This syllabus may be modified at any time without prior notice.

Course Description
This course involves the study of the nature, composition, origin, and history of igneous and metamorphic rocks. Students will be introduced to the principles that govern the mineralogical and textural diagenesis of these systems and their unique mineral assemblages. Lab exercises in optical microscopy, geochemical data interpretation, graphical analysis and classification modalities are essential components. Prior working knowledge of polarized optical microscopy, mineralogy, and chemistry is prerequisite. Familiarity with programming simple electronic spreadsheet algorithms is highly recommended. A fieldtrip is required.

Prerequisites: GEL 1010, GEL3050, CHE1800  
Highly Recommended: Basic algebra concepts as well as some trig

Required Materials
- Field Notebook, Rockhammer, Camera
- Thin Section Kit + previous tools from GEL1010 and GEL3050!
- Software: GCD kit (http://www.gcdkit.org/); Zotero (https://www.zotero.org/)
- i-clicker (ABSOLUTE MUST! YOUR GRADE DEPENDS ON IT)

Specific (Measurable) Student Behavioral Learning Objectives
Upon completion of the course the student should be able to:
1. Calculate CIPW normative igneous mineralogies from geochemical data
2. Evaluate igneous rock formative processes from observed mineral assemblages
3. Compare Bowen’s Reaction Series to observed minerals
4. Construct the mineralogy of igneous rocks using multi-phase solid solution diagrams
5. Correctly estimate igneous classifications from hand samples and optical microscopy
6. Differentiate between various minerals, both in igneous and metamorphic samples
7. Diagram the mineral diagenesis in appropriate metamorphic P/T systems
8. Assess pressure and temperature conditions of metamorphic formations from observed mineralogies

Major Topics & Subtopics
I. Igneous Rocks
   A. Igneous Mineralogy & Bowen’s Reaction Series
   B. Identifying Igneous Rocks - Macroscopic Samples
   C. Igneous Rocks Thin Section Analysis (Polarized Light Microscope)
   D. Whole Rock Geochemical Analysis
      1. CIPW Norm calculations
   E. Evolution of Magmas / Minerals in Igneous Systems
I. Metamorphic Rocks
   A. Metamorphic Mineralogy
   B. P/T Diagrams
   C. Identifying Metamorphic Rocks – Macroscopic Samples
   D. Metamorphic Rocks Thin Section Analysis (Polarized Light Microscope)
   E. Metamorphic Rock Interpretation – Geobarometer & Geothermometer

Grading in GEL4050
<table>
<thead>
<tr>
<th>Participation / i-clicker</th>
<th>Max. Points</th>
<th>MY GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 selected LAB assignments (2 x 50pts, 1 x 100pts)</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>4 unannounced random quizzes (25pts ea.)</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Mineral ID precursor Exam HANDSAMPLE</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Mineral ID precursor Exam OPTICAL</td>
<td>(50 pts ea.)</td>
<td></td>
</tr>
<tr>
<td>Igneous Rocks Comprehensive Module Exam</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>Metamorphic Rocks Comprehensive Module Exam</td>
<td>(100 pts ea.)</td>
<td></td>
</tr>
<tr>
<td>2 hands-on practical research labs (150 ea.)</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>1000</td>
<td></td>
</tr>
</tbody>
</table>

Note: NO comprehensive FINAL
C+ = 770-794  C = 700-769  C- = 695-699  D+ = 670-694  D = 600-669  D- = 595-599
F = ≤ 594 points
WARNING! MINUS POINTS FOR LAB INFRACTIONS, ESPECIALLY CLEAN-UP VIOLATIONS!

