CLINICAL CHEMISTRY I - BIMS 4325
DEPARTMENT OF LIFE SCIENCES
FALL 2016

A. COURSE INFORMATION

Course number/section: BIMS_4325_001-101-102
Class meeting time: LEC MW 2:00-2:50 PM
                 LAB 1 R 8:00-10:50 PM
                 LAB 2 F 11:00-1:50 PM
Class location: MW BH 128, R CS 228 & F CS 231
Course Website: https://bb9.tamucc.edu/

B. INSTRUCTOR INFORMATION

Instructor: Dr. Felix Omoruyi
Office location: Center for the Sciences 130B
Office hours: M – 12:00 - 1:00 PM; T – 12:00 – 2:00 PM; R – 2:00 – 4:00 PM
Telephone: 825-2473
E-mail: felix.omoruyi@tamucc.edu
Appointments: N/A

C. COURSE DESCRIPTION

This course consists of the principles and practice of procedures found in general clinical chemistry laboratory. It includes methodology of diagnostic tests of normal and abnormal human physiology as applied to the diagnosis of pathological conditions.

D. PREREQUISITES AND COREQUISITES

CHEM 4401

Corequisites
SMTE 0092 and SMTE 0093

E. REQUIRED TEXTBOOK(S), READINGS AND SUPPLIES


Optional Textbook(s) or Other References

Supplies
You will need a scientific calculator.
F. STUDENT LEARNING OUTCOMES AND ASSESSMENT

Assessment is a process used by instructors to help improve learning. Assessment is essential for effective learning because it provides feedback to both students and instructors. A critical step in this process is making clear the course’s student learning outcomes that describe what students are expected to learn to be successful in the course. The student learning outcomes for this course are listed below.

By collecting data and sharing it with students on how well they are accomplishing these learning outcomes students can more efficiently and effectively focus their learning efforts. This information can also help instructors identify challenging areas for students and adjust their teaching approach to facilitate learning.

SPECTROPHOTOMETRY AND BEER'S LAW
The student should be able to:
1. describe the relationship between color of light, color of solution or substance, wavelengths absorbed, and wavelengths transmitted or reflected
2. describe the relationships between wavelength, frequency, and energy and define the major regions of the electromagnetic spectrum in terms of wavelength and energy.
3. describe the relationship between transmittance, % transmittance, and absorbance
4. state Beer's Law and perform calculations involving Beer's Law
5. define absorptivity and molar absorptivity and perform calculations using Beer's Law and molar absorptivity
6. describe how the wavelength for an assay is selected
7. discuss deviations from Beer's Law.
8. discuss the use of standard curves to set assay limits

THE SPECTROPHOTOMETER
The student should be able to:
1. name the components of a spectrophotometer and describe the functions of each
2. define: bandpass, linearity, wavelength accuracy, photometric accuracy, stray light and discuss methods used to check for each.

ATOMIC ABSORPTION SPECTROPHOTOMETRY AND FLAME EMISSION PHOTOMETRY
The student should be able to:
1. name the components of a generalized emission flame photometer or atomic absorption spectrophotometer and describe the function of each component and in general terms describe the principle of each technique
2. describe the major sources of interference in each method and measures used to control each type of interference
3. explain the use of an internal standard

FLUOROMETRY, TURBIDIMETRY, AND NEPHELOMETRY
The student should be able to:
1. describe in general terms the process of fluorescence
2. explain in general terms the two characteristic spectra of a fluorescent species
3. describe the components and configuration of generalized fluorometer and the use of the instrument in an assay
4. describe advantages and limitations of fluorometry
5. define: turbidimetry and nephelometry
6. describe instrumental requirements for each technique and the components and configuration of a nephelometer
7. name some applications of turbidimetry and nephelometry
8. identify sources of interference in turbidimetry and nephelometry

