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Glassboro State College Senate Curriculum Committee

Approval Form

Proposal Title: Statistical Mechanics 902-355

Sponsor(s) Edwardo Flores Dept.: Physical Science Ext. 6336

Koren Ward-Bauer Physical Science 6335

Check one: ☒ Course ☐ Specialization ☐ Concentration ☐ Minor ☐ Achievement Certificate

☐ Certification Program ☐ Major Program ☐ Minor Change _____ (please name deletion or credit/title/catalog change)

☐ Undergraduate ☒ Graduate + Credit Hours

Step 1 (Department)

☐ Approved Feb 16, 1993 Date

☐ Not Approved

_____ Dept. CC Chairperson

☐ Reviewed _____ Date

_____ Dept. Chairperson

Step 2 (Receipt)

☐ SCC# _____

Proposal Received _____ Date

Mary L. Gutman SCC Chairperson

Step 3 (School CC)

Reviewed 2-22-93

☒ Approved

☐ Not Approved

Comments:
Clarify rationale for offering as a graduate course
Curricular effect unclear – where does this fit? what degree program?

J Caldwell School Curr. Comm. Chairperson

Step 4 (Academic Dean)

☐ Recommend

☐ Not Recommend

☐ Conditionally Recommend (see comments)

Reviewed 2/22/93 Date

Comments:

Signature, Dean of School

Step 5 (SCC)

Open Hearing 4/2/93 Date ☑ Approved by Senate Curriculum Committee 4/2/93 Date

☐ Returned to sponsor(s) for the following reasons:

Step 6 (Senate)

Presented to Senate 4/30/93 Date ☐ Approved ☐ Not Approved

Notification to Executive Vice-President/Provost 4/30/93 Date

Mary L. Gutman Signature SCC Chairperson

Step 7 (Executive V.P./Provost)

Received _____ Date

If no, reasons are as follows:

Approved ☒ Yes ☐ No

Student credit hours 4

Faculty load hours _____

Equalized credit hours _____

Official copy and approval sheet filed 5/25/93 Date

Signature, Executive Vice President/Provost

Registrar

Approved course description received 2 June 93 Date

Hegis Taxonomy and Course Number assigned 1902.355

B J Kelly
Signature, Registrar

2 June 93 Date

Notification forwarded:

- ☐ Senate Curriculum Committee Chairperson
- ☐ Department Chairperson(s)
- ☐ Academic Dean(s)
- ☐ Registrar
- ☐ Sponsor(s)

Statistical Mechanics

1. Details:

Sponsor	Eduardo Flores, Karen Magee-Sauer, Department of Physical Sciences
Credit Hours	4 (lecture and lab)
Course Level	Undergraduate: Junior/Senior
Curricular Effect	Elective
Prerequisites	1902.201 or 1902.203, 1701.131
Time of Implementation	Fall 95
Adequacy of Resources	Sufficient staff, facilities, and library holdings are available.

2. Rationale:

The study of physics is a logical progression. The required curriculum is remarkably uniform from program to program not only on a national level, but on an international level as well. Students begin their study with introductory courses in Mechanics, Heat, Waves and Optics, Electricity and Magnetism, and Quantum Mechanics. They then take intermediate/advanced courses in these same five areas to complete the "core" of their program. The core of the program is usually covered by advanced courses in Mechanics, Electricity and Magnetism, Quantum Mechanics, and Statistical Mechanics. Upper level electives complement and expand on these five basic areas as well.

Courses in Quantum Mechanics and Statistical Mechanics are not present in our current curriculum. As part of our commitment to the "Revising the Major" (a grant from The Association of American Colleges), we are trying to develop our Physics program into a program that has a logical progression of courses with milestones and a capstone. We need to establish a solid core of intermediate/advanced level courses. We currently offer Mechanics and Electricity & Magnetism. We are developing new courses in Quantum Mechanics and Statistical Mechanics. In the future a capstone experience will be submitted.

Statistical Mechanics is a subject that deals with the physics of a large number of objects (>10). Introductory physics courses cover a basic study of gases and thermodynamics. A course in Statistical Mechanics explains the behavior of gases and heat from a statistical model. Statistics is a subject that handles large populations with the help of averages, standard deviations, distributions, etc.

