DLSHSI
DE LA SALLE HEALTH SCIENCES INSTITUTE
Nurturing Life

College of Humanities and Sciences
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Local: 5007 (Dean's Secretary) | 1412 (Dean)
1345 (Dept. of Integrated Humanities and Sciences)
1408 (Dept. of Chemistry)
1115 (Chemistry Lab) | 1405 (Biology & Physics Lab)

COURSE SYLLABUS

DEPARTMENT: **CHEMISTRY DEPARTMENT**
COURSE CODE: **CHEM 130**
COURSE TITLE: **ANALYTICAL CHEMISTRY**
CREDIT UNITS: 5.0 units (54 hours lecture & 108 hours laboratory)
PRE-REQUISITE: CHEM 110
SCHEDULE: _____
INSTRUCTOR: _____
CONSULTATION TIME: _____

COURSE DESCRIPTION: This course deals with the fundamentals of qualitative and quantitative methods of chemical analyses. It covers basic statistical tools of analytical chemistry, chemical equilibria, classical methods of analysis, introduction to electrochemical methods, and introduction to spectroscopic methods of analysis. The laboratory component is designed to enable the students to master the basic skills required to perform chemical analysis based on absolute and simple instrumental methods.

EXPECTED LASALLIAN GRADUATE ATTRIBUTES (ELGA)	**LEARNING OUTCOMES BASED ON ELGA** At the end of this course, the students shall manifest the ELGA by:
GOD-LOVING Spirit of Faith	○ imparting to the public and making them realize the amazing works of God in our world and society through chemistry and ○ demonstrating the love of God by showing to the public how chemistry can change and improve the lives of people in our society.
PATRIOTIC PROFESSIONALS Zeal for Service	○ developing ways on how to increase the awareness of the public to the common health and environmental problems in our country through chemistry and ○ developing means on how to address the common health and environmental problems in the society through chemistry.
PERSON-ORIENTED Communion in Mission & Reverence for Life	○ extending help to the community by increasing the awareness of the public to the common health and environmental problems in the society or in the community through chemistry.

LEARNING OUTCOMES

LO 1. Higher levels of comprehension
LO 2. Proficient and effective communication
LO 3. Understanding of basic concepts across the domains of knowledge
LO 4. Critical, analytical, and creative thinking
LO 5. Application of different analytical modes in tackling problems methodically
LO 6. Ability to contribute personally and meaningfully to the country's development
LO 7. Capacity to reflect critically on shared concerns and think of innovative, creative solutions guided by ethical standards
LO 8. Working effectively in a group
LO 9. Problem-solving
LO 10. Basic work-related skills and knowledge

PRELIMINARY PERIOD LEARNING PLAN

COURSE OUTLINE

LEARNING OUTCOMES At the end of each topic, the students should be able to:	**TOPICS**	**LEARNING ACTIVITIES/ TEACHING STRATEGIES**	**ASSESSMENT**
• distinguish analytical chemistry from the other fields of chemistry; • give examples of professions and industries involved in analytical chemistry; and • differentiate qualitative and quantitative analysis	**1. Definition of Analytical Chemistry** a. The Role of Analytical Chemistry b. Qualitative Analysis vs Quantitative Analysis	• Lecture Discussion • Video Presentation • Group Discussion	• Formal Examinations • Recitations • Board Work • Seat Work • Problem Set
• properly discern and handle reagents and other chemicals in an analytical laboratory; • properly clean and handle laboratory glassware; • properly evaporate liquids; • properly handle an analytical balance; • correctly measure and record mass; • properly set up for filtration and ignition; • properly measure volume; • properly calibrate volumetric glassware; • properly write on laboratory notebook; • use Spreadsheets in analytical chemistry; and • apply/practice the safety in the laboratory.	**2. Chemicals and Apparatus: Putting the Tools to Work** a. Selecting and Handling Reagents & Other Chemicals b. Cleaning and Marking Laboratory Ware c. Evaporating Liquids d. Measuring Mass e. The Equipment and Manipulations Associated with Weighing f. The Equipment and Manipulations for Filtration and Ignition g. Measuring Volume h. Calibrating Volumetric Ware i. The Laboratory Notebook j. Using Spreadsheets in Analytical Chemistry	• Lecture Discussion • Video Presentation • Group Discussion	• Formal Examinations • Recitations • Board Work • Seat Work • Problem Set