ELECTROCHEMICAL METHODS
The student should be able to:
1. discuss the theory of ion measurement using potentiometry
2. describe the construction of the glass-membrane pH electrode, the calomel reference electrode, and the silver-silver chloride reference electrode
3. name other ions that are commonly measured using potentiometric electrodes
4. define 'coulometric titration' and explain, using Faraday's Law, why the time required for the titration is related to the chloride concentration of the sample
5. explain how the instrument generates titrant and detects the endpoint of the titration

PROTEINS-NATURE AND ASSAY
The student should be able to:
1. describe the general characteristics of a protein including structure and nature of amino acids, the peptide bond, primary, secondary, tertiary, and quaternary protein structure
2. describe the following methods for assay of total protein: Briefly - Kjeldahl technique, UV light absorption in detail, including reaction or principle, sensitivity, specificity, interferences - Biuret, refractive index, anionic precipitation, Folin-Lowry
3. explain the principle of dye-binding methods for albumin assay, list dyes used, and discuss specificity and interferences
4. give the reference range (adult) for serum total protein and serum albumin
5. discuss the clinical significance of hyperproteinemia and hypoproteinemia
6. describe the stability of the sample and recognize factors in sample collection which can influence results

INTRODUCTION TO ENZYMES
The student should be able to:
1. explain what an enzyme is, chemically and functionally
2. describe the type reaction catalyzed by each of the six classes of enzymes and the specificity of an enzyme for its substrate
3. discuss the Michaelis-Menten theory regarding substrate concentration and reaction velocity. Define 'Km' and describe practical application of the Km
4. define 'zero-order' and 'first-order' as applied to enzyme kinetics and requirements for each
5. describe the effects of pH and temperature on reaction velocity and define the assay temperature proposed by the IVB
6. define the terms coenzyme and activator. Discuss the role that each serves and the effect in the regulation of reaction velocity. List 2 hydrogen and 2 nonhydrogen transfer enzymes used in many clinical enzyme assays
7. discuss competitive and noncompetitive inhibition and effect of each type of inhibition on the Km. Discuss the effects of metal ions on enzyme activity
8. list 3 methods of measuring enzyme concentrations and discuss the theory of each method. Designate the method that is preferred when enzyme activity is measured
9. define the International Unit of enzyme activity and calculate enzyme activity in U/L or mU/mL
ENZYMES: ASSAY METHODS AND DIAGNOSTIC APPLICATIONS
The student should be able to:
1. discuss the meaning and etiology of plasma-specific, non-plasma-specific, and inducible enzymes in the plasma
2. define the term isoenzyme and list methods of separating isoenzymes
3. discuss each of the following enzymes: function, source, specimen requirements, assay methods, isoenzyme separation (if applicable), and clinical significance - lactate dehydrogenase, creatine kinase, aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, acid phosphatase, gamma-glutamyl transferase
4. discuss each of the following enzymes: function, source, clinical significance - pseudocholinesterase, isocitrate dehydrogenase, glucose-6-phosphate dehydrogenase, ceruloplasmin

CARBOHYDRATES AND GLUCOSE METABOLISM
The student should be able to:
1. chemically define a 'carbohydrate' and define: aldoses, ketoses, D and L sugars, alpha and beta configuration
2. list the three monosaccharides of biological importance and name the monosaccharide units of the three disaccharides of biological importance
3. define: glycogenesis, glycogenolysis, gluconeogenesis, glycolysis, lipogenesis, lipolysis
4. trace the biochemical pathways associated with carbohydrate metabolism: digestion and absorption, glycolytic pathway, pentose phosphate shunt pathway, common pathways
5. identify the source organ and effect on glucose metabolism of the hormones: insulin, glucagon, epinephrine, growth hormone, cortisol, thyroxine

