LSC Use Only Proposal No:	UWUCC Use Only Proposal No: 12-24e
LSC Action-Date:	UWUCC Action-Date: AP 9/4/12 Senate Action Date: App-10/9/12

Curriculum Proposal Cover Sheet - University-Wide Undergraduate Curriculum Committee

Contact Person(s) **Nate McElroy**	Email Address **nate@iup.edu**
Proposing Department/Unit **Chemistry**	Phone 74829

Check all appropriate lines and complete all information. Use a separate cover sheet for each course proposal and/or program proposal.

1. Course Proposals (check all that apply)

__X__ New Course _____ Course Prefix Change _____ Course Deletion

_____ Course Revision _____ Course Number and/or Title Change _____ Catalog Description Change

Current course prefix, number and full title: CHEM 326 Analytical Chemistry II
Proposed course prefix, number and full title, if changing: _____

2. Liberal Studies Course Designations, as appropriate

____ This course is also proposed as a Liberal Studies Course (please mark the appropriate categories below)

_____ Learning Skills _____ Knowledge Area _____ Global and Multicultural Awareness _____ Writing Intensive (include W cover sheet)

_____ Liberal Studies Elective (please mark the designation(s) that applies – must meet at least one)

_____ Global Citizenship _____ Information Literacy _____ Oral Communication

_____ Quantitative Reasoning _____ Scientific Literacy _____ Technological Literacy

3. Other Designations, as appropriate

_____ Honors College Course _____ Other: (e.g. Women's Studies, Pan African)

4. Program Proposals

_____ Catalog Description Change _____ Program Revision _____ Program Title Change _____ New Track

_____ New Degree Program _____ New Minor Program _____ Liberal Studies Requirement Changes _____ Other

Current program name: _____

Proposed program name, if changing: _____

5. Approvals	Signature	Date
Department Curriculum Committee Chair(s)		4/11/12
Department Chairperson(s)	Lynn B Long	4/11/12
College Curriculum Committee Chair	Anne Kordy	4/20/12
College Dean	Diane Lange	4/20/12
Director of Liberal Studies (as needed)		
Director of Honors College (as needed)		
Provost (as needed)		
Additional signature (with title) as appropriate		
UWUCC Co-Chairs	Gail Sechrist	9/5/12

Received
SEP 5 2012
Liberal Studies

Received
APR 20 2012
Liberal Studies

SYLLABUS FOR CHEM 326
ANALYTICAL CHEMISTRY II

I. CATALOG DESCRIPTION

COURSE TITLE:	CHEM 326 Analytical Chemistry II
NUMBER OF CREDITS:	4cr (3c-1l-4cr)
PREREQUISITES:	CHEM 325 and 341
COURSE DESCRIPTION:	A more detailed examination of the principles of analytical chemistry. Student learns theoretical and practical aspects of sampling, data acquisition, spectroscopic, electrochemical, chromatographic, thermal, mass spectrometric, and affinity methods of analysis.

II. COURSE OUTCOMES

The student will be able to:

1. Understand and explain the ways in which sampling influences the outcome of a measurement, and what factors are important in achieving a truly representative sample.
2. Understand and explain how simple sensors can be interfaced to computerized data acquisition systems.
3. Understand and explain the relationship between the signal bandwidth and the sampling frequency necessary to represent the signal with acceptable distortion.
4. Identify and explain the applicability, strengths, and limitations of each of the analytical methods introduced in Section III below, when applied to solving real-world problems.
5. Describe the basic design features and the fundamental operational principles for each of the analytical instruments introduced in Section III below.
6. Explain, with greater breadth and depth than the information covered in CHEM 325 (Analytical Chemistry I), the analytical instruments introduced and/or reviewed in Section III below.
7. Demonstrate that she/he can recognize which analytical technique of that covered in CHEM 325, Analytical Chemistry I, and that listed in Section III, below, is an appropriate analytical methodology for specific problems.

III. DETAILED COURSE OUTLINE

LECTURE

The lecture portion of Analytical Chemistry II course is taught in a single lecture section. The laboratory portion is taught in small sections, all sections doing the same experiments. The topics are listed below. Four hours are allotted for exams. Each hour represents one academic hour, or 50 minutes.