FINAL GRADE POINT DEDUCTIONS: 1st Infraction: Warning!  2nd Infraction: -5pts of Final Grade  
3rd Infraction: -10pts of Final Grade  4th Infraction: -15pts of Final Grade  
5th Infraction: -20pts of Final Grade and revocation of Lab privileges  
Note: Deductions are cumulative!!! Example: 4th Infraction = -15 + -10 (3rd Infr.) + -5 (2nd Infr.) = -30pts

PARTICIPATION: You are EXPECTED to attend class & labs and PAY ATTENTION in both. Attendance & Student Responses will be tracked using the I-clicker interactive student response system. The timely purchase of the device is REQUIRED in order to earn full participation points (see point distribution below). If you forget your clicker or do not have one (NOT recommended), you MUST sign a special roll in order to receive at least partial credit for attending class (Lowest score of the day minus 10%). Points can NOT be assigned retroactively !!! Students can earn daily points toward their participation grade by responding CORRECTLY to i-clicker questions randomly presented during lectures / labs. I absolutely DESPISE students with less than 80% participation, whining about their grade at the end of the semester. (So, don’t even try!). In regards to attendance & class materials: Any handout, any notes, any exam questions discussed will only be given IN CLASS. If you miss class, you are on your own. I do not keep extra copies and NO, I do not have or publish lecture notes for your convenience! (THIS NOT AN ONLINE CLASS!)

Point Distributions:  
- 15 Week Course meeting  (a) twice per week: 3.3pts/day  
- 10 Week Course meeting  (a) twice per week: 5pts/day  
- 8 Week Course meeting  (a) twice per week: 6.25pts/day

ABSENCES: Frankly, registering for this course is equivalent and as serious as you taking a job. I expect from you the same professional courtesies that you would extend toward your employer. As with any employer, you do NOT get paid for missed days, meaning, there are NO participation points awarded if you do not show up for class. Period! However, similarly to the real employment world, I will grant you “sick or leave days” worth a total of 10 participation points, which you may use at your discretion. As with most employment situations, you may “cash in” your remaining “sick or leave days” for extra credit at the end of the semester. Absences beyond these allotted points will never be awarded anything, no matter the reason, including but not limited to illness, work conflicts, car accidents, booked vacations, etc.

Exception: Jury-Duty: You must bring official proof of your actual court room duty validated by the court / judge! (No, the little card you get in the mail soliciting you for jury duty does NOT count!)

Note: Nothing in this policy shall require the instructor to reschedule classes, repeat lectures or other ungraded activities or provide ungraded individualized instruction solely for the benefit of students who are unable to attend regularly scheduled classes or activities.

TEST MAKE-UP: Only with a Doctor’s note or Jury-Duty!

EXAMS: There are two precursor exams (100pts ea) covering mineral identification of common rock forming minerals in handsample and thinsection will be given during the first week of class. Students who fail any of these two exams are encouraged to drop the course. In addition, there are two comprehensive module exams for igneous and metamorphic rocks respectively. These in-class exams consists of 5 essay questions. Each question is graded on a 20pt scale. You will lose points for uncertainties, errors, and/or incompleteness as well as spelling and grammar. If math is required, make sure units are present and your mathematical solution shows a step by step approach. Explain any symbols or shorthand that is used. You may use additional pages as needed. Make-up only possible with legitimate excuse in writing accompanied by official documentation.

QUIZZES: There are 4 unannounced random in class quizzes (25pts ea.). These short quizzes can NOT be made up unless you have a legitimate excuse in writing accompanied by official documentation.

PETROLOGY HANDS ON PROJECT LABS & FIELDTRIP: There are two involved Petrology Labs for this course using analytical procedures and a write-up. This is about 1/3 of your grade. See separate handout for details. You may work together in collecting data, however, the write-up of the final report must be uniquely yours. See grading rubric for details.

COMPREHENSIVE FINAL EXAM: NONE!

LATE WORK: Since all labs and other assignments are available within the first few weeks of class, I will not accept ANY late work. Please note, this means ANY!!! You had practically the whole semester to complete the exercise(s), so don’t blame broken printers, crashed computers, uncooperative emails, sudden work conflicts or bouts of illness the day(s) before or even during the deadline for missing the deadline. Hint: Turn your work in early and there will be NO problems! Since the last deadline is always the last day of your regular scheduled class for the semester, there will be absolutely NOTHING accepted during and after Finals Week! Don’t even try!