GLUCOSE METHODS AND FUNCTIONAL TESTS
The student should be able to:
1. discuss specimen requirements for glucose assay including the variability of glucose concentration in the following situations: whole blood vs serum, capillary vs venous sample
2. discuss each of the following glucose methods including reaction, specificity, and interferences: 0-toluidine, glucose oxidase (calorimetric and electrode), hexokinase
3. give normal and panic blood glucose values for adults and neonates
4. describe proper performance of the OGTT including preparation of the patient, contradictions, glucose load, collection of samples
5. describe the clinical and biochemical features of diabetes mellitus types I and II, and other classification groups and list diagnostic criteria for group classification
6. discuss the glycosylated hemoglobin test including: origin of glycosylated fractions, clinical applications of the test, methods of glycosylated fractions, methods of assay, sources of error
7. discuss hypoglycemia in adults and neonates, definition, etiology, evaluation
8. describe the clinical application of the C-Peptide assay
9. briefly describe performance and interpretation of: tolbutamide test, epinephrine test, lactose tolerance test
10. describe the fecal carbohydrate test for glucose intolerance
LIPIDS
The student should be able to:
1. structurally characterize the triglycerides, cholesterol, and phospholipid
2. discuss the metabolism of cholesterol and triglycerides including the role of the liver and apoproteins
3. describe or give the reactions for assay methods for triglycerides and cholesterol
4. give the desirable ranges for cholesterol and triglycerides in serum and indicate general variation with age and sex. Describe proper collection and handling of samples

NPN SUBSTANCES OF PLASMA
The student should be able to:
1. briefly outline nephron structure and the formation of urine
2. describe sources of plasma urea, creatinine, and uric acid and factors affecting plasma levels
3. define: azotemia, prerenal azotemia, renal azotemia, postrenal azotemia, uremia
4. describe current methods for assay of urea, creatinine, and uric acid, including reactions, specificity, and interferences
5. give the normal ranges for urea, BUN, uric acid, creatinine, and BUN/creatinine ratio

ELECTROLYTES, REGULATION AND METHODS
The student should be able to:
1. name and define the three body fluid compartments, name the major cations and major anions of each compartment, and point out the primary differences in composition of the three fluids
2. explain the function of the plasma proteins in maintaining intravascular fluid volume, including Gibbs-Donnan equilibrium
3. describe the operation of control mechanisms - thirst, ADH, renin-aldosterone
4. discuss factors affecting plasma levels of water, sodium, potassium, chloride, and bicarbonate
5. discuss current methods for assay of each electrolyte and proper collection and handling of specimens
6. give the reference range and panic values for each electrolyte.

ELECTROLYTES AND ANION GAP
The student should be able to:
1. give the rules for electrolyte balance, define 'anion gap', calculate anion gap, and give the normal range for anion gap
2. give possible causes of increased anion gap and decreased anion gap
3. identify common patterns of electrolyte imbalance and associate these with possible disease processes. Recognize incompatible electrolyte values and give reasonable course of action.

BODY WATER AND OSMOLALITY
The student should be able to:
1. define 'colligative properties', name the colligative properties, and indicate what change occurs in each when solute is added to solvent
2. given concentration, calculate freezing point or, given freezing point, calculate osmolality and given molarity, calculate osmolarity
3. explain the principle of the freezing-point osmometer and the principle of the vapor-pressure (dew-point) osmometer
4. calculate expected osmolality and osmolal gap given Na, glucose, and BUN values and discuss the significance of these values

5. describe performance of a concentration test and interpretation of results
6. give normal values for urine/serum Osmolality ration
7. calculate and discuss the significance of osmolal clearance and free water clearance

**RENAL FUNCTION TESTS**

The student should be able to:
1. define: total renal blood flow, effective renal plasma flow, glomerular filtration rate, tubular secretory capacity
2. give the normal volume for 24 hour urine collections in adults
3. calculate clearance problems when given a suitable set of data
4. discuss the procedure for and interpretation of clearance tests that measure GFR and those that measure the secretory ability of the tubules

**CALCIUM & PHOSPHORUS**

The student should be able to:
1. discuss the metabolism of calcium and phosphorus - activation of vitamin D, factors influencing absorption, hormonal mechanisms, and feedback systems for maintaining calcium homeostasis
2. give the normal range for Ca and P, explain the fractions of plasma calcium and the relationship of total and ionized calcium to protein and pH
3. for the following diseases discuss etiology and expected laboratory findings:
   - primary hyperparathyroidism, secondary hyperparathyroidism, primary hypoparathyroidism, osteomalacia or rickets, osteoporosis, Paget's disease
4. list other conditions commonly associated with hyper-or hypocalcemia
5. discuss assay methods for calcium and phosphorus