Newton's laws of motion and the laws of thermodynamics are the foundation of classical physics. Introductory physics courses concentrate on the laws of motion and only briefly introduce thermodynamics. In real life, thermodynamic laws affect our lives more than any other law. For example, our laboratory measurements are subject to thermal fluctuations, all

known processes are irreversible, and heat flow is essential for our subsistence. The second law of thermodynamics or the law of increase of entropy, applies to all physical systems. This law summarizes the process of decay that all living and non living organisms experience. The direction of time is another asymmetry of Nature that is equivalent to the second law of Thermodynamics.

Therefore, a course in Statistical Mechanics is not only interesting, but necessary for a better understanding of the physical world. Majors and non-majors who take this course will benefit from such a study. This course is a required part of any physics program.

Statistical Mechanics will be offered as a physics elective. Majors will be strongly advised to take the course. In the future, when we have established the necessary courses to achieve our goals of "Revising the Major," we will require Statistical Mechanics as part of our intermediate milestone experience.

3. Essence of the Course:

Objectives:

After completing this course the student will be able to

1. Obtain the thermodynamic properties of a system from a distribution function
2. Identify the laws of thermodynamics and their implications
3. Model a simple thermodynamic system using a Pictorial Representation
4. Competently use the computer via simulations to model a thermodynamic system

Topics:

1. Temperature:
   Macroscopic and Microscopic, Thermal Equilibrium, Measurement of Temperature, Devices
2. Simple Thermodynamic Systems:
   PV diagrams, $P\theta$ diagrams, $PV\theta$ surface, equations of state, examples
3. The Laws of Thermodynamics:
   Work and Heat, Adiabatic Work, Internal Energy, First Law, Heat Capacity, Conduction, Convection, Radiation
4. Phase Transitions
   Melting, Vaporization, Sublimation, Clapeyron's Equation, Kirchhoff's Equation
5. Statistical Mechanics
   Equilibrium Distribution, Partition functions, equipartition of energy, distribution of molecular speeds, statistical interpretation of Work and Heat, Disorder, Entropy
6. Thermal Properties of Solids
   Crystals, Nonmetals, Metals

7. Higher Order Phase Transitions
   Joule-Kelvin Effect, Critical State, Critical Point, Liquid and Solid Helium
8. Special Topics: Chaos, Heat Engines, Electric Conductors, Lasers, etc.

Laboratories

Laboratory time will be spent to help the student visualize and grasp the content being presented in lecture. Whenever possible students will be in the lab doing experiments that show the principles of Statistical Mechanics. One valuable tool we will implement is the computer. Due to the nature of the course, the computer enables us to study in a laboratory setting, systems that are not available in our current laboratories.

Computer Simulation Labs:

Statistical Mechanics deals with a large number of objects. In general, it is easier for a computer to handle the large number of computations involved in a many-body problem. We will use the computer to simulate systems for statistical thermodynamics study. There are several software packages available that can be easily adapted to this course.

Pictorial Representation of Statistical Mechanics

There is a new approach to teach Statistical Mechanics with pictures. This approach will be included as part of the lab. Systems can be modeled geometrically to aid in the understanding of the interrelationships among the variables.

Collaborative Learning Lab:

Students will work in groups to solve challenging problems and examples in Statistical Mechanics. The groups will be modeled after the Uri Treismann and BETA groups currently in practice here at Rowan.

Course Requirements:

1. Students are required to do weekly homework assignments, laboratory write ups, exams, and a final.
2. A graduate laboratory project and/or research paper

Course Evaluation:

There will be student and department evaluations of the merits of the course.

4. Results of Consultation:

Robert Newland, Department of Chemistry and Physics, Chair
Pearl Bartelt, Dean, SLAS
Gary Itzkowitz, Chair, Department of Mathematics

Statistical Mechanics

5. Catalog Description

Prerequisites: 1902.201 or 1902.203, 1701.131

The student will study in detail the laws of thermodynamics. The statistical derivation of these laws will be presented. Topics include: ideal gases, classical and quantum distribution functions, phase transitions, and other special topics. A graduate laboratory project and/or research paper is required.

Rowan Math Department Memo

To: Prof. Eduardo Flores

From: Gary Itzkowitz

Date: March 11, 1993

Subject: Consultation on the new "Statistical Mechanics" course

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I support yuor effoits in creating these new courses on statistical physics and statistical mechanics. I believe these courses are necessary in any physics program. The only other advice I have for you concerning this course is to add a course in statistics as a prerequisite for this course. To my mind you would have to spend to much time teaching statistics rather than physics if the students came to you with no statistical background.

You have my best wishes!

Gary Itzkowitz