Syllabus
Mineralogy and Optical Crystallography
GEOL2013 (Distance)

Credit Hours: 04

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Pre-requisites: CHEM1040, or equivalent classes with instructor consent.

Principal Text:

  ISBN10: 0195106911 hardback, 466 pages. Sep 1999 (about $125 new, $65 used)

The ‘principal text’ will be used in class lectures, and pages or chapters for readings (where provided) will be referenced to this text. See further discussion regarding the use of the text under the References section.

Required Materials:

- A student’s petrographic microscope (available for about $460, e.g.,
  http://www.geologicalmicroscopes.com/40x-400x-power-monocular-polarizing-petrographic-microscope/ )
- A digital camera (with 1.2 megapixel or better resolution);
- A paperback copy of Dictionary of Geologic Terms (McGraw-Hill, 420 p., about $15 used on Amazon.com);
- A magnifying glass or hand lens with about 10X magnification.
- Lecture Notes – provided online in Blackboard through Auburn University;
- Videos of Lectures – provided online in Blackboard through Auburn University;
- Videos of Laboratory Sessions – provided online in Blackboard through Auburn University;
- Laboratory Exercises Lecture Notes – provided online in Blackboard through Auburn University;
- Laboratory Mineral and Thin Section Kits – mailed by Auburn University.
Course Overview:

This course covers topics related to the study of minerals in the context of geology, and is organized in five basic units, as follows:

1) **Introduction to Mineralogy** covers the definition and characteristics of minerals, the main types of minerals, and some of their uses and occurrences;
2) **Crystallography** will be addressed in the second unit. This section begins with an abstract discussion of the symmetry for objects and repeating patterns, and then applies the principles of symmetry to define the six crystal systems. ‘Exceptions’ or special considerations to crystalline material are also addressed in this section, including the role of defects, twinning, etc. This section will also include an introduction to advanced techniques for study and characterization of mineral structures, including X-ray diffraction and transmission electron microscopy (TEM);
3) **Mineral Chemistry** is the focus of the third unit, beginning with the nature of the atom and atomic bonding mechanisms, and emphasizing the chemical composition and main mechanisms of chemical variation (i.e., substitution) in minerals;
4) **Optical Crystallography**, defined by mineral interactions with light, particularly in an optical microscope, is an important aspect of mineral study and will be covered in a fourth unit;
5) **Systematic Mineralogy** is a major, culminating unit of the course that emphasizes the study and identification of common rock-forming minerals and representatives from each of the major mineral groups. This section concludes with modules discussing the applications of mineralogy in various fields of Earth and environmental science, engineering, and health.

Objectives of Course:

1. Teach you the relationships among the internal structure of a mineral, the form or shape of the mineral, its chemical composition, and its physical properties;
2. enable you to identify samples of the common rock-forming minerals in samples of the common rocks, *both in hand-sample and with a microscope*;
3. familiarize you with the equipment and other resources available at Auburn University and elsewhere to characterize and identify minerals;
4. help you to understand factors that affect the stability and occurrence of minerals, and how their properties affect and record Earth processes;
5. to provide context for understanding the applications of mineralogy in industry, materials science, health, and environmental protection.

Course Content:

Mineralogy comprises a considerable number of topics that are distributed over five units as outlined below. You are expected to read the assigned textbook materials, lecture outlines, watch lecture presentations in the form of Microsoft PowerPoint presentations, take self-quizzes, work on and watch videos of laboratory demonstrations. You are also expected to develop your scientific vocabulary, particularly in regard to describing, writing about, and reading technical
discussions of mineralogy. More information is given about these activities in the Course Requirements section in this document. The proctored final examination is taken under the supervision of an approved proctor. The Distance Learning & Outreach Technology (DLOT) office of Auburn University verifies the proctors for the examinations. More information about the proctors is given in the Examination Process section in this document.

A variety of media provided by Blackboard are used for communication among class members and the instructor. These are online submission of assignments, email, and discussion board.

**Course Topics:**

**Unit 1: What is a Mineral?**
- 1.1 Introduction;
- 1.2 The definition of a mineral;
- 1.3 Examples of mineral and non-mineral materials;
- 1.4 Historical overview of mineralogy;
- 1.5 The role of crystallography, optics, and advanced instrumentation in mineral study;
- 1.6 Major Mineral Groups.