CIVILITY: The student code of conduct will be enforced in this class at all times!!!
A SPECIAL NOTE ABOUT ELECTRONIC DEVICES: YES, bring your i-clicker. Secondly, you may use recording devices, tablets, smart phones, cell phones or laptops in class for COURSE RELATED ACTIVITIES!!! Put ALL other consumer electronics away (which means they are NOT to be visible, even if you don’t use them) including but not limited to ipods, MP3 players, headphones, etc.

For Exams: NO electronic devices allowed, whatsoever!!! Cell phone calculators are NOT ALLOWED, you must bring a “real” calculator. Repeat offenders will face disciplinary action on the college level. You have been warned!

LAB TIME: This class requires a lot of lab time. While some time for lab exercises will be given during the assigned lecture block, we have created an open lab schedule outside regular class periods. Please look carefully at the posted calendar and sign-up accordingly. Lab spaces are limited and sign-ups will be taken on a first-come, first-served basis. While you may sign-up for several lab times in advance, keeping these times is a crucial commitment. If you miss ANY of your appointments, ALL your future sign-ups will be bumped in favor of other students willing to keep their commitment. You have been warned! Also, be aware that certain labs are only set up during certain times. Missing these labs does not automatically qualify you for a lab make-up at a later date. In fact, these make-ups will be RARELY GRANTED and will need full official documentation of circumstances preventing a student from completing the lab during the assigned time slot. You have been warned again!

LAB RULES:
ATTN. NEW LAB POLICY IN FORCE
All students needing to work in the lab MUST:

☐ attend a Lab Safety Lecture, pass a Lab Exam and be certified (Only those will get FOB access and can be in the Lab)
   If you are already certified, bring proof
☐ sign a Lab Liability Waiver
☐ sign in, state the purpose of their activities
☐ wear an appropriate name badge identifying you legitimacy to be in the lab
☐ work in groups of at least two while in the Lab

Students must follow instructions of the Lab Assistants and are responsible for thoroughly cleanig their work space and lab equipment used after the completion of the lab exercise. BE AWARE: LAB INFRACTIONS CONCERNING EQUIPMENT & CLEAN-UP CARRY MINUS POINTS FOR THE COURSE! ALL students must read and sign the following Liability Waiver:

LAB LIABILITY WAIVER

(1) Students in the course will use analytical & cutting machinery as well as assemble chemical kits for rapid mineral field assay to be taken outside of the classroom. All students participating in such lab activities taught by the Department of Earth and Atmospheric Sciences should be aware that there is always an element of risk involved when working with equipment, machinery and/or chemicals. These risks involve serious injury or death, especially if safety protocols are not followed and/or equipment, machinery, and chemicals are misused. Instructors and/or Lab Personnel will use all reasonable precautions and students need to exercise prudent behavior during such activities, but even then there exists the possibility of an accident or injury.  Since many of these activities are to be undertaken in the field and outside of the classroom without the direct supervision of an instructor, students must be alert and aware of possible risks and dangers when using chemicals, equipment, and/ or machinery with or without supervision.

(2) Neither the University, nor the instructor, nor any assigned Lab Personnel shall be liable for any damages, including but not limited to injuries, death, loss of property or profits, or incidental, consequential, exemplary, special or other damages that may result from use of chemical, equipment, and/or machinery used in conjunction with or outside the framework of this college course. This condition also expands to the use of procedures and formulations given in LAB texts.

(3) The associated LAB instructions and described analytical procedures are intended for use by persons with a basic knowledge of inorganic chemistry, they are advised to follow strictly the safety instructions. Neither the author, nor the instructor, nor the University does accept liability or responsibility for any injury or damage to persons or property incurred by performing the experiments described in the LAB texts, nor for the content of any outside material referred to in class or manual, including linked websites.

(4) EXPLICIT SAFETY RULES & REGULATIONS:
I. Students MUST wear Safety Goggles when working with chemicals or using equipment or machinery.
II. Students MUST read and follow instructions precisely.
III. Students shall NOT misappropriate chemicals, equipment and/or machinery other than its intended and prescribed use.
IV. Students must take care not to ingest, inhale, taste or otherwise orally contact chemicals or reactive products. Students MUST wash hands after each experiment.
V. Some tests may include open flames. Students MUST take precautions in hair and clothing to avoid accidental or intentional contact of persons and property with flames and fire.
VI. Students MUST take care when transporting equipment to avoid spillage and unintended contact with property and persons.

