory Techniques Manual

Video	**Unknown Amino Acid**	**Ferrocene**	**Essential Oils**	**Kinetics**	**Potentiometric Titration**
1. Volumetric Techniques	**Buret only**			**Volumetric Flask, Pipet**	**Pipet, Buret**
2. Titration	**Required**				**Required**
3. TLC basics		**Required**			
4. TLC advanced					
5. Reaction Work-up I: Extracting, Washing and Drying					
6. Reaction work-up II: Using the Rotovap					
7. Filtration	**Required**	**Required**	**Required**		
8. Sublimation		**Required**			
9. Recrystallization	**One solvent system only**				
10. Column Chromatography		**Required**			
11. Use of balances	**Required**	**Required**	**Required**	**Required**	**Required**