Course Outline

UNIVERSITY OF CALGARY
DEPARTMENT OF PHYSICS and ASTRONOMY
COURSE OUTLINE

1. Course: **Physics 617, Advanced Quantum Mechanics II**

   Lecture/Time/Session(s): L01; TR, 14:00-15:15, CHE 102, Winter 2013

   Instructor(s): Dr. D.L. Feder   **Office:** SB 535, 220-3638
   Office Hours: W, 13:30-15:30
   Email: dfeder@ucalgary.ca
   Physics and Astronomy Office: SB 605, 220-5385

   Course website: http://people.ucalgary.ca/~dfeder/617

2. Prerequisite(s): None

3. **GRADING:** The University policy on grading and related matters is described sections F.1 and F.2 of the online University Calendar. In determining the overall grade in the course the following weights will be used:

Weekly Previews	10%
Assignments	40%
Midterm Examination	25%
Final Examination	25%

   A table of conversion from final course percentage to final course letter grade can be found on the Phys 617 site.

   There will be a final examination scheduled by the Registrar's Office. A passing grade on the final examination is required in order to pass the course.

4. **Missed Components of Term Work.** The regulations of the Faculty of Science pertaining to this matter are found in the Faculty of Science area of the Calendar in section 3.6: **http://www.ucalgary.ca/pubs/calendar/current/sc-3-6.html**. It is the student's responsibility to familiarize himself/herself with these regulations. See also **http://www.ucalgary.ca/pubs/calendar/current/e-3.html**.

5. **TEXTBOOK:** There is no official textbook for this course, but we will be loosely following "*An Introduction to Thermal Physics*," by Daniel Schroeder (Addison-Wesley, 2000). Other suggestions for textbooks can be found on the course website.

6. **EXAMINATION POLICY:** Students are encouraged to read the Calendar, Section G, on Examinations: **http://www.ucalgary.ca/pubs/calendar/current/g.html**

7. **Writing across the curriculum:** In this course, the quality of the student's writing in laboratory reports will a factor in the evaluation of those reports. See also **http://www.ucalgary.ca/pubs/calendar/current/e-2.html**.

Department Approval _____   Date _____

**Associate Dean's Approval for
out of regular class-time activity:** _____   Date: _____

8. OTHER IMPORTANT INFORMATION FOR STUDENTS:

(a) **ACADEMIC MISCONDUCT** (cheating, plagiarism, or any other form) is a very serious offence that will be dealt with rigorously in all cases. A single offence may lead to disciplinary probation or suspension or expulsion. The Faculty of Science follows a zero tolerance policy regarding dishonesty. Please read the sections of the University Calendar under K. Student Misconduct (**http://www.ucalgary.ca/pubs/calendar/current/k.html**) to inform yourself of definitions, processes and penalties

(b) **ASSEMBLY POINTS in case of emergency during class time. Be sure to FAMILIARIZE YOURSELF with the information at** http://www.ucalgary.ca/emergencyplan/assemblypoints.

(c) **ACADEMIC ACCOMMODATION POLICY.** Students with documentable disabilities are referred to the following links:
Calendar entry on students with disabilities: **http://www.ucalgary.ca/pubs/calendar/current/b-1.html**
Disability Resource Centre: **http://www.ucalgary.ca/drc/**

(d) **SAFEWALK:** Campus Security will escort individuals day or night (**http://www.ucalgary.ca/security/safewalk/**). Call **220-5333** for assistance. Use any campus phone, emergency phone or the yellow phones located at most parking lot pay booths.

(e) **FREEDOM OF INFORMATION AND PRIVACY:** This course will be conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPP). As one consequence, **students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page.** For more information see also **http://www.ucalgary.ca/secretariat/privacy.**

(f) **STUDENT UNION INFORMATION:** VP Academic **Phone:** 220-3911 **Email:** suvpaca@ucagary.ca.
SU Faculty Rep. **Phone:** 220-3913 **Email:** sciencerep@su.ucalgary.ca Website http://www.su.ucalgary.ca/home/contact.html.
Student Ombudsman: http://www.su.ucalgary.ca/services/student-services/student-rights.html

(i) **INTERNET and ELECTRONIC COMMUNICATION DEVICE Information.** You can assume that in all classes that you attend, **your cell phone should be turned off**. Also, communication with other individuals, via laptop computers, Blackberries or other devices connectable to the Internet is not allowed in class time unless specifically permitted by the instructor. If you violate this policy you may be asked to leave the classroom. Repeated abuse may result in a charge of misconduct.

Here's a breakdown of the material. This is what I would put in to cover the core material, but I am totally flexible on the kinds of applications that you might like to see. Let's discuss this together.

1. **Introduction (Roughly Chs. 2.1, 2.2, and 2.5 of Sakurai)**

   (a) Review of quantum mechanics

   (b) Schrödinger, Heisenberg, and interaction pictures

   (c) Propagators and Green's functions

   (d) Examples in classical mechanics, E & M, and quantum mechanics

   (e) Review of Complex Analysis: poles and branch cuts

   (f) Feynman path integral, derivation of Schrödinger's equation

   (g) Gauge transformations: Aharonov-Bohm effect and Berry phases

2. **Review of Statistical Mechanics (Roughly Ch. 10 of Bowley & Sanchez)**

   (a) energy, entropy, specific heat

   (b) virial coefficients

   (c) Bose-Einstein condensation

3. **Second Quantization (Roughly Chs. 1 and 3 of Fetter & Walecka)**

   (a) Fock space

   (b) Quantization of the electromagnetic field; coherent states (from Meystre and Sargent, *Elements of Quantum Optics, 3rd ed.*, Ch. 13)

   (c) Green's functions in second quantization

   (d) Particles and holes

   (e) Wick's theorem

4. **Interacting Fermions (Roughly Ch. 4 of Fetter & Walecka)**

   (a) Feynman diagrams and Feynman rules

   (b) Self-energy; Dyson's equation

   (c) Hartree-Fock approximation

   (d) Scattering: Born series, Bethe-Salpeter equation

   (e) Ground state energy

5. **Interacting Bosons (Roughly Ch. 6 of Fetter & Walecka)**

   (a) Bose-Einstein condensation

   (b) Superfluidity

   (c) Ground state energy

6. **Finite Temperature (Roughly Ch. 8 of Fetter & Walecka)**

   (a) Matsubara frequencies

   (b) Heat capacity of an interacting Fermi gas

   (c) BEC transition temperature of an interacting Bose gas

   (d) Neutron stars