SIMON FRASER UNIVERSITY

S.78-150

MEMORANDUM

13-A-2

To: SENATE	From: Senate Committee on Undergraduate Studies
Subject: Chemistry 465-3 Electrochemistry	Date: 1978-10-31

Action taken by the Senate Committee on Undergraduate Studies at its meeting on October 24, 1978 gives rise to the following motion:

Motion

"That Senate approve and recommend approval to the Board of Governors, as set forth in S.78-150 the new course Chem. 465-3 Electrochemistry."

Note

1. Subject to the approval by Senate and the Board of Governors of these courses, the Senate Committee on Undergraduate Studies has approved waiver of the time-lag requirement in order that this course may be offered in the summer semester 79-2.

2. In the light of the concerns in some quarters as to the mode of instruction to be employed in the course, the Senate Committee on Undergraduate Studies undertook to review the course in one year's time.

Due to concerns of the student representatives on the Senate Committee on Undergraduate Studies and the concerns of the Chemistry Student Society, the proposed mode of instruction in certain of the offerings of this course by means of a combination of tapes and tutorials was the subject of considerable discussion by the Senate Committee on Undergraduate Studies. When offered in this mode the course will have 12 components, for each of which there will be a tape of up to 45 minutes plus written material to be studied by the students. The students will cover roughly one component per week, would meet for 2 hours per week with the instructor, do weekly assignments and have regular quizzes. As a result, the Senate Committee on Undergraduate Studies concluded that the instructional methods to be employed when Dr. Lower conducts the course would be quite effective with the students who elected to take the course. In this connection, it should be noted that the course is not a required course for any program.

.....2...

With regard to the appropriateness of the 3-0-0 vector, it was noted by the committee that the course may be offered in the traditional lecture mode as well as in the audio-tutorial mode. Consequently, while recognizing that the 3-0-0 vector will not be an accurate description of the course for some of the offerings of the course, the committee found the proposed vector an acceptable description.

N. R. Reilly

:jeh

Scus 78-41

SIMON FRASER UNIVERSITY

MEMORANDUM

To H.M. EVANS - Secretary
Senate Committee on Undergraduate Studies

From N. Heath - Administrative Assistant to the Dean of Sciences

Subject New Course Proposed CHEMISTRY 465 - 3

Date 1978 09 05

The Faculty of Science approved the attached new course proposed at its meeting of the 19th of July 1978. The proposal has been circulated to other Faculties for overlap purposes and we have also received a statement from L. Thomas to the effect that no additional Library resources will be required for this course to be offered (see attached memo).

N. Heath

RECEIVED
SEP 8 1978
REGISTRAR'S OFFICE
MAIN DESK

Waiver requested

RATIONALE FOR CHEM 465

Although electrochemistry is basically a division of physical chemistry, it has applications in organic, analytical, inorganic and biological chemistry. The purpose of Chem 465 is to present the theory (beyond the limited amount taught in our core sequence) that students will need in order to understand and critically apply electrochemistry to these various areas.

Electrochemistry is, moreover, a discipline that makes contact with a number of other disciplines, such as industrial chemistry, metallurgy, engineering, environmental chemistry, etc. An important second purpose of Chem 465 is to acquaint our students with these cross-disciplinary applications. A commonly-heard criticism of Canadian majors and honors programs in chemistry is their lack of content relating to modern industrial and technological practice. This course would hopefully be a step toward alleviating this deficiency. In this connection it should be recalled that a large segment of B.C. industry is based on, or utilizes electrochemistry--both in the pulp/paper and extractive metallurgical sectors. The availability of a course such as Chem 465 that industrial scientists and managers would perceive to be of immediate application would enhance the attractiveness of our students in co-op programs, and for eventual employment.

The low frequency of offering of our present 400-level elective courses has led to considerable complaint on the part of our students, who are required to take a number of these courses in their degree programs. I have designed Chem 465 in a format that should make it practical to offer this particular course during semesters when the anticipated enrolment would not be large enough to warrant a regular offering. Thus, although I would like to nominally offer 465 every year or two in a more-or-less traditional format, I hope that I can make the course available in other semesters on a more individualized-study basis, and I am preparing the course materials with that goal in mind. This would enable students to take the course during the summer semester, for example--something that simply cannot be done now.

F-78-3

SENATE COMMITTEE ON UNDERGRADUATE STUDIES

NEW COURSE PROPOSAL FORM

1. Calendar Information

Department: CHEMISTRY

Abbreviation Code: CHEM Course Number: 465 Credit Hours: 3 Vector: *3-0-0

*A portion of the lecture component will be delivered by audio-tutorial means during semesters in which the course is given by S.K. Lower

Title of Course:

Calendar Description of Course: ELECTROCHEMISTRY

Theory of electrochemistry, and its applications to chemical and industrial processes. Interfacial potential and charge transfer at electrodes; mechanisms of electrode reactions. Nature and control of corrosion. Electrodeposition and electro-refining of metals; industrial electrochemical processes. Batteries, fuel cells, energy storage and conversion.