**Unit 2: Crystallography**
- 2.1 Introduction;
- 2.2 Point Symmetry;
- 2.3 The Six Crystal Systems (defined by point symmetry);
- 2.4 Symmetry in a 2-D pattern;
- 2.5 3-D Symmetry with translation (Lattice Symmetry);
- 2.6 The Six Crystal Systems defined by Lattice Symmetry;
- 2.7 Forms, Habits, and Miller Indices;
- 2.8 Polymorphism and Isostructuralism;
- 2.9 Twinning;
- 2.10 X-ray Diffraction Study of Mineral Structure;
- 2.11 TEM Study of Mineral Structure.

**Test 1 covers material from units 1 and 2.**

**Unit 3: Crystal Chemistry**
- 3.1 Introduction;
- 3.2 Atoms, Elements, and Isotopes;
- 3.3 Chemical Bonding;
- 3.4 Atomic size and Coordination;
- 3.5 Packing and Coordination;
- 3.6 Binary and ternary phase diagrams;
- 3.7 Solid Solution Mechanisms;
- 3.8 Mineral Formulas;
- 3.9 Polymorphism;
- 3.10 Defects;
3.11 Exsolution;
3.13 Mass spectrometry in the study of Minerals.

Test 2 covers material from unit 3.

Unit 4: Optical Crystallography
4.1 Introduction;
4.2 The Nature of Light;
4.3 Isotropic and Anisotropic Materials;
4.4 The Indicatrix and Optic Sign;
4.5 Uniaxial Interference Figures;
4.6 Biaxial Interference Figures;
4.7 Light and the Six Crystal Systems;
4.8 Refractometry;
4.9 Spindle Stage Techniques;
4.10 Reflected Light Microscopy.

Test 3 covers material of unit 4.

Unit 5: Systematic Mineralogy
5.1 Introduction;
5.2 Silicate Minerals
   5.2.a Tectosilicates;
   5.2.b Silica Minerals
   5.2.c Feldspars
   5.2.d Feldspathoids
   5.2.e Zeolites
   5.2.f Scapolite;
   5.2.g Phyllosilicates;
   5.2.h Trioctahedral Phyllosilicates;
   5.2.i Dioctahedral Phyllosilicates;
   5.2.j Micas;
   5.2.k Serpentine;
   5.2.l Clay;
   5.2.m Inosilicates;
   5.2.n Pyroxenes
   5.2.o Amphiboles
   5.2.p Cyclosilicates;
   5.2.q Beryl, Tourmaline and Cordierite
   5.2.r Sorosilicates;
   5.2.s Epidote Group;
   5.2.t Lawsonite;
   5.2.u Nesosilicates;
   5.2.v Olivine;
5.2.w Garnets;
5.2.x Aluminum silicates;
5.2.y Staurolite, Chloritoid, Zircon and Topaz;

5.3 Non-Silicate Minerals
5.3.a Carbonates
5.3.b Calcite Group and Aragonite
5.3.c Other Carbonates
5.3.d Sulfates, Phosphates and Vanadates
5.3.e Gypsum and Anhydrite, and Barite
5.3.f Apatite;
5.3.g Vanadianite;
5.3.h Halides
5.3.i Oxides and Hydroxides
5.3.j Spinel Group
5.3.k Corundum and Ilmenite
5.3.l Sulfides
5.3.m Pyrite, Pyrrhotite, Galena, Arsenopyrite and Marcasite
5.3.n Chalcopyrite, Bornite, Chalcocite, Covellite
5.3.o Native Elements
5.3.p Diamond and Graphite
5.3.q Gold and the ‘Gold Group’ Metals
5.3.r Platinum and the ‘Platinum Group’ Metals
5.3.s Iron and the ‘Iron Group’ Metals

5.4 Extensions of Mineralogy
5.4.a Introduction
5.4.b Igneous Petrology;
5.4.c Sedimentary Petrology;
5.4.d Metamorphic Petrology;
5.4.e Materials Science;
5.4.f Environmental Science;
5.4.g Minerals and Health;
5.4.h Minerals of the Moon and Meteorites;
5.4.i Gems and Precious Stones

Test 4 covers material from unit 5.
The final exam is comprehensive.