(5) Students who violate any of the above rules, policies and stipulations which are written in this document or implied through
instruction and professional laboratory behavior or who fail to conform to directives from the instructor or lab personnel may be immediately dismissed from the course. They may also be subject to a failing grade in the course, be required to withdraw from the course, and be subject to disciplinary action by the University.

(6) All participants MUST SIGN the following LIABILITY WAIVER.

In consideration of my being permitted to participate in this activity, I, the undersigned hereby release and hold harmless: the Trustees of the Metropolitan State Universities of Denver, the Earth and Atmospheric Sciences Department, and respective employees, from all claims, losses, damages, or expenses because of property damage or personal or bodily injury incurred or caused by me during or in conjunction with the above mentioned activity or activities. In filling out this form, I acknowledge that I fully understand the risk that is inherent with on and off campus laboratory procedures and/or equipment and/or machinery use. The undersigned also indicate with their signature that they will follow appropriate safety rules and regulations. Furthermore, I have fully read and understand the department policies and my liability and do accept the restrictions.

Addendum to ACADEMIC INTEGRITY section below

I-CLICKER: Responding to i-clicker questions for someone else (e.g., by using their i-clicker together with your own) CONSTITUTES ACADEMIC CHEATING (same as cheating on a test or exam).
Students are responsible for full knowledge of the provisions and regulations pertaining to all aspects of their attendance at MSU Denver, and should familiarize themselves with the policies found in the MSU Denver Catalog: MSU Denver Catalog. For more information and most recent updates from these sources, click on the links provided below. This document is also posted on the CLAS website: https://msudenver.edu/las/policies/students/

WITHDRAWAL FROM A COURSE
Students should be aware that any kind of withdrawal can have a negative impact on some types of financial aid and scholarships. For further information, click on the Financial Aid/Withdrawals page. The Withdrawal (W) notation is assigned when a student officially withdraws from a course via the Student Hub after the drop deadline (census date) and before the withdrawal deadline posted in the Academic Calendar. Deadlines differ proportionally for courses offered during part of a semester, including late-start and weekend courses. Students should refer to the Student Detail Schedule via the Student Hub to review drop and withdrawal deadlines for individual courses. When a student withdraws from a course, no academic credit is awarded. The course remains on the student’s academic record with a “W” notation and counts toward the student’s attempted hours. The course is not calculated in the student’s GPA or quality points. Students who withdraw from a course are responsible for the full tuition and fees for that course. After the withdrawal deadline, students may not withdraw from a course and will be assigned the grade earned based on the course syllabus. A student-initiated withdrawal will appear as an “F” on the student’s academic record in any case of academic misconduct resulting in a permanent “F”. For more information see “Grades and Notations” in the “Academic Policies and Procedures” section in the current Catalog.

ADMINISTRATIVE WITHDRAWAL
The Administrative Withdrawal (AW) notation is assigned when a student, or representative, requests to be withdrawn from a course due to unforeseen or extenuating circumstances beyond the student’s control. When the “AW” notation is assigned, no academic credit is awarded. The course remains on the student’s academic record with an “AW” notation and counts toward the student’s attempted hours. The course is not calculated in the student’s GPA or quality points. Students may request an administrative withdrawal from the Office of the Registrar after the drop deadline (census date) posted in the Academic Calendar. Deadlines differ proportionally for courses offered during part of a semester, including late-start and weekend courses. Students should refer to the Student Detail Schedule via the Student Hub to review drop deadlines for individual courses. For more information see “AW-Administrative Withdrawal” in the “Academic Policies and Procedures” section in the current Catalog.