Nature of Course:
Lectures, problems and assigned readings.

Prerequisites: Chem 261 or equivalent background in thermodynamics.

What course (courses), if any, is being dropped from the calendar if this course is approved:
NONE

2. Scheduling

How frequently will the course be offered? Once a year.

Semester in which the course will first be offered? 79-2

Which of your present faculty would be available to make the proposed offering possible? Dr. S.K. Lower; Dr. B.L. Funt

3. Objectives of the Course

This course, which will be an upper-level elective in Chemistry, is intended to give students a good command of the basic theory of electrochemistry and electrode processes, as well as a broad view of its applications to other areas of chemistry, and to related disciplines such as material science, engineering and industrial practice.

4. Budgetary and Space Requirements (for information only)

What additional resources will be required in the following areas:

Faculty

Staff Nil

Library

Audio Visual

Space

Equipment

5. Approval

Date: 26 May 1978 78/09/07 31 Oct 1978

E.J. Wells
Department Chairman

Dean

Norman R. Reilly
Chairman, SCUS

SCUS 73-34b:- (When completing this form, for instructions see Memorandum SCUS 73-34a. Attach course outline).

OUTLINE OF ELECTROCHEMISTRY COURSE (CHEM 465-3)

EC1 THERMODYNAMICS OF REVERSIBLE ELECTRODE PROCESSES

Electron transfer reactions
Electrochemical cells
Chemical potential of charged species
the Electrode potential
Reversible EMF and the Nernst equation
Types of electrode systems
Standard electrode potentials
Experimental determination of EMFs and activities
Applications of EMF measurements
Concentration cells and transference
Liquid junction potentials
Membrane potentials and Donnan equilibrium

EC2 ELECTROLYTIC CONDUCTANCE

Nature of aqueous ionic solutions
Conductivity of solutions
Equivalent conductivity
The Arrhenius ionization theory
Applications of conductance measurements
Ionic migration
Transport numbers
Effects of the medium on conductivity
Factors influencing ionic mobilities
The ionic atmosphere

EC3 THE ELECTRIC DOUBLE LAYER

Basic laws of electrostatics
Electric potential
The Poisson equation
Potential differences at interfaces
Helmholtz model of the electric double layer
The diffuse double layer
Role of adsorbed ions: the Stern double layer
Present view of the electric double layer
Electrocapillarity
Double layers around colloidal particles
Electrokinetic phenomena
Electrophoresis
Electro-osmosis
Streaming potential
Sedimentation potential

EC4 IRREVERSIBILITY AND OVERVOLTAGE

Electrode polarization and overvoltage
Energetics of charge transfer at an electrode
Dependence of charge transfer rate on potential
Net reaction velocity and electrode potential
The Butler-Volmer equation: effect of overvoltage
Transport processes in the region of the electrode
Transport processes in the region of the electrode
Limiting current and diffusion overvoltage
Potential-current relations for complete cells

EC5 ELECTROCHEMICAL KINETICS

Factors influencing rate processes at electrodes
Electrodes as catalysts
Multi-step mechanisms
Kinetics involving double-layer structure
Electrode processes involving chemisorption
The hydrogen evolution reaction

EC6 CORROSION AND THE STABILITY OF METALS

Nature of corrosion
Corrosion cells
Kinetics of corrosion processes
Passivation
Anodic and cathodic control of corrosion
Corrosion properties of specific metals
Hydrogen damage to metals.

EC7 ORGANIC AND BIOLOGICAL ELECTROCHEMISTRY

Mechanisms of organic electrode processes
Cleavage of single bonds
Reduction of multiple bonds
Oxidation reactions

EC8 ELECTRODEPOSITION OF METALS

Nature of the metal surfact
Mechanisms of ion discharge
Kinetics of electrodeposition
Deposition of real crystals
Dendritic growth
Nature and quality of electrodeposits

EC9 CATHODIC INDUSTRIAL PROCESSES

Electroplating
Electrowinning and electrorefining of metals
Electrolysis of fused salts
Production of aluminum
Production of copper
Electroreduction

EC10 ANODIC INDUSTRIAL PROCESSES

Production of chlorine
Anodic oxidations
Electropolishing
Anodizing

EC11 ELECTROCHEMICAL CONVERSION AND STORAGE OF ENERGY

Primary cells
The Leclanche cell
Other primary cells
Secondary cells
The lead-acid cell
The Edison alkaline cell
Other secondary cells
Fuel cells
Hydrogen-oxygen fuel cell

READING LIST FOR CHEMISTRY 465-3

TEXT:

Bockris J.& Drazic D. Electrochemical Science
Barnes & Noble, N.Y., 1972.