1.	Principles of sampling Representative samples from real materials; minimum sample size for particular method.	2 hours
2.	Basic electronics for chemical measurements Concept of data domain; impedance matching; an introduction to operational amplifiers	2 ½ hours
3.	Signals, noise, and data acquisition Signal/noise ratio and detection limit. Fourier transforms, power spectra and information content. Nyquist theorem. Jitter, latency, and digital capture of analog data.	1 ½ hours
4.	Review of equilibrium concepts Relationships of K, ΔG°, E^{o} and E. Activities, activity coefficients,formal potentials, Debye-Huckel theory.	2 hours
5	An introduction to analytical electrochemistry Overview of electrochemical methods: bulk methods versus interfacial methods. The classes of interfacial methods: static ($i = 0$) versus dynamic ($i \neq 0$) interfacial methods.	1 hours
6.	Instrumentation for analytical electrochemistry Instrumentation for the measurement of electrochemical cell potentials. Interpretation of the measured cell potentials. Junction potentials. Reference electrodes. Indicator electrodes including electrodes of the first, second, and third kind. Membrane electrodes including the pH and other ion selective electrodes. Applications of potentiometric methods	2 hours
7.	Coulometry Potentiostatic (controlled potential) coulometry. Amperostatic (controlled current) coulometry. Instrumentation. Applications	2 hours
8.	Voltammetry Excitation signals applied to working electrode. Working electrodes. Experimental set-up. Sign convention used in voltammetry. Factors affecting Faradaic current in voltammetry. Non-Faradaic currents. Residual currents. Shapes of voltammograms. Qualitative and quantitative aspects of voltammograms. Voltammetric methods of analysis	3 hours

9.	An Introduction to Mass Spectrometry Electron impact, CI, FABS, SIMS ionization; time-of-flight, electric- and magnetic sector, quadrapole mass filters. MS-MS. Applications.	3 hours
10.	Review of Spectroscopic Methods Absorption of radiation. Absorbance, emission, and scattering. Beer's law.	2 hours
11.	Instrumentation for Optical Spectroscopy Light sources. Wavelength selectors. Detectors. Transform techniques and multiplex advantage. Methods based on light scattering. Considerations for emission spectroscopy.	4 hours
12.	Atomic Spectroscopy Instrumentation Atomic spectroscopy based on flame atomization. Atomic spectroscopy with non-flame atomizers. Atomic emission methods based on plasma sources	3 hours
13.	Chromatographic Theory Migration rates of solutes in chromatographic systems. Band broadening and column efficiency. Column resolution. The general elution problem. Qualitative and quantitative analysis. Mass selective detection.	3 hours
14.	Gas Chromatograpy Instrumentation. Stationary phases. Detection systems.	2 hours
15.	Liquid Chromatography Instrumentation. Detection systems. Stationary phases for adsorption, partition, ion-exchange, size exclusion, and affinity chromatography.	2 hours
16.	Electromigration methods	1 hour
17.	Affinity methods Molecular recognition, adaptamers, and antibodies as selective reagents. An Introduction to ELISA.	1 hour
18.	Thermal methods Thermogravimetry, differential scanning calorimetry, isothermal titration calorimetry.	1 hour
	Terminating activity scheduled during final exam period.	2 hours

LABORATORY

(the topics are listed below, with example exercises listed in italics)

1. ATOMIC ABSORPTION *e.g., The Effects of Interferences on Calcium Determination*
2. POTENTIOMETRY *e.g., Determination of Fluoride with and without TISAB*
3. SPECTROPHOTOMETRY *e.g., The Determination of Stray Light in Spectrophotometry*
4. UV SPECTROPHOTOMETRY *e.g., UV Absorbance of Caffeine*
5. HPLC *e.g., Determination of Components in Soda*
6. GS-MS *e.g., Determination of Pesticides in Spiked Samples*
7. ION CHROMATOGRAPHY *e.g., Determination of Anions in Environmental Samples*
8. COULOMETRY *e.g., Determination of Vitamin C by Constant Current Coulometry*
9. X-RAY POWDER DIFFRACTION *e.g., Determination of $CaCO_3$ in Antacid*

10. ICP-OES *e.g., Determination of Metals in Aqueous Environmental Samples*
11. VOLTAMMETRY *e.g., Stripping Voltammetry*
12. FIELD TRIP *e.g., A Visit to Environmental Services Laboratory*

A total of twelve experiments will be performed, one per weekly class meeting. The first week is dedicated to laboratory safety/check-in, and the last week to check-out.

IV. EVALUATION METHODS

The specific evaluation methods for the course will be determined by the instructor. Typically, this might include weekly lecture quizzes, three to four lecture exams, four lab quizzes, 11-12 lab reports, and a comprehensive final exam. Usually, the lecture portion of the course counts for 54%, the laboratory 30%, and the final exam 16%.

V. EXAMPLE GRADING SCALE

A: ≥ 90%, B: 80-89%, C: 70-79%, D: 60-69%, F: < 60%

VI. ATTENDENCE POLICY

The specific attendance policy for the course will be determined by the instructor, in accordance with the general policy described in the current IUP undergraduate catalog.