Course Laboratory Sessions:

1. Point Symmetry and 2-D Lattice Symmetry;
2. Miller Indices and Crystal Systems;
3. Atomic Bonding and Coordination;
4. Calculation of Mineral Formulas;
5. Optics I (Isotropic and Uniaxial Mineral Optics);
6. Optics II (Biaxial Mineral Optics);
7. Tectosilicates
8. Phyllosilicates
9. Inosilicates
10. Cyclo- and Sorosilicates
11. Nesosilicates
12. Carbonates, Sulfates, Phosphates, Halides
13. Oxides and Hydroxides, Sulfides, and Native Elements

Suggestions for Study:

The course units are divided into several basic elements: the reading assignment, the lecture outline, the lecture presentation, resources from websites, self-study quizzes. Never rush through a unit. Remember to follow each step specified to achieve the course goal. Some of the reading assignments are very long and include many examples. After reading them, you may wonder if you have mastered the material. In these cases the lecture outline notes and self-study quizzes should help you to realize if you need to review the reading.

A Note on Using the Lecture Notes:

The lecture notes are not simply an outline of the readings. They are a guide to the most important concepts and terms. They contain the same information as in the PowerPoint presentations, but in a form that should facilitate study. The textbook and other readings present the material from a different perspective and contain information that complements the lectures. I suggest that before you do the readings, scan over the outline in order to get an idea of what you are about to read. Then, after reading and listening to the PowerPoint lectures, check your understanding of the material by again going over the outline. If parts of the material seem confusing, you will have a good indication of what you need to review in the reading. The lecture notes are not a substitute for the reading. The lecture notes are tools that you may use to better understand the material. They can also help to relieve some of the stress involved with learning many new concepts and terms.

Course Requirements:

1. Lectures:

Lecture outlines and lecture presentations for each topic are made available in the course website on Blackboard.

2. Laboratory:

Laboratory exercises will begin with the second course unit (crystallography) and proceed through crystal chemistry, mineral optics and systematic mineralogy. The first four laboratory exercises are available in electronic formats, and can be downloaded through the course website. Subsequent laboratories will require material mailed from Auburn University. The student must also purchase a petrographic microscope for use with the course, beginning with laboratory 5 and
proceeding throughout the remainder of the class. (For an example of an acceptable microscope, see http://www.geologicalmicroscopes.com/40x-400x-power-monocular-polarizing-petrographic-microscope/). Videos of exercises will provide an opportunity to experience a “hands-on” application of principles relating to subjects.

3. **Self Study Quizzes:**

There are self-study quizzes available on Blackboard and you are expected to take these as many times as possible to master the content. Self-study quizzes are not graded (and I do not see what score you make on them), however, I do have the ability to see if you spend time to take the self quizzes.

4. **Term Paper with PowerPoint Presentation, and Journal Article Critique:**

Each student will prepare a written report and an MS PowerPoint presentation on an assigned topic related to one of the lecture topics. The grade for the report and presentation will reflect the quality of the document and the presentation (factors of importance related to the document include extent of relevant information, extent of research through references, organization of materials, clarity and completeness). Students are expected additionally to summarize and critique two journal articles specified by the instructor on Blackboard. Please review the information at the end of the syllabus for more detailed instructions.

5. **Exams:**

You will use Blackboard for taking exams. There are four timed open book examinations and a final proctored examination.

6. **Proctored Final Examination:**

The proctored final examination is at the end of course and will be available in the course website on Blackboard. This examination gives you an opportunity to assess your assimilation of the learning objectives of the course. The examination will include material from the assigned textbook readings, lecture outline, quizzes, lecture presentations and laboratory assignments. It will consist of multiple-choice questions, true/false, matching questions and other questions answered by computations and written statements. This is NOT an open book examinations. More information about the proctors is given in the *Examination Process* section in this document.

**Examination Process:**

After the first session, you must select a proctor to supervise the final examination. Examples of approved proctors are academic administrators in the learner’s locale: school superintendents or principals, academic deans or department heads at colleges, or an independent learning office test supervisor at another college, or an education officer at a military installation. All proposed proctors are verified for appropriateness by Distance Learning and Outreach Technology
(DLOT) student services staff at 334-844-3106 or audl@auburn.edu. At the time of the final examination, the proctor and the student fill out the Examination Information Verification form. This form along with any written material is mailed in a confidential self-addressed sealed envelope to DLOT office.