INCOMPLETE POLICY
The Incomplete (I) notation may be assigned when a student who is achieving satisfactory progress in a course and who has completed most class assignments is unable to take the final examination and/or does not complete all class assignments due to unusual circumstances, such as hospitalization or disability. Incomplete work denoted by the Incomplete “I” notation must be completed within one calendar year or earlier, at the discretion of the faculty member. If the incomplete work is not completed within one year, the “I” notation will convert to an “F.” Students must have completed at least 75% of the course work to qualify for consideration for an incomplete. The student must be passing the course in order to be granted an incomplete. The course counts toward the student’s attempted hours, does not count toward earned hours, and is not
calculated in the GPA or quality points. Determination of eligibility does not guarantee that an incomplete will be granted. Students who meet the qualifications may request an incomplete from the faculty member who is teaching the course. The decision to grant an incomplete is up to the faculty member or at the department chair’s discretion. The decision to grant an incomplete as an accommodation based on a student’s disability shall be made by the faculty member or the department chair, if the faculty member is not available, in consultation with the Director of the Access Center. If an incomplete is granted, the student and instructor should fill out and sign an Incomplete Agreement form to clarify what the student needs to do to complete the course. For further information, see the “I - Incomplete” section in the “Academic Policies and Procedures” section of the current Catalog.

BEST GRADE STANDS
A student’s grades for repeated courses will be removed from GPA calculations up to 18 semester hours, regardless of the original grade earned. If a student repeats more than 18 credit hours, the student may designate which of the course grades are removed from GPA calculations (up to 18 semester hours). Only the best grade and its associated credit will be calculated in the GPA and earned hours totals. Other attempts for the course will appear on the official academic record but will be annotated to indicate they do not count for academic credit or GPA calculation. This policy applies only to courses taken at MSU Denver, and it does not apply to courses designated as repeatable toward degree requirements. For more information, see “Best Grade Stands” in the “Academic Policies and Procedures” of the current Catalog:

ACADEMIC INTEGRITY
As students, faculty, staff and administrators of Metropolitan State University of Denver, it is our responsibility to uphold and maintain an academic environment that furthers scholarly inquiry, creative activity and the application of knowledge. We will not tolerate academic dishonesty. We will demonstrate honesty and integrity in all activities related to our learning and scholarship. We will not plagiarize, fabricate information or data, cheat on tests or exams, steal academic material, or submit work to more than one class without full disclosure. For further information see “Academic Integrity” on the Dean of Students website.

SEXUAL MISCONDUCT
Follow the link for information regarding the MSU Denver Sexual Harassment Policy.
Follow the link for information regarding Title IX.
For more information, refer to the Student Code of Conduct page.

ACCESS CENTER – ACCOMMODATING STUDENTS WITH DISABILITIES
The Metropolitan State University of Denver is committed to providing an accessible and inclusive learning environment for all students, including those with disabilities. Students with a diagnosed condition/disability which may impact their access, performance, attendance, or grades in this class should contact the Access Center, located in the Plaza Building, Suite 122, 303-615-0200.

The Access Center is the designated department responsible for coordinating accommodations and services for students with disabilities. Students will need to provide an Accessibility Notification Letter obtained from the Access Center to their faculty to activate their accommodations. Information pertaining to a student’s disability is treated in a confidential manner. Further information is
available by visiting the Access Center website www.msudenver.edu/access.

“ADA Syllabus Statement” above available at https://msudenver.edu/access/facultyinformation/.

CLASS ATTENDANCE
Attendance during the first week of class is required. It contributes greatly to teaching and learning. Some departments determine a student’s enrollment in a course based upon attendance during the first week of class. Consult the department for more information about the attendance policy for the class that you are attending. Students who drop classes are financially responsible for those classes in accordance with withdrawal/refund policies. . . .  Students at MSU Denver who, because of their sincerely held religious beliefs, are unable to attend classes, take examinations, participate in graded activities or submit graded assignments on particular days shall, without penalty, be excused from such classes and be given a meaningful opportunity to make up such examinations and graded activities or assignments provided that proper notice and procedures are followed. For further information, see the Class Attendance policies page.

ELECTRONIC COMMUNICATION POLICY
Use of MSU Denver email services should follow standards of normal academic and professional ethics, and is governed by University policies and applicable law. Inappropriate use may result in revocation of access to University computing systems, and could result in disciplinary action pursuant to the Student Handbook, Faculty Handbook, and Staff Handbook. For more information, see the Electronic Communication policy page.