	k. Safety in the Laboratory		
• apply the mole concept in simple stoichiometric calculations; • express concentrations/quantities of chemicals in various ways; • use dilution factors in stoichiometric calculations; • write correct equilibrium expression; • identify the different types of equilibrium constants; and • explain the various factors that affect equilibrium states.	**3. Basic Chemical Concepts and a Simple Approach to Chemical Equilibrium** a. Some Important Units of Measurement b. Solutions and Their Concentrations c. Chemical Stoichiometry d. The Chemical Composition of Aqueous Solutions e. Chemical Equilibrium	• Lecture Discussion • Video Presentation • Group Discussion	• Formal Examinations • Recitations • Board Work • Seat Work • Problem Set
• identify systematic errors; • explain the nature of random errors; • treat/deal with random errors with statistics; • calculate standard deviation; • report statistical data; • determine confidence limits; and • analyze two-dimensional data using the least-squares method.	**4. Errors, Random Errors, and Statistical Data in Chemical Analyses** a. Important Terminologies b. Systematic Errors c. The Nature of Random Errors d. Treating Random Errors with Statistics e. The Standard Deviation of Computed Results f. Reporting Computed Data g. Confidence Limits h. Analyzing Two-Dimensional Data: The Least-Squares Method	• Lecture Discussion • Video Presentation • Group Discussion	• Formal Examinations • Recitations • Board Work • Seat Work • Problem Set
• explain the theoretical basis of gravimetric analysis; • outline the general steps in gravimetric analysis; • differentiate between colloidal and crystalline precipitates; • enumerate the different coprecipitation errors encountered in precipitation; • distinguish the appropriate experimental techniques used to maximize coprecipitation errors; • apply the concept of gravimetric factors; and • calculate gravimetric problems.	**5. Gravimetric Methods of Analysis** a. Properties of Precipitates and Precipitating Reagents b. Drying and Ignition of Precipitates c. Calculating Results from Gravimetric Data d. Applications of Gravimetric Methods	• Lecture Discussion • Video Presentation • Group Discussion	• Formal Examinations • Recitations • Board Work • Seat Work • Problem Set
• apply the concept of Ksp in calculating solubility of precipitates using the systematic method; • write mass balance and charge balance equations; and • calculate solubility using the thermodynamic and concentration-based Ksp	**6. Electrolyte Effects and Equilibrium: Calculations in Complex Systems** a. Effects of Electrolytes on Chemical Equilibria b. Activity and Activity Coefficients	• Lecture Discussion • Video Presentation • Group Discussion	• Formal Examinations • Recitations • Board Work • Seat Work • Problem Set

	c. Equilibrium Calculations in Complex Systems: Solving Multiple-Equilibrium Problems by a Systematic Method d. Separating Ions by pH Control: Sulfide Separations		
PRELIMINARY PERIOD ASSESSMENT			

MIDTERM PERIOD LEARNING PLAN

LEARNING OUTCOMES At the end of each topic, the students should be able to:	**TOPICS**	**LEARNING ACTIVITIES/ TEACHING STRATEGIES**	**ASSESSMENT**
• explain the theoretical basis of titrimetric analysis; • outline the general steps in titrimetric analysis; • distinguish between primary and secondary standards; • enumerate the general types of titration; • compare the different titration curves; • differentiate between endpoint and equivalence point; • define titration error; • explain the function of indicators; and • explain the principles behind the different types of titration techniques.	**7. Titrations: Taking Advantage of Stoichiometric Reactions** a. General Aspects of Volumetric Titrimetry b. Standard Solutions c. Volumetric Calculations d. Titration Curves	• Lecture Discussion • Video Presentation • Group Discussion	• Formal Examinations • Recitations • Board Work • Seat Work • Problem Set
• recall the concept of acid/base; • define strong/weak acids/bases; • calculate pH/pOH of solutions of strong and weak acids/bases; • write the mass balance and charge balance equations; and • recall the Bronsted-Lowry acid/base concept (conjugate acid/base pairs). •	**8. Principles of Neutralization Titrations: Determining Acids, Bases, and the pH of Buffer Solutions** a. Types of Solutions and Indicators Used b. Calculating pH in Titrations of Strong Acids and Strong Bases c. Buffer Solutions d. Calculating pH in Weak Acid Titrations e. Calculating pH in Titrations of Weak Bases f. Changes in Buffer Solutions as a Function of pH	• Lecture Discussion • Video Presentation • Group Discussion	• Formal Examinations • Recitations • Board Work • Seat Work • Problem Set

• calculate pH/pOH of polyfunctional acids/bases; • describe polyfunctional bases; • construct titration curves for polyfunctional acids/bases; and • determine the composition of polyprotic acid solution as a function of pH.	**9. Titrating Polyfunctional Acids and Bases** a. Polyfunctional Acids b. Describing Polyfunctional Bases c. Finding the pH of Solutions of Amphiprotic Salts d. Constructing Titration Curves for Polyfunctional Acids e. Drawing Titration Curves for Polyfunctional Bases f. The Composition of Polyprotic Acid Solutions as a Function of pH	• Lecture Discussion • Video Presentation • Group Discussion	• Formal Examinations • Recitations • Board Work • Seat Work • Problem Set
• determine the reagents for neutralization titrations; • identify some applications of neutralization titrations; and • explain the principle behind the Kjeldahl method for nitrogen determination.	**10. Applying Neutralization Titrations** a. Reagents for Neutralization Titrations b. Typical Applications of Neutralization Titrations	• Lecture Discussion • Video Presentation • Group Discussion	• Formal Examinations • Recitations • Board Work • Seat Work • Problem Set
MIDTERM PERIOD ASSESSMENT			

FINAL PERIOD LEARNING PLAN

LEARNING OUTCOMES At the end of each topic, the students should be able to:	**TOPICS**	**LEARNING ACTIVITIES/ TEACHING STRATEGIES**	**ASSESSMENT**
• recall the concepts behind complex-formation; • write the titration and endpoint reaction of the Liebig titration; • identify the predominant EDTA species at different pH values; and • relate the stability of metal-EDTA; • construct EDTA titration curves using pM calculations; • describe the effects of pH, complex stability and the presence of complexing agents on the EDTA titration curve; • explain the basis for the proper choice of indicator in EDTA titrations; and write the titration and endpoint reactions of an EDTA titration.	**11. Complexation and Precipitation Titrations:** a. Forming Complexes b. Titrations with Inorganic Complexing Agents c. Organic Complexing Agents d. Titrations with Aminocarboxylic Acids	• Lecture Discussion • Video Presentation • Group Discussion	• Formal Examinations • Recitations • Board Work • Seat Work • Problem Set

• recall the basic terms in electrochemistry; • compare relative strengths of reducing agents and oxidizing agents; • differentiate the two types of electrochemical cell; • apply basic rules in writing cell notations; and • define the term electrode potential.	**12. Elements of Electrochemistry** a. Characterizing Redox Reactions b. Electrochemical Cells c. Electrode Potentials	• Lecture Discussion • Video Presentation • Group Discussion	• Formal Examinations • Recitations • Board Work • Seat Work • Problem Set
• explain the function of the SHE and the measurement of electrode potential; • apply the IUPAC convention to electrode potential; • recall the Nernst Equation; • explain the significance of Nernst equation for different redox systems; • differentiate between formal potential and standard electrode potential; • explain this thermodynamic potential; • calculate Ecell problems; • calculate equilibrium constant from standard electrode potentials; • explain the concepts in redox titration; • differentiate redox titrations from other titration systems; • construct redox titration curves using electrode potentials; and • differentiate a complex redox titration system from a simple one.	**13. Electrode Potentials and Their Applications to Redox Titrations** a. Calculating Potentials of Electrochemical Cells b. Calculating Redox Equilibrium Constants c. Constructing Redox Titration Curves d. Redox Indicators e. Potentiometric End Points f. Auxiliary Oxidizing and Reducing Reagents g. Applying Standard Reducing Agents h. Applying Standard Oxidizing Agents	• Lecture Discussion • Video Presentation • Group Discussion	• Formal Examinations • Recitations • Board Work • Seat Work • Problem Set
• define potentiometry; • enumerate and describe the different components of potentiometric cell assembly; • write the schematic representation of the electrochemical cell for potentiometric measurements; • explain the function of salt bridge in relation to liquid junction potential; • identify the two types of potentiometric methods; • define, classify and give examples of the different types of metallic indicator electrodes; • describe qualitatively the response of metallic electrodes; • express the response of metallic indicator electrode in terms of the Nernst equation;	**14. Potentiometry: Measuring Concentrations of Ions and Molecules** a. General Principles of Potentiometry b. Reference Electrodes c. Liquid-Junction Potentials d. Indicator Electrodes e. Instruments for Measuring Cell Potential f. Direct Potentiometry g. Following Titrations by Potentiometry	• Lecture Discussion • Video Presentation • Group Discussion	• Formal Examinations • Recitations • Board Work • Seat Work • Problem Set

• describe the construction or general configuration of membrane electrode; • classify and give examples of the different types of membrane indicator electrode; • discuss qualitatively the response of membrane electrodes; • express the Nernst equation describing the membrane indicator electrode potential; • describe the importance of reference electrodes in potentiometric measurements; • identify and describe commonly used reference electrodes in potentiometric measurements; • express the response of reference electrode in terms of the Nernst equation; • explain the equations used in direct potentiometric measurements; • identify the errors affecting pH measurements; • explain the different graphical methods of endpoint detection in potentiometric titrations; and • apply the principles of potentiometric titration in the calculation of different equilibrium constants.			
• explain the theoretical basis of spectroscopy; • describe electromagnetic radiation in terms of its wave properties and its particle properties; • distinguish the region of the electromagnetic spectrum; • define important spectroscopic terms; • describe the mathematical relationship between absorbance and transmittance; • differentiate between atomic and molecular absorptions; • differentiate between electronic, vibrational, and rotational transitions; • explain the significance of λmax; • explain the principles of Beer's law and its application to quantitative analysis; • explain the limitations of Beer's law; • describe the components of a spectrophotometer; • differentiate a single-beam from a double beam spectrophotometer; • calculate concentration of analyte using direct calibration and	**16. Spectroscopic Methods of Analysis** a. The Nature of Light b. Interaction of Matter and Radiation c. Absorbing Light d. Instrument Components e. UV/Visible Photometers and Spectrophotometers f. Infrared Spectrophotometers	• Lecture Discussion • Video Presentation • Group Discussion	• Formal Examinations • Recitations • Board Work • Seat Work • Problem Set

standard addition methods; • apply Beer's law in the analysis of mixtures; and • differentiate various photometric titration curves.			
FINAL PERIOD ASSESSMENT			

LEVELS OF ASSESSMENT

Lecture Components (60%)		Laboratory Components (40%)	
• Long Exams	25%	• Practical Exam	10%
• Major Exam	25%	• Major Exam/s	20%
• Others	10%	• Lab. Performance & Others	5%
		• Laboratory Reports a. Experiment Sheets b. Results & Discussion Reports (RDR)	5%
Total	**60%**	**Total**	**40%**

COMPUTATION OF GRADES

- *Each form of assessment will be computed as follows:*

$$\text{ASSESSMENT SCORE} = \frac{\text{RAW SCORE}}{\text{TOTAL SCORE}} \times 50 + 50$$

- *At the end of the course, the final course output will computed as follows:*

$$\text{FINAL COURSE OUTPUT SCORE} = \frac{\text{GARNERED POINTS}}{\text{TOTAL POINTS}} \times 50 + 50$$

- *At the end of the course, the final course grade will be computed as follows:*

$$\text{FINAL COURSE GRADE} = \left(\frac{\text{PRELIM GRADE} + \text{MIDTERM GRADE} + \text{FINAL GRADE}}{3} \times 0.95 \right) + \left(\text{FINAL COURSE OUTPUT SCORE} \times 0.05 \right) = 100$$

REFERENCES

Textbook

- Skoog, D., West D., Holler, F., Crouch, S. and Chen, S. (2012) *Introduction to Analytical Chemistry, 8th ed*., Singapore: Cengage Learning.

Other References

- Christian, G., Dasgupta, P., and Schug, K.(2014). Analytical Chemistry, 7th ed., Singapore: John Wiley & Sons

COURSE POLICIES

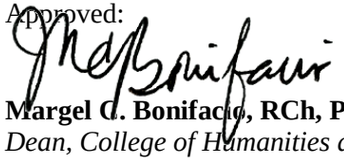
- Students are allowed 20% of the total number of schooldays of absences inclusive of tardiness. All absences after that will mean excessive absences, which will merit a grade of 0.00.
- Home works will be due at the beginning of the class. No home works will be accepted thereafter.
- The students will be given a score of zero (0) with corresponding grade of zero percent (0%) in a requirement which is not submitted under the following conditions:
    - They are given a chance to make-up for the said requirement.
    - They are given enough time to work on the make-up requirement.
- The students will be given a score of zero (0) with corresponding grade of zero percent (0%) in a quiz which is given during their absence under the following conditions:
    - The absent is unexcused.
    - They are offered a make-up quiz and still fail to appear during the given time.
    - They are given enough time to prepare for the make-up quiz.
- In case the students submitted a requirement given by the instructor/professor to make-up for their lost grade, a certain percent will be deducted on their actual grade.
- Special major exams are scheduled one week after the administration of the major exams. No special exams will be given thereafter EXCEPT IN SPECIAL SITUATIONS.
- Students must be honest at all times; cheating and plagiarism in any form will merit a grade of 0.00.
- Cellular/Mobile phones should always be in silent mode during class hours; the use of cellular phones is prohibited in class unless a special permission is sought. Cellular phones cannot also be used as calculator during examination.
- Borrowing of calculators and modern periodic table of elements during examination is strictly prohibited.
- Wearing of laboratory gowns and safety goggles during experiments will be strictly implemented. No lab gown and safety goggles, no experiment.
- The laboratory instructor will not be held legally responsible to accidents due to student's unawareness of safety measures and non-compliance with experimental guidelines.
- Any complaints (teaching, grades, etc.) against the teacher or against classmates (relative to the class) should be properly addressed to the subject-teacher for appropriate action. Students may seek the help and guidance of their academic/registration adviser in resolving the issue with the subject–teacher.

All policies (attendance, tardiness, decorum, grievances, etc.) will be subject to the provisions of the latest revision of the Student Handbook.

Endorsed:

Tabitha L. Amora, RCh, PhD
Program Director for Biochemistry
Head, Chemistry Department

Approved:



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