Gives probably the best up-to-date view of electrochemistry in its broadest sense. Not really a textbook, but still the single most useful book for the beginner.

The electrochemical future; the structure of electric double layers; charge transfer; transport properties and the action of electrochemical cells; electrocatalysis and electrosynthesis; electrogrowth and electro-extraction; direct conversion of chemical energy to electrical energy; the electrochemical storage of electrical energy; the stability of metals; electrobiophysics.

Supplementary Reading

Conway, B.E. Theory and Principles of Electrode Processes
Ronald Press, N.Y., 1965 (QD553 C69)

-A moderately advanced treatment of electrochemical adsorption and kinetics.

Bockris, J.O'M & Conway, B.E. Modern Aspects of Electrochemistry
Plenum Press, N.Y.

-A series of volumes containing specialized papers by various authors.

Delahay, Paul. Double Layer and Electrode Kinetics.
Interscience, N.Y., 1965 (QD571 D43)

-A fairly advanced treatment of these two topics.

Eyring, Henry. Physical Chemistry: An Advanced Treatise.
Academic Press, N.Y.

Vol. 9A: Some aspects of the thermodynamics and transport behaviour of electrolytes; the electrical double layer; principles of electrode kinetics; techniques for the study of electrode processes; semiconductor electrochemistry.

Vol. 9B: Gas evolution reactions; the mechanism of deposition and dissolution of metals; fast ionic reactions; electrochemical energy conversion; fused-salt electrochemistry; bioelectrochemistry; kinetics of reactions with charge transport.

Fry, Albert J. Synthetic Organic Electrochemistry
Harper & Row, 1972 (QD273 F78)

-An excellent introduction to the use of electrochemistry in organic chemistry.

Milazzo, G. Electrochemistry
Elsevier, 1963 (QD 553 M513)

-General coverage of principles and industrial applications.

Potter, Edmund. Electrochemistry: Principles and Applications
Cleaver-Hume Press, London, 1956 (out of print) (QD553 P64)

-A well-written, non-rigorous treatment.

Vetter, Klaus. Electrochemical Kinetics
Academic Press, 1967 (QD553 V413)

-The definitive work on the subject, translated from the 1961 German edition. Rigorous treatment, many references, a large amount of experimental data.

Yaeser, E and Salkind, A. Techniques of Electrochemistry.
Wiley Interscience, 1972 (QD553 T4)

-A collection of papers by various authors. Emphasis is on the theory and applications of standard electrochemical techniques, suitable as introductions to nonspecialists in the field.

MacInnes, Duncan M. Principles of Electrochemistry
QD553 M2 1961

-A classic text.

Denaro, A.R. Elementary Electrochemistry
QD553 D44

SIMON FRASER UNIVERSITY

MEMORANDUM

cc. Calendar - Sarah - Hans - Dennis

To: H. Evans, Registrar

From: R. Frindt, Chairman, Physics UGCC

Subject: 1978-79 Physics Calendar Entry

Date: 1978-11-30

Anticipating that our Upper Levels Physics revision will be approved by Senate, it is our intention that our revised 300 level Physics Courses will be first offered in the Fall 1979.

We are planning to start our new 400 level Physics courses in the Fall, 1980.

Our present 400 level Physics courses will be offered for the last time in the Fall 1979 and Spring 1980. This will enable students entering their fourth year in the Fall 1979 to complete their programmes without disruption under the current requirements.

I therefore suggest that the 1979-80 Caldendar include the following:

1. Course descriptions for:

   PHYS 100-3, 120-3, 121-3, 131-2, 211-3, 221-3, 233-2, 234-2, 325-3, 326-3, 331-3, 332-3, 344-3, 345-3, 355-3, 384-3, 385-3, 413-3, 415-3, 425-3, 431-4, 432-4, 465-3, 484-3,
   NUSC 442-3, NUSC 485-3

2. A statement saying that the courses PHYS 413-3, 415-3, 425-3, 465-3, 484-3, NUSC 485-3 will commence in the Fall, 1980.

3. The following courses (listed in the 1978-79 Calendar) will be offered for the last time in the 1979-80 Session: PHYS 411-4, 412-4, 421-4, 465-4, 471-4. (Students should discuss their programme with a Physics Adviser).

RECEIVED
DEC 1 1978
REGISTRAR'S OFFICE
MAIL DESK

R. Frindt

R. Frindt

RF/jam

cc: Dean of Science
L. Kemp, Biology
Nick Heath