Physics 589 – ***Graduate Spectroscopy***
Books: *Molecules and Radiation*, J. Steinfeld; and *Symmetry,* R. McWeeny – both Dover
Office Hours: Posted on the office doors or by appointment – use email
Course Time: 9:30-10:45 TR, Workman 352, Spring 2016
Instructor: M. Creech-Eakman, Workman 357; mce@kestrel.nmt.edu, x5809
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Website for course updates, details, HW, etc: http://kestrel.nmt.edu/~mce/phys589.html

Course Learning Outcomes/ Purpose of Course: Our goal is to help you establish a broad and somewhat in depth foundation in spectroscopy at the graduate level, including topics in basic quantum mechanics and electromagnetism leading to the formation and detection of spectral lines, atomic and molecular spectroscopy, radiative transfer and methods, detection and diagnostics about spectral lines (including principles behind how spectrometers function), some group theory leading to analysis of molecules, and some special topics driven by inquiry during the course. We learn by doing and so there will be many opportunities to prove that you are learning the material in this course. Homework will generally be assigned weekly (a few problems each week). You are encouraged to work together, to consult us, other professors and many books (below) and articles….however, each person must turn in individual homework sets that are clear evidence of their mastery and understanding of the material. We will provide generalized but not detailed solutions to the problems upon request. If you need to go through a problem in gory detail, please come see one of us.

Along with the homework, there will be opportunities to work with actual spectrometers as part of the class work. You are encouraged to approach the material from a hands-on perspective as the course is intended to be a mix of theory and practical application, but heavy on practicality. There will be a take-home midterm and a final project in the course, with details to be discussed later in the semester for both.

These learning outcomes discussed above are in-line with the department's goals for our graduate students: to become independent learners, researchers and eventually teachers of this material and to go on to successful careers as professionals, likely in STEM fields.

Tips for Success in this class:
1) Please endeavor to always be on time for class. If you expect to be late or absent, drop us an email or stop by the office. You are still responsible for all the material assigned for that class meeting whether or not you attend.
2) Homework is expected to be turned in to Ken during class-time or by 4:45 pm on the day it is due. Late homework will only be accepted in pre-approved and extenuating circumstances….don't come by after class to discuss why you won't be turning in your work. (Illness and personal emergencies are exceptions to this and will be handled on a case-by-case basis.)
3) We will always endeavor to be fair and prompt in returning your work to you, as our feedback to you is part of the learning process. If you feel you have been graded you unfairly or we've misunderstood a solution you've turned in, please speak with one of us immediately about the problem so that we can resolve the issue while it is still fresh. Waiting until the last week of class to ask for points is generally frowned upon.

4) Cheating is strictly frowned upon. The first instance results in no credit for that assignment, a second, and you will be dropped from my course and reported for disciplinary action to the Chair and Graduate Dean. Cheating includes, but is not limited to, plagiarism, copying another's homework, having another complete homework for you, etc. Please consult the NMT Student Honor code for all the specifics (below). If you are unsure, when writing a paper for instance, whether something should be referenced/cited, the safest assumption is to cite it.
5) We expect you to challenge us and each other about what is discussed as we cover the course material. We will not learn to become skeptical, critical thinkers if we do not question assumptions. Please try to always do this questioning in a respectful manner…the same way you would wish to be treated by your peers or one of us.
6) We work very hard and expect that you will also. In general, you should spend about 4-5 hours outside of class for every hour you spend in class. If you find you cannot accomplish the work assigned in that time frame, please come see one of us before you fall behind so that we can attempt to remedy the situation.

Schedule and Grading:

The detailed reading, homework and grading information will be posted on the web page for the class. It is your responsibility to keep track of your own grades (but come ask about the participation aspect if you don't know how you are doing). In our classes, all points are considered equivalent and everything is calculated based strictly on percentages – 97.5%^ A+, 91.5-97.4% A, 89.5-91.4 % A-, 87.5-89.4% B+, etc. The final project is still under development as this is the first offering of this course, but it will undoubtedly include a paper and presentation to your classmates, likely during finals week. The class will consist of the following general components:

Component	**Points**
Homework (~10 sets)	300
Midterm	300
Final Project/Paper	300
Class Participation/Teamwork	100
TOTAL	**1000**

A note for people auditing the course: You are expected to participate in class as a full member of the course for the purposes of the discussions if you want to get a *Satisfactory Audit* mark. In order to do this, you need to maintain an up-to-date status on the reading assignments. You also should try to turn in at least half of every homework assignment. Participating in the midterm and final project are optional. We will inform you at midterm time if you are falling behind, and will grade your homework in the same manner I grade that of the people participating in the course for credit. You should be spending about 2 hours outside of class for every hour in class; however, the material may be challenging enough for you that you are unable to complete it in that time frame. If this begins to happen, please see one of us immediately.

Counseling and Disability Services

Reasonable Accommodations: New Mexico Tech is committed to protecting the rights of individuals with disabilities. Qualified individuals who require reasonable accommodations are invited to make their needs known to the Office of Counseling and Disability Services (OCDS) as soon as possible. In addition, New Mexico Tech offers mental health and substance abuse

counseling through the Office of Counseling and Disability Services. The confidential services are provided free of charge by licensed professionals. To schedule an appointment, please call 835-6619.

Academic Honesty: NMT's Academic Honesty Policy can be found starting on page 64 of the NMT catalog http://www.nmt.edu/images/stories/registrar/2015-2016_UNDERGRADUATE_Catalog_FINAL.pdf. You are responsible for knowing, understanding, and following this policy.

Supplemental Texts to Consult for the Course:

There are a tremendous number of books which could be used for studying various spectroscopy topics. The following books below, most at the graduate level, are ones on our personal shelves or that we have borrowed from the library and find useful at times. You should also feel free to borrow books or make use of interlibrary loans throughout our class.

Quantum Mechanics:
Griffiths, 2004, *Intro. To Quantum Mechanics* (undergrad level, basic fundamentals)
Townsend, 2012, *A Modern Approach to Quantum Mechanics* (undergrad level)
Sakurai & Napolitano, 2014, *Modern Quantum Mechanics*
Messiah, 2014, *Quantum Mechanics* (now at Dover)
Merzbacher, 1997, *Quantum Mechanics*
Shankar, 2011, *Principles of Quantum Mechanics*

Spectroscopy or Radiative Transfer:
Chandrasekhar, 2011, *Radiative Transfer* (now at Dover)
Wendisch & Yang, 2012, *Theory of Atmospheric Radiative Transfer*
Hollas, 2010, *Modern Spectroscopy*
Liou, 2002, *An Intro. to Atmospheric Radiation*

Molecules:
Herzberg, several volumes mostly out of print, except one or two with Dover
Brown and Carrington, 2003, *Rotational Spectroscopy of Diatomic Molecules*
Hirschfelder & Curtiss, 1964, *The Molecular Theory of Gases and Liquids*
Slater, 1963, *Quantum Theory of Molecules and Solids*

Others:
Jackson, 2006, *Mathematics for Quantum Mechanics*
Griffiths, 2012, *Intro. to Electrodynamics* (undergrad level)
Jackson, 1998, *Classical Electrodynamics*

Stellar Physics pertaining to Lines:
Shu, (2 vols), 1991 & 1992, *The Physics of Astrophysics: Vol 1 and 2 – Vol 1 – Gas Dynamics is more useful for this course*
Rybicki & Lightman, 1979, *Radiative Processes in Astrophysics*
Mihalas, 1978, *Stellar Atmospheres*
Gray*, Stellar Photospheres*
Novotny, 1973*, Intro. To Stellar Atmospheres and Interiors*
Rose, 2008*, Advanced Stellar Astrophysics*

Lamers & Cassinelli, 1999, *An Introduction to Stellar Winds*
Spitzer, 1978*, Physical Processes in the Interstellar Medium*

Modeling:
Press et al., 1992, *Numerical Recipes: The Art of Scientific Computing* (this book comes in different flavors, for Fortran, C ,etc., so pick your favorite language)

Schedule:
The following is a basic schedule of the work we intend to cover this semester, in rough order. The detailed schedule will be posted on the website.

Topic/Section/Book	**Time Spent**
Chapters 1-3, Steinfeld	5 weeks
Spectrometers	3 weeks
(midterm)	
Gauges/Symmetry, McWeeny/Steinfeld	1 week
Chapters 4-5, 7-8, Steinfeld	5 weeks
Other topics	2 weeks
(final project)	