**MAGNESIUM, AND COPPER**

The student should be able to:
1. describe distribution, functions, and regulation of magnesium and discuss conditions associated with abnormal levels of serum magnesium
2. describe assay methods for serum magnesium
3. describe the metabolism of copper, the functions of copper as ceruloplasmin, and describe 2 copper-storage diseases and give typical lab findings in Wilson's Disease
4. describe specimen requirements for each of the above ions.

**PHYSIOLOGIC ACID-BASE BALANCE**

The student should be able to:
1. use the Henderson-Hasselbalch equation to solve physiologic acid-base problems.
2. identify the fractions of CO2 in blood, distinguish between the respiratory and metabolic fractions, and explain the terms 'buffer base' and 'base excess'.
3. give the normal range for blood pH, total CO2 or bicarbonate, pCO and give the blood pH range considered compatible with life
4. distinguish between: acidosis/alkalosis, metabolic/respiratory, compensated/uncompensated
5. discuss the pathophysiology of common acid-base disturbances
6. describe or recognize laboratory results in common acid-base disturbances.
BLOOD GASES AND TRANSPORT SYSTEMS
The student should be able to:
1. discuss control of respiration, O2 transport in blood, and the O2 dissociation curve
2. discuss CO2 transport and factors affecting pCO2
3. define and describe the chloride shift.

BLOOD GASES, METHODS AND INTERPRETATION
The student should be able to:
1. give the principle of each electrode in a blood gas instrument
2. explain how a blood-gas analyzer is calibrated and calculate the theoretical partial pressure of the calibrating gases based on Dalton's Law
3. describe the measurements dealing with O2 transport at the blood-tissue level and their measurement and/or calculation
4. give the normal range for the following (arterial whole blood: PCO2, CO2 content, PO2, O2 saturation, P50
5. describe specimen requirements for blood gases. Discuss the effect on blood gas results in the following situations: patient hyperventilate during collection, sample exposed to room air, venous blood used, sample allowed to stand at room temp before analysis, plastic syringe rather than glass, patient temperature is not 37oC

THE LIVER AND BILIRUBIN
The student should be able to:
1. describe the anatomy of the liver
2. briefly outline the physiologic role of the liver in the following: carbohydrate, protein, and lipid metabolism; excretory and protective function; normal bile pigment metabolism
3. discuss the Evelyn-Malloy and Jendrassik-Grof methodology for bilirubin
4. correlate direct/indirect, conjugated/unconjugated, soluble/insoluble bilirubin and give the normal ranges for serum total and direct bilirubin

JAUNDICE AND LIVER FUNCTION TESTS
You should be able to:
1. classify the type of jaundice based on bilirubin test results and list disease states associated with each group
2. describe the reactions that occur in the brain during the process of ammonia detoxification and applications of and methods for serum ammonia
3. describe: Gilbert's disease, Crigler-Najjar syndrome, Dubin-Johnson syndrome, posthepatic obstructive jaundice, hepatitis (various forms), Wilson's Disease, Hemochromatosis
4. describe clinical and lab findings associated with Reye's syndrome
5. list the criteria for neonatal physiologic jaundice and criteria for exchange transfusion

G. INSTRUCTIONAL METHODS AND ACTIVITIES
You will be provided with lecture notes. Instructional methods will include lecturing with discussion, problem solving and case studies.

H. MAJOR COURSE REQUIREMENTS AND GRADING
The final course grade will be based on four exams, attendance, problem portfolio, and a final exam according to the following percentages:

<table>
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<tr>
<th>ACTIVITY</th>
<th>PERCENT OF FINAL GRADE</th>
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<tbody>
<tr>
<td>Examination average (3 exams)</td>
<td>45%</td>
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<tr>
<td>Laboratory average</td>
<td>25%</td>
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<td>Problem portfolio</td>
<td>10%</td>
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<tr>
<td>Final examination</td>
<td>20%</td>
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<td>100%</td>
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**Grades**

Specific Course and Laboratory objectives are included in the required laboratory workbook. You are expected to read the material that corresponds to the objectives as they are covered. Mastering course objectives will require that you have read the material.