**Grading and Final Examination:**

The grade for this course will be based upon four timed exams during the semester, 13 laboratory reports, a term paper with PowerPoint presentation, the critique of two journal articles, and a proctored final exam. The following scale determines the final course grade, reflecting the combination of all tests, laboratory reports, presentations and exams:

**Grades:**

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<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Test 1</td>
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<td>Test 2</td>
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<td>Test 3</td>
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<tr>
<td>Test 4</td>
<td>15%</td>
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<tr>
<td>Laboratory Exercises</td>
<td>20%</td>
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<tr>
<td>Report</td>
<td>5%</td>
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<tr>
<td>Article Critiques</td>
<td>5%</td>
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<tr>
<td>Final Exam</td>
<td>10%</td>
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</tbody>
</table>

**Grading Scale:**

- 90-100% = A (Superior)
- 80-89% = B (Good)
- 70-79% = C (Acceptable)
- 60-69% = D (Passing but unsatisfactory)
- below 60% = F (Failure)

The following criteria are used in assessing the letter grades:

**A:** Shows that the work is superior and exemplary. You have demonstrated that you have mastered the material and have successfully conveyed your mastery in your responses.

**B:** Shows that the work is good. You have demonstrated that you have a good understanding of the material and can apply that understanding.

**C:** Shows that you have responded satisfactorily. A response that meets the basic requirements will receive a C grade.

**D:** Shows that you have responded unsatisfactorily.

**F:** You have failed to respond correctly.
Equipment and Technical Skills:

The following are necessary for this course:

- A computer with an Internet connection;
- A petrographic microscope, fitted with standard items for petrographic study of thin sections;
- A digital camera, from which you can save pictures to your computer and upload to a web page or send via email (as a jpeg file or part of a PDF document, etc.);
- Knowledge of basic computer skills and experience using Microsoft Word and Excel (or equivalent), email and the Internet.

Class Parameters, Resources and Limitations:

You are expected to stay on track because the examinations will be focused on each unit’s topics. This type of course allows quite a bit of freedom, for instance, in determining at what time of day and where you do your coursework. It does, however, entail quite a bit of self-discipline and determination in order to keep up with the assignments. There are grade penalties for late work.

Attendance Policy

1. Students are expected to review all lectures and laboratory sessions
2. Failure to complete assignments or to take exams at designated times without an acceptable excuse will result in a zero for that assignment or exam.
3. University-approved reasons for missing a deadline for an assignment will be considered if they are received in a timely way (generally within 24 hours of the absence or incomplete assignment, and preferably before the absence if possible). The standard causes for missing or incomplete material that may be considered include:
   a. Illness of the student or serious illness of a member of the student’s immediate family;
   b. Death of a member of the student’s immediate family;
   c. Subpoena for court appearance;
   d. Participation in intercollegiate athletic events (verified by letter from professor, Dean or Athletic Department official);
   e. Religious holidays;
   f. Certain military service;
   g. Other reasons the instructor deems appropriate, e.g. job interview.

Late Submissions:

As a distance education learner, it is your responsibility to share a significant responsibility for preparing and assimilating course material. If a serious situation arises and you anticipate that you will not be able to meet a deadline, it should be discussed with the instructor, before the due date. If the instructor is contacted, regarding the problem at least several days before the due date, and judges it to warrant special consideration (as for cases as noted above) the instructor and you will negotiate an alternate due date. If the instructor has not been contacted and special consideration has not been granted, all material turned in after the due date will be penalized
10% of total possible points for each day late on the written assignments and discussion questions. Late exams will be penalized 5 points a day for each day late.

Make-up Examinations:

Make-up exams will only be given with a valid university excuse. This means a Doctor's statement or other documentation must be provided. **You are responsible** for informing the instructor prior to missing an examination or no later than one week after the examination’s official date with an official excuse. The student must initiate arrangements to take the make-up immediately after returning to the class. A Make-up must occur within 1 week from the time that the student initiates arrangements for it or the student will receive a zero grade. The format of any makeup test or exam is at the discretion of the instructor, and may be in the form of an essay.

Learners with Disabilities:

Auburn University is committed to providing accommodations and services to learners with documented disabilities. Any learner with a qualified disability which requires accommodations should contact The Program for Learners with Disabilities, 1244 Haley Center, Auburn University, AL 36849, 334-844-2096 PH, 334-844-2099 FAX, haynemd@auburn.edu. More information is available on their website at www.auburn.edu/disability. The office will fax or mail the required forms to learners to apply for services. Learners who have questions regarding participation in this course should contact the above office in advance to ensure proper accommodations. Visual impairments, including ‘color blindness,’ should be discussed with the disability office as they could affect participation in laboratory exercises, but these can generally be accommodated.

References

The textbook for the course is *Introduction to Mineralogy* by William D. Nesse (Oxford Press). This is among the most popular and well-written introductory texts for mineralogy, with content that is comparable to several editions of *Manual of Mineralogy* by C. Klein and C. Hurlbut (Wiley), a venerable standard in teaching mineralogy, and the recently released successor to that text *Mineral Science* by C. Klein and B. Dutrow (Wiley). Another recent text provided by D. Dyar, M. Gunter, and D. Tasa, *Mineralogy and Optical Crystallography*, is available for purchase directly from the Mineralogical Society of America (http://www.minsocam.org). Each textbook has certain advantages, but they all provide essentially the same content. Students may find that used texts are available (through Amazon.com, etc.) at substantial savings over the cost of a new text (about $40-$60 vs. $125). The class notes will refer to topics in the latest edition of the text by W. Neese, but a careful and attentive student will find the same content by topic in the other texts.

You are also expected to purchase and use a paperback copy of *Dictionary of Geologic Terms* (McGraw-Hill), or a similar inexpensive dictionary (a small, paperback format is easy to carry around). Students planning on a career in Geoscience are encouraged to purchase *Glossary of Geology* (American Geologic Institute, about $100 new through Amazon.com), as this is a
valuable desktop reference for professionals.

Additional resources supporting course topics will be provided to each student or be available in the Auburn University Library or in Blackboard. The list of references is made available in the course website on Blackboard.

**The Auburn University Oath of Honor**

“In Accordance with those virtues of Honesty and Truthfulness set forth in the Auburn Creed, I, as a student and fellow member of the Auburn Family, do hereby pledge that all work is my own, achieved through personal merit and without any unauthorized aid. In the promotion of integrity, and for the betterment of Auburn, I give honor to this, my oath and obligation.”

**Plagiarism and Academic Dishonesty:**

Plagiarism is the act of presenting directly or indirectly someone else’s work as your own. Plagiarism occurs in different forms, including taking an extended quotation from another’s writing, without indicating that is a direct quote. If you are not sure of how to cite the use of previous work, then ask for help from a librarian or the course instructor. Plagiarism is a major type of academic dishonesty and will not be tolerated. Similarly cheating on tests in any way, falsifying bibliographies, fraudulent quotes, and similar practices are intolerable forms of academic dishonesty. The University’s policy for academic misconduct in the Learner Code of Conduct will be followed for this course (see ‘Handbook’ and ‘Oath of Honor’ in the Tiger Cub at [http://www.auburn.edu/tigercub/](http://www.auburn.edu/tigercub/)). If there are any questions regarding academic honesty the students are expected to contact the instructor.

*You are expected to sign a plagiarism creed online in your course on Blackboard.*

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**Critique of Papers**

Students will read and be prepared to discuss two published articles that are specified in the course lectures during the term. Students will briefly summarize the arguments made by the authors and then provide a critique of the two articles, giving the strengths or weaknesses of the arguments. Maximum 2 pages per article.

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**Individual Report**

You may choose any one of the following topics or suggest another topic related to the subject matter of the course and of potential value to the class. Your choice of topic should be made by the middle of the term, and you will provide the topic of your report to the instructor via email. You will also provide an abstract for your report to the instructor before the final report is due. These submission deadlines will help you to get feedback before turning in your report at the end
of the semester. Only one student in the class may choose a given topic, and these are ‘available’ on a first come basis.

