S.79-109

# SIMON FRASER UNIVERSITY

## MEMORANDUM

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|---|---|
| To SENATE | From SENATE COMMITTEE ON ACADEMIC PLANNING/ SENATE COMMITTEE ON UNDERGRADUATE STUDIES |
| Subject CURRICULUM CHANGES - NUCLEAR SCIENCE | Date OCTOBER 3, 1979 |

Action taken by the Senate Committee on Undergraduate Studies meeting of 11 September 1979 gives rise to the following motions. At its meeting on 3 October 1979 the Senate Committee on Academic Planning gave approval to Motion 2. SCAP approval is not required on either Motions 1 or 3.

MOTION 1 "That Senate approve, and recommend approval to the Board of Governors, the proposed new courses in Nuclear Science as outlined in Paper S.79-109 and listed below (and that the predecessor courses be discontinued as requested):

New Course Proposals:

1. NUSC 341-3 - An Introduction to Radio Chemistry with discontinuance of CHEM 341-3
2. NUSC 446-2 - Nuclear Chemistry Laboratory with discontinuance of CHEM 446-2
3. NUSC 342-3 - Introduction to Nuclear Science
4. NUSC 344-3 - Nucleosynthesis and Distribution of the Elements
5. NUSC 346-2 - Radiochemistry Laboratory
6. NUSC 444-3 - Special Topics in Nuclear Science."

MOTION 2 "That Senate approve, and recommend approval to the Board of Governors, the proposed Minor in Nuclear Science as specified in Paper S.79-109."

Note: Approval and offering of the courses in the previous motion is not contingent on the approval of the Minor. Whether or not the Minor is approved the field of Nuclear Science represents a common interest of faculty member in the departments of Chemistry and Physics. It is an important field of scientific inquiry and one appropriately identified on a student's transcript whether that student had taken one or two courses or a greater concentration of study in the field. This statement is not intended to diminish the argument for approval of the proposed Minor and such approval is recommended by the Nuclear Science Group, the Faculty of Science, the Senate Committee on Undergraduate Studies, and the Senate Committee on Academic Planning.

MOTION 3 "That Senate approve, and recommend approval to the Board of Governors, the proposed change in description and in prerequisite for NUSC 442-3 - Properties of Nuclear Matter, as set out in Paper S.79-109."

# SIMON FRASER UNIVERSITY SCUS 79-26

**MEMORANDUM**

| | |
|---|---|
| To: Mr. H.M. Evans, Secretary<br>SCUS | From: J.C. Irwin<br>Acting Dean of Science |
| Subject: PROPOSED NUCLEAR SCIENCE MINOR | Date: 1979 07 26 |

The enclosed Proposal for a Nuclear Science Minor was passed at a meeting of the Faculty of Science and is now being forwarded to you, for consideration and approval by SCUS at the earliest possible meeting.



J.C. Irwin

JCI/mgj

Enclosures

Registrar's Note: Revised dates for proposed first offerings will be presented

SIMON FRASER UNIVERSITY

MEMORANDUM



To Mr. Harry Evans, Registrar

From Colin Jones, Chairman, Chemistry Department

Subject Nuclear Science Minor

Date September 6, 1979

Further to our telephone conversation of today, this is to acknowledge that because of delays that have occurred en route we now anticipate that the Nuclear Science Minor, if granted appropriate approval, will be introduced in the Fall of 1980. As a result the following revised schedule for the introduction of courses should be included with the documentation and the appropriate changes made throughout.

| Fall 1980 | Spring 1981 | Summer 1981 | Fall 1981 |
|---|---|---|---|
| NUSC 341-3 | NUSC 342-3 | nil | (NUSC 341-3) |
| 344-3 | 346-3 | | ( 344-3) |
| 442-3 | 444-3 | | ( 442-3) |
| | 485-3 | | NUSC 446-2 |

We also acknowledge that where students have previously completed CHEM 341 or CHEM 446 that NUSC 341 and NUSC 446 would not be available for credit.

C.H.W. Jones

mc

cc: N. Heath

# SIMON FRASER UNIVERSITY

F-79-7

**MEMORANDUM**

| | | | |
|---|---|---|---|
| | Faculty of Science | From | N. Heath, Assistant to the Dean of Science |
| Subject | Nuclear Science | Date | 1979 04 26 |

At the meeting of 1979 03 27, the Faculty of Science Undergraduate Curriculum Committee approved the proposals listed below. These are now submitted to the Faculty for approval. The proposals were earlier approved by the Department of Chemistry. The Department of Physics has been consulted on the changes of calendar description and prerequisites for NUSC 442-3, which is currently listed in both the Chemistry and Physics sections of the University Calendar.

Proposed Minor Programme in Nuclear Science

New Course Proposals:

NUSC 341-3, An Introduction to Radiochemistry
NUSC 342-3, Introduction to Nuclear Science
NUSC 344-3, Nucleosynthesis and Distribution of the Elements
NUSC 346-2, Radiochemistry Laboratory
NUSC 444-3, Special Topics in Nuc.Sc.
NUSC 446-2, Nuclear Chemistry Laboratory

Revised Calendar Description and Prerequisite:

NUSC 442-3, Properties of Nuclear Matter

Enclosed for information (no changes):

NUSC 485-3, Particle Physics

# SIMON FRASER UNIVERSITY

## MEMORANDUM

| | | | |
|---|---|---|---|
| To | Dr. C.L. Kemp, Chairman<br>Faculty of Science<br>Undergraduate Studies Committee | From | Nuclear Science Group |
| Subject | Proposed Nuclear Science Minor | Date | March 26, 1979 |

The past decade has witnessed a substantial growth in the study and application of nuclear phenomena. This includes not only the investigation of the properties of the nucleus and the development of theories to account for these properties, but also the application of this newly acquired knowledge, for example in the development of new power sources and analytical tools for other disciplines. Given the present widespread interest in nuclear science, as evidenced by the lay public's interest in nuclear reactors by chemists and biologists in tracer and other techniques, and by physicists and chemists in the structure of the nucleus, it would appear an appropriate time to complete our course offerings at the upper level in this area and to offer a minor programme in nuclear science.

The introduction of this minor is also timely in the light of the ongoing development of the Tri-University Meson Facility (TRIUMF), located on the UBC campus. This collaborative facility is a national and international centre of excellence for research in the area of nuclear physics and chemistry and in applied programmes that stem from these. The mounting of a nuclear science minor at SFU will provide an important link between the undergraduate teaching programme and the major research programme at TRIUMF to which SFU faculty contribute.

The nuclear science minor would be, to our knowledge, the first of its kind in Canada and would serve to clearly identify Simon Fraser University as an important centre for the study of this subject. The courses comprising the minor span a range such that they should prove of benefit and interest both to non-specialists and to those considering a career in the nuclear field. Thus, some courses will emphasise the application of nuclear techniques and as such may prove of interest to students from other disciplines, including biology, biochemistry and kinesiology, while other courses will present a more detailed treatment of nuclear structure and theory for the specialist.

The minor programme includes the following nuclear science courses:

i) