KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
Department of Physics

Phys 307: Laser Molecular Spectroscopy (3-0-3)

Term 042: Second Semester 2004-2005

- **Instructor:**
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- **Pre-Requisites:** Phys. 212
- **Course Description:**
  This is an introductory course on laser molecular spectroscopy. We will cover the following main topics:
  - Lasers
  - Basics of spectroscopy
  - Rotational, vibrational and electronic spectroscopy.
- **Books:**
  - Textbook:
    - "Introduction to lasers and their application" by D. C. O'shea, W.R. Callen and T. Rhodes.
    - "Fundamental of Molecular Spectroscopy" by C. W. Banwell, 4th edition.
  - References:
    - "Modern spectroscopy" by J. M. Hollas, 2nd edition.
    - "Laser Spectroscopy Basic concepts and Instrumentation" by W. Demtröder, 2nd edition.
- **Grading Policy**:
  - Major 1 20 %
  - Major 2 20 %
  - Final 20 %
  - Project 20 %
  - Homework and Quizzes 20 %
    - A total of three exams will be given: See the course syllabus for the dates of these exams and the material they cover. All exams will be closed book and will be given during the class hour.
    - You are advised to choose your project topic as soon as possible. The deadline for choosing your topic is March 22, 03. The topic of the project is open, but it should be related to laser molecular spectroscopy. Here are some very general suggestions: build a device, conduct an experiment, develop a computer program, and write about new advances or about history. During and at the end of the term, you will present your progress in front of your fellow students.
    - As per KFUPM policy, a DN will be assigned if the number of unexcused absences exceeds one-fifth of the total class hours scheduled for the course. That is 9 lectures.

PHYS 307
Laser Molecular Spectroscopy
Lecture Schedule
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Day #	Date	Topics
1	Saturday, February 12, 2005	Introduction 2.1 Light waves
2	Monday, February 14, 2005	2.3 Directionality
3	Wednesday, February 16, 2005	n.1 Gaussian Beams and laser beam focusing 2.4 Brightness
4	Saturday, February 19, 2005	2.2 Monochromaticity 2.6 Coherence
5	Monday, February 21, 2005	2.7 Polarization
6	Wednesday, February 23, 2005	3.1 Atomic basis for laser action
7	Saturday, February 26, 2005	3.2 Creating a population inversion
8	Monday, February 28, 2005	3.3 The laser resonator
9	Wednesday, March 2, 2005	n.2 Generating short pulses
10	Saturday, March 5, 2005	1.3 Regions of the spectrum 1.4 Representation of spectra
11	Monday, March 7, 2005	1.5 Basic elements of practical spectroscopy
12	Wednesday, March 9, 2005	1.6 Signal-to-noise: resolving power 1.7 The width and intensity of spectral transition
13	Saturday, March 12, 2005	1.8 Fourier transform spectroscopy
14	Monday, March 14, 2005	1.9 Enhancement of spectra: computer averaging
15	Wednesday, March 16, 2005	**First exam**
16	Saturday, March 19, 2005	2.1 The rotation of molecules 2.2 Rotational spectrum 2.3 Diatomic molecules
17	Monday, March 21, 2005	2.3 Diatomic molecules
18	Wednesday, March 23, 2005	2.3 Diatomic molecules
19	Saturday, March 26, 2005	2.4 Polyatomic molecules
20	Monday, March 28, 2005	2.5 Techniques and instrumentation 2.6 Chemical analysis by microwave spectroscopy
21	Wednesday, March 30, 2005	3.1 The vibrating diatomic molecule
22	Saturday, April 2, 2005	3.2 The diatomic vibrating rotator 3.3 The vibration-rotation spectrum of carbon monoxide
23	Monday, April 4, 2005	3.4 Breakdown of the Born-Oppenheimer approximation: the interaction of rotations and vibrations 3.5 The vibrations of polyatomic molecules
24	Wednesday, April 6, 2005	3.6 The influence of rotation on the spectrum of polyatomic molecules
	Saturday, April 9, 2005	Midterm Break
	Monday, April 11, 2005	Midterm Break

	Wednesday, April 13, 2005	Midterm Break
25	Saturday, April 16, 2005	3.7 Analysis by infra-red techniques
26	Monday, April 18, 2005	3.8 Techniques and instrumentation
27	Wednesday, April 20, 2005	4.1 Introduction 4.2 Pure rotational Raman spectra
28	Saturday, April 23, 2005	4.3 Vibrational Raman spectra
29	Monday, April 25, 2005	4.4 Polarization of light and the Raman effect 4.5 Structure determination from Raman and infra-red spectroscopy
30	Wednesday, April 27, 2005	4.6 Techniques and instrumentation 4.7 Near-infra-red FT-Raman spectroscopy
31	Saturday, April 30, 2005	**Second Major**
32	Monday, May 2, 2005	5.1 The structure of atoms
33	Wednesday, May 4, 2005	5.2 Electronic angular momentum
34	Saturday, May 7, 2005	5.3 Many-electron atoms 5.4 The spectrum of lithium and other hydrogen-like species
35	Monday, May 9, 2005	5.2 Electronic angular momentum
36	Wednesday, May 11, 2005	5.3 Many-electron atoms 5.4 The spectrum of lithium and other hydrogen-like species
37	Saturday, May 14, 2005	5.5 Photoelectron spectroscopy 5.6 The Zeeman effect
38	Monday, May 16, 2005	5.7 The influence of nuclear spin
39	Wednesday, May 18, 2005	6.1 Electronic spectra of diatomic molecules
40	Saturday, May 21, 2005	6.1 Electronic spectra of diatomic molecules
41	Monday, May 23, 2005	6.2 Electronic structure of diatomic molecules
42	Wednesday, May 25, 2005	6.2 Electronic structure of diatomic molecules
43	Saturday, May 28, 2005	6.3 Electronic structure of polyatomic molecules
44	Monday, May 30, 2005	6.4 Techniques and instrumentation 6.5 Molecular photoelectron spectroscopy
45	Wednesday, June 1, 2005	project presentation
		Final