VII. REQUIRED TEXTBOOK(S)

Lecture: an appropriate undergraduate analytical chemistry textbook that will provide students with an overview of the field, such as: Robinson J.W., et. al. *"Undergraduate Instrumental Analysis"*, 7th Edition, CRC (2011), Harris, Daniel C., *"Quantitative Chemical Analysis,"* 8rd Edition, W. H. Freeman, New York, (2011); or: Skoog, D. A., Holler, F. J., and S. R. Crouch, *"Principles of Instrumental Analysis"*, 6th Edition, (2007), Cengage Learning.

VIII. SPECIAL RESOURCE REQUIREMENTS

Students are expected to have their own scientific calculators and access to a computer.

IX. BIBLIOGRAPHY

Additional textbooks and other references are available in the Chemistry Department Educational Resources Room and in the Stapleton Library.

Books:

D. C. Harris, *Quantitative Chemical Analysis*, 8th Edition, New York: W. H. Freeman and Company, 2010.

R. Kellner, J.-M. Mermet, M. Otto, M. Valcárcel, and H. M. Widmer, Editors, *Analytical Chemistry*, 2nd Edition, Germany: Wiley-VCH, 2004.

D. T. Sawyer, W. R. Heineman, J. M. Beebe, *Chemistry Experiments for Instrumental Analysis*. New York/John Wiley & Sons, 1984.

D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition. United States: Thomson Brooks/Cole, 2004.

D. A. Skoog, F. J. Holler, and S. R. Crouch, *Principles of Instrumental Analysis*, 6th Edition. United States: Thomson Brooks/Cole, 2007.

Treatises:

I. M. Kolthoff and P. J. Elving, Eds., *Treatise on Analytical Chemistry*. New York/Wiley, 1961-1986.

R. A. Meyers, Ed., *Encyclopedia of Analytical Chemistry: Applications, Theory and Instrumentation*. New York: Wiley, 2000.

B. W. Rossiter and R. C. Baetzold, Eds., Physical Methods of Chemistry, 2nd Edition. New York: Wiley, 1986-1993.

C. L. Wilson and D. W. Wilson, Eds., *Comprehensive Analytical Chemistry*. New York: Elsevier, 1959-2003.

Official Methods of Analysis:

Annual Book of ASTM Standards. Philadelphia: American Society for Testing Materials.

Official Methods of Analysis, 18th Edition, 3rd Revision. Washington, D.C.: Association of Official Analytical Chemists, 2010.

Standard Methods for the Examination of Water and Wastewater, 21st Edition. New York: American Public Health Association, 2005.

Review Serials:

Analytical Chemistry, Fundamental Reviews. American Chemical Society, Washington D.C., June 15, 2010.

Analytical Chemistry, Application Reviews. American Chemical Society, Washington, D.C., June 15, 2009.

Critical Reviews in Analytical Chemistry. CRC Press, Boca Raton, FL.

Trends in Analytical Chemistry. Elsevier, New York.

Monographs:

Gravimetric and Titrimetric Analysis

R. deLevie, Aqueous Acid-Base Equilibria and Titrations. Oxford: Oxford University Press, 2001.

L. Erdey, Gravimetric Analysis. Oxford: Pergamon, 1965.

Spectrometric Methods

J.D. Ingle and S.R. Crouch, *Spectrochemical Analysis*, Prentice Hall, 1988.

L.H. Lajunen and P. Permaki, *Spectrochemical Analysis by Atomic Absorption and Emission*, 2nd ed., Royal Society of Chemistry, 2004.

F.M. Mirabella, *Modern Techniques in Applied Molecular Spectroscopy*, Wiley-Interscience, 1998.

Electroanalytical Methods

A. J. Bard and L. R. Faulkner, *Electrochemical Methods*, 2nd Edition. New

York: Wiley, 2001.
J. Wang, *Analytical Electrochemistry*. New York: John Wiley & Sons, 2006.

Analytical Separations
C. E. Meloan, *Chemical Separations: Principles, Techniques, and Experiments*. New York: John Wiley & Sons, 1999.

Miscellaneous
E. Prichard, *Quality Assurance in Analytical Chemistry*. New York: John Wiley & Sons, 2007.

Periodicals:
American Laboratory
The Analyst
Analytical Chemistry
Analytica Chimica Acta
Analytical Letters
Applied Spectroscopy
Journal of the Association of Official Analytical Chemists
Journal of Chromatographic Science
Journal of Chromatography
Spectrochemica Acta
Talanta

Course Analysis Questionnaire

Section A: Details of the Course

A1 How does this course fit into the programs of the department? For what students is the course designed? (majors, students in other majors, liberal studies). Explain why this content cannot be incorporated into an existing course.
This course is designed for chemistry majors. The ACS-CPT requirement is for 'in-depth' courses that build on the foundation topics. CHEM 326 is designed to meet the requirement for an in-depth (or advanced) course in analytical chemistry, as well as to contribute to the required 400 hours of laboratory beyond General Chemistry.