You must score ≥ 70% in both LAB and LEC (Exam & Problem Portfolio) components to earn the final passing grade.

All questions are keyed to the specific course and lab objectives. Use these objectives to study.

**Unannounced quizzes may be given throughout the course of the semester and grades for this will be assigned to Problem portfolio.**

There is no provision for making up late work and/or missed exams or quizzes. A grade of zero will be entered for any late or missed exam, lab, quiz or practical due to an unexcused absence. The only **excused** absences are personal illness, immediate family medical emergency or immediate family funeral.

You are expected to read the material that corresponds to the objectives as they are covered. Mastering course objectives will require that you have read the material.

The following scale will be used to report grades:

- A 90 - 100
- B 80 - 89
- C 70 - 79
- D 60 - 69
- F below 60

**I. COURSE CONTENT/SCHEDULE**

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<thead>
<tr>
<th>Aug.</th>
<th>24</th>
<th>Spectral Techniques</th>
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<tbody>
<tr>
<td></td>
<td>29</td>
<td>Beer’s Law &amp; Problem solving</td>
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<tr>
<td></td>
<td>31</td>
<td>Spectrophotometry and Curves</td>
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<tr>
<td>Sep.</td>
<td>05</td>
<td>Labor Day</td>
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<td>07</td>
<td>Flame Photometry &amp; Atomic Absorption</td>
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<td>12</td>
<td>Fluorometry &amp; Chemiluminescence</td>
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<td>Nephelometry &amp; Turbidity</td>
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<td>Electrochemistry</td>
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<td>21</td>
<td>Osmolality</td>
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<td>26</td>
<td>Exam 1</td>
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</tbody>
</table>
Proteins
Oct. 03 Proteins
05 Enzymes
10 Enzyme assays
12 Carbohydrates Glucose
17 Assays & Glyco Hgb
19 Diabetes Mellitus
24 Exam 2
26 Lipids
31 Non-Protein Nitrogen Compounds
Nov. 02 Electrolytes
07 Anion Gap
09 Renal Function
14 Acid-Base Balance
16 Blood Gases
21 Calcium & Phosphate
23 Exam 3
28 Liver, Bilirubin & Jaundice
30 Liver, Bilirubin & Jaundice
Dec. 05 Review
12 FINAL 1:45 pm - 4:15 pm

Laboratory Schedule
LAB 1 R: Time: 8:00-10:50 AM
Room: CS 228
LAB 2 F: Time: 11:00-1:50 PM
Room: CS 231

Thurs Aug. 25 Introduction to Lab & Safety
Thurs Sep. 01 Pipet Exercise
Thurs 08 Spectrophotometer Function
Thurs 15 Calibration Curves
Thurs 22 Molar Absorptivity
Thurs 29 Total Protein & Albumin
Thurs Oct. 06 Enzymes
Thurs 13 Glucose
Thurs 20 Cholesterol & Triglyceride
Thurs 27 BUN & Creatinine
Thurs Nov. 03 Uric acid
Thurs 10 Calcium & Phosphorous
Thurs 17 Total & Direct Bilirubin
Thurs 24 Thanksgiving Holiday
Note: Changes in this course schedule may be necessary and will be announced to the class by the Instructor. The assignments and exams shown are directly related to the Student Learning Outcomes described in Section F.

J. COURSE POLICIES

Attendance/Tardiness
Students are expected to attend all lectures. If you know in advance that you will miss an exam due to official University business, you must provide the Professor with official documentation of the absence at least fourteen days prior to missing. It is the student’s responsibility to obtain official documentation in timely fashion. Once the documentation has been verified, the Professor will decide how to handle the absence. In the overwhelming majority of cases, assignments and exams will be turned in or completed prior to the planned, official absence. Exams given outside regularly scheduled times may vary in format and content at the discretion of the faculty member. Absolutely nothing may be turned in late by anyone for any reason.