GENERAL STUDIES
General Studies is an important part of your degree and makes you a well-educated person. These courses teach you about the world you live in and also provide highly desirable skills for employment. Follow this link to learn about the skills you are learning in each category of General Studies and feel free to use these descriptions in job applications.

NOTE: If you have any difficulty accessing the hyperlinks in this document, please inform the instructor.
ADDENDUM: Essential General Knowledge Prerequisites!

It is assumed that you have acquired the following general knowledge skills in the sciences, language, and math through your education up to this point. It is the students FULL responsibility to make-up ANY deficiencies in these areas, preferably before enrolling in the course. I will NOT teach, lecture, or tutor any student in these basic High School skills and general knowledge subjects and no further instruction on the topics listed below will be given.

Basic Office Software
YOU know how to properly use and command MS Word, MS Powerpoint, MS Excel. Graphing with Excel, putting figures / pictures into Word documents, compiling a short presentation using PowerPoint are expected skills in my course.

English Language
Students should be able to write in short, clear, concise sentences when answering questions. Proper syntax becoming to a college student is expected. In many instances you will also be graded on professionalism which includes expressing yourself accordingly in writing. Unless otherwise instructed, always use third person when writing for the sciences. Usage of “I”, “we”, “my”, “mine”, “our”, is uncommon in technical writing and needs to be avoided.

Basic Mathematical Operations
Students should be able to do the following mathematical operations without any further instructions:
• Round answer to significant digits
• Doing unit conversions (e.g.; continental drift happens at about 5.5cm/yr. How fast would this be in mph?)
• Percent calculations (e.g.; you measure 2.58g/cm$^3$. The actual density is 2.65g/cm$^3$. What is your percent error?)
• Using units in ALL your operations (I am real stickler about that!)
• Solving equations for an unknown value; manipulating equations (basic Algebra)
• Basic Geometry: surface areas, volumes, circumferences, areas, angles
• Scientific notations (e.g.; 1.8×10$^{-9}$m/s) & scientific prefixes (milli-, mega-, terra-, micro-, etc.)
• Metric system & conversions within (µg, mg, g, kg, t, µm, mm, cm, m, km, m$^2$, km$^2$, cm$^3$, m$^3$, km$^3$)
• Weights & Measurements (Both American and Metric)
• Operating a scientific calculator (e.g.; know how to switch between degrees and radians, know how to use the arctangent function) $\theta^\circ=\arctan$(rise/run) WARNING: NO cell phone calculators are allowed!

Graphing
You are required to be able to differentiate between bar, line and scatter graphs and know how and when each one needs to be constructed. Students should be able to hand-draw curved graphs without being sloppy. Be able to extrapolate values from any graph given, no matter the scale and type. You should also be very familiar with various types of graph paper and how to plot & read data with semi-log and log-log paper.

Physics
Students should be familiar with basic Newtonian laws of motion and understand terms such as velocity, acceleration, inertia, mass vs. weight, force, gravitational constants, kinetic energy, potential energy. Being able to work with the following basic physics equations is a must (Middle School Physics!):

\[ v = \frac{d}{t} \quad a = \frac{d}{t^2} \quad a = (v_f - v_i) / t \quad F = ma \quad I = mv \quad KE = \frac{1}{2}mv^2 \quad PE = ma_gh \quad a_y = 9.8\, m/s^2 \text{ or } 30ft/s^2 \]

Chemistry
Background in basic High School chemistry is essential. Students should know element names and associated symbols, how to read atomic weight and atomic mass from the periodic table, difference between covalent, ionic, metallic and hydrogen bonding, meaning of chemical formulas and subscripts. Students also need to understand pH and the difference between oxidizing and reducing environments. Furthermore, a working knowledge of solutions, solubility, mixtures, homogenous and heterogenous systems, and precipitation is a must.

Geography
Students should know basic physical geography, which includes the location of countries, major mountain ranges, and major rivers.

Drawing & Drafting
While the world is moving rapidly to electronic PC drafting, sketching results by hand is a essential skill in geology. Students must be able to use a drawing compass and a protractor. Sketching curves through data points neat and clean is another requisite skill.