A2 Does this course require changes in the content of existing courses or requirements for a program? If catalog descriptions of other courses or department programs must be changed as a result of the adoption of this course, please submit as separate proposals all other changes in courses and/or program requirements.
This is considered a new course proposal that will merge content of the current CHEM-321 (Quantitative Analysis) and CHEM-322 (Instrumental Analysis). This course is designed to provide Chemistry majors (BS, BSEd) with more depth of analytical chemistry and instrumental methods of analysis. Students in other majors who plan to earn a minor in Chemistry could, in partial fulfillment of those requirements, opt to take CHEM-326 from a menu of other options.

A3 Has this course ever been offered at IUP on a trial basis (e.g. as a special topic) If so, explain the details of the offering (semester/year and number of students).
No

A4 Is this course to be a dual-level course? If so, please note that the graduate approval occurs after the undergraduate.
No

A5 If this course may be taken for variable credit, what criteria will be used to relate the credits to the learning experience of each student? Who will make this determination and by what procedures?
This course is not available for variable credit.

A6 Do other higher education institutions currently offer this course? If so, please list examples (institution, course title).
Cheyney Univ. of Pennsylvania offers Analytical Chemistry II (SCH-202); Clarion University of Pennsylvania offers Analytical Chemistry II, CHEM 358 (Lecture, 3sh) and CHEM 368 (lab, 1sh); West Chester University of Pennsylvania, CHEM 424 (Lecture, 3sh) and Experimental Analytical Chemistry II (lab, 2sh); East Stroudsburg University of Pennsylvania, CHEM 372 (4sh); Kutztown University of Pennsylvania, CHEM 340 (4sh)

A7 Is the content, or are the skills, of the proposed course recommended or required by a professional society, accrediting authority, law or other external agency? If so, please provide documentation.
The ACS-CPT requirement is for 'in-depth' courses that build on the foundation topics. CHEM 326 is designed to meet the requirement for an in-depth (or advanced) course in analytical chemistry, as well as to contribute to the required 400 hours of laboratory beyond General Chemistry.

Section B: Interdisciplinary Implications

B1 Will this course be taught by instructors from more than one department? If so, explain the teaching plan, its rationale, and how the team will adhere to the syllabus of record.
This course will be taught by Chemistry Department faculty only.

B2 What is the relationship between the content of this course and the content of courses offered by other departments? Summarize your discussions (with other departments) concerning the proposed changes and indicate how any conflicts have been resolved. Please attach relevant memoranda from these departments that clarify their attitudes toward the proposed change(s).
The content of this course does not overlap content offered by any other department.

B3 Will this course be cross-listed with other departments? If so, please summarize the department representatives' discussions concerning the course and indicate how consistency will be maintained across departments.
This course will not be cross-listed.

Section C: Implementation

C1 Are faculty resources adequate? If you are not requesting or have not been authorized to hire additional faculty, demonstrate how this course will fit into the schedule(s) of current faculty. What will be taught less frequently or in fewer sections to make this possible? Please specify how preparation and equated workload will be assigned for this course.
Faculty resources are adequate. This course will replace CHEM-322.

C2 What other resources will be needed to teach this course and how adequate are the current resources? If not adequate, what plans exist for achieving adequacy? Reply in terms of the following:

*Space
*Equipment
*Laboratory Supplies and other Consumable Goods
*Library Materials
*Travel Funds
This new course will not require additional resources from what is already available.

C3 Are any of the resources for this course funded by a grant? If so, what provisions have been made to continue support for this course once the grant has expired? (Attach letters of support from Dean, Provost, etc.)
No.

C4 How frequently do you expect this course to be offered? Is this course particularly designed for or restricted to certain seasonal semesters?
This course will be offered once per academic year.

C5 How many sections of this course do you anticipate offering in any single semester?
Based on current numbers for CHEM-322, one lecture section and one or two lab sections. The current CHEM-321, CHEM-322, and CHEM-323 lab sections are limited to 12 students per lab sections because of space restrictions, amount of equipment/hood space, and number of instruments used in the experiments.

C6 How many students do you plan to accommodate in a section of this course? What is the justification for this planned number of students?
A lecture can hold as many students as needed. A lab section is currently limited to 12 students because of space restrictions, amount of equipment/hood space, and number of instruments used in the experiments.

C7 Does any professional society recommend enrollment limits or parameters for a course of this nature? If they do, please quote from the appropriate documents.
No

C8 If this course is a distance education course, see the Implementation of Distance Education Agreement and the Undergraduate Distance Education Review Form in Appendix D and respond to the questions listed.
This is not a distance education course.

Section D: Miscellaneous

Include any additional information valuable to those reviewing this new course proposal.