1. Variations of symmetry within a particular mineral;
2. Exceptions to the standard symmetries and crystal systems in minerals;
3. The crystallography of nanomaterials;
4. Applications of polymorph stability to the study of Earth’s interior;
5. Advances in XRD or TEM analysis of minerals;
6. Deformation mechanisms in minerals;
7. Diffusion or radiogenic isotopes in geochronology;
8. Diffusion and crystal chemistry of high-temperature metamorphic rocks;
9. Exsolution in minerals of Meteorites;
10. Mineralogical techniques for evaluating the thermal histories of sedimentary basins;
11. Applications and limitations of EM and SEM analysis;
12. Elemental substitutions in tectosilicates and silicon semiconductors;
13. Synthesis and use of diamond and diamond substitutes;
14. Synthesis and use of zeolites;
15. Asbestos minerals;
16. Biomineralogy of minerals formed in humans;
17. Environmental Mineralogy of nuclear wastes;
18. Environmental Mineralogy of chemical contaminants (Hg, As, Pb, etc.)
19. Solid state mineral lasers;
20. Crystallography and chemistry of advanced alloys;
21. Crystallography and chemistry of advanced ceramics;
22. Advances in the mineralogy of fertilizer production;

Suggestions for Individual Reports: Pick a topic, look at what information is available, and then decide what aspect of the topic you want to focus on. Then collect information that relates to that particular aspect of the subject. Make an outline to help organize your thoughts. As you write, check the grading criteria to be sure that you are on the right track. Make copies or take good notes on who said what as you compile information and references. Prepare a complete reference list in your report.

Note: The report must include information that is not covered in class or in a textbook. To be sure that what you are presenting is not just a repeat of what is covered in class, look ahead at the lecture notes for the section that relates to your topic. You will find the lecture notes in the class website in Blackboard.

Minimum Standards for Individual Reports:
Minimum length: 5 pages of text double-spaced with 12-point font and one-inch margins.
Minimum 5 references. At least two references should be scientific journal articles, with at least one published in the last five years.
Quality Considerations for Individual Reports:

The report should be original, that is, based upon your own summary of factual information gleaned from the library and/or other sources. The report should include information different from, but supplemental to, what is presented in class lectures, labs and assigned readings. The report should not be simply a generalized summary of a topic, but should have a focus on a particular aspect of current research and applications within that topic. Information relevant to some of these topics will be made available on Blackboard.

The report should follow standard format for a technical report. The title should be brief but interesting and provide some clue to the content. For example, a title of “Asbestos Minerals” would be too general. The title should give an indication of what aspect of asbestos minerals, and the current research or health considerations of them, that you plan to discuss as a focus of the paper. The introduction should introduce the subject, indicate why it is important and indicate to the readers what you plan to cover in the focus of the paper. The conclusions should summarize the answers to the problems or issues that were raised in the introduction.

In scientific writing, it is very important to give the source of the information you are presenting. This is done by citing the author and date within the sentence or paragraph, e.g. (Jones, 2006), or ‘Smith and Jones (2005) reported that....’ Give complete references in a list at the end of the paper. For documents from web, give web address and date viewed. Use the reference format for the Mineralogical Society of America’s journal American Mineralogist (http://www.minsocam.org/MSA/AmMin/All_About_References.html).

Grading of the Individual Reports:
The table below explains how I will allocate marks on the report, and therefore how you should write the paper.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature review - Is it well written and adequate in scope? Are the references well chosen to address the issue? Do they justify what you want to say?</td>
<td>10</td>
</tr>
<tr>
<td>Title - is it appropriate? Does it tell readers what to expect in the report?</td>
<td>3</td>
</tr>
<tr>
<td>Objectives of paper - Are they clearly stated? Are they appropriate?</td>
<td>5</td>
</tr>
<tr>
<td>Organization of paper.</td>
<td>10</td>
</tr>
<tr>
<td>Does the paper focus on a particular issue and stay on topic?</td>
<td>10</td>
</tr>
<tr>
<td>Conclusions. All they appropriate and clearly stated? Do they flow logically from text? Do they address the objectives of the paper?</td>
<td>8</td>
</tr>
<tr>
<td>Proper Citations within text</td>
<td>4</td>
</tr>
<tr>
<td>Reference list: Proper citation.</td>
<td>4</td>
</tr>
<tr>
<td>References: Sufficient number and quality</td>
<td>4</td>
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<tr>
<td>Category</td>
<td>Score</td>
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<td>-------------------------------------------------------------------------</td>
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<tr>
<td>Originality. Does the author demonstrate that he is thinking critically about the subject matter, or is he just repeating other people’s statements and ideas.</td>
<td>10</td>
</tr>
<tr>
<td>Substance. Is there solid information or is it all fluff?</td>
<td>10</td>
</tr>
<tr>
<td>Overall quality of paper</td>
<td>12</td>
</tr>
<tr>
<td>New Information that is not covered in lectures or labs</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
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