Late Work and Make-up Exams
There is no provision for making up late work and missed exams.

Extra Credit
There is no provision for extra credit

Cell Phone Use
No use of cell phone in class

Laptop Use
Only for assessing lecture notes posted on blackboard

Food in Class
No eating in class

Missed Exam
Unexcused absence during exams will result in a zero for that exam. It is the student’s responsibility to contact me in cases of extreme emergency. The only excused absences are personal illness, immediate family medical emergency, or attending funeral of immediate family.

K. COLLEGE AND UNIVERSITY POLICIES

- **Academic Integrity (University)**
  It is expected that university students will demonstrate a high level of maturity, self-direction, and ability to manage their own affairs. Students are viewed as individuals who possess the qualities of worth, dignity, and the capacity for self-direction in personal behavior.
  See Full University Policy at http://catalog.tamucc.edu/content.php?catoid=10&navoid=313#Academic_Integrity

- **Classroom/Professional Behavior**
  Texas A&M University-Corpus Christi, as an academic community, requires that each individual respect the needs of others to study and learn in a peaceful atmosphere. Under Article III of the
Student Code of Conduct, classroom behavior that interferes with either (a) the instructor’s ability to conduct the class or (b) the ability of other students to profit from the instructional program may be considered a breach of the peace and is subject to disciplinary sanction outlined in article VII of the Student Code of Conduct. Students engaging in unacceptable behavior may be instructed to leave the classroom. This prohibition applies to all instructional forums, including classrooms, electronic classrooms, labs, discussion groups, field trips, etc.

- **Deadline for Dropping a Course with a Grade of W (University)**
  The grade of W will be assigned to any student officially dropping a course by Friday, November 11, 2016. No student is eligible to receive a W without completing the official drop process by this deadline. Visit the Office of the University Registrar for the Course Drop Form that must be submitted. After November 11, 2016 a student will not be allowed to drop a course.

- **Grade Appeals (College of Science and Engineering)**
  As stated in University Procedure 13.02.99.C2.01, Student Grade Appeal Procedures, a student who believes that he or she has not been held to appropriate academic standards as outlined in the class syllabus, equitable evaluation procedures, or appropriate grading, may appeal the final grade given in the course. The burden of proof is upon the student to demonstrate the appropriateness of the appeal. A student with a complaint about a grade is encouraged to first discuss the matter with the instructor. For complete details, including the responsibilities of the parties involved in the process and the number of days allowed for completing the steps in the process, see University Procedure 13.02.99.C2.01, Student Grade Appeal Procedures. These documents are accessible through the University Rules website at [http://www.tamucc.edu/provost/university_rules/index.html](http://www.tamucc.edu/provost/university_rules/index.html), and the College of Science and Engineering Grade Appeals webpage at [http://sci.tamucc.edu/students/GradeAppeal.html](http://sci.tamucc.edu/students/GradeAppeal.html). For assistance and/or guidance in the grade appeal process, students may contact the chair or director of the appropriate department or school, the Office of the College of Science and Engineering Dean, or the Office of the Provost.

- **Disability Services**
  The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please call (361) 825-5816 or visit Disability Services in Corpus Christi Hall 116. If you are a returning veteran and are experiencing cognitive and/or physical access issues in the classroom or on campus, please contact the Disability Services office for assistance at (361) 825-5816. [http://disabilityservices.tamucc.edu/](http://disabilityservices.tamucc.edu/)

L. **OTHER INFORMATION**
You are expected to read the material that corresponds to the objectives as they are covered. Mastering course objectives will require that you have read the material.

**GENERAL DISCLAIMER**
I reserve the right to modify the information, schedule, assignments, deadlines, and
policies in this syllabus if and when necessary. I will announce such changes in a timely manner during regularly scheduled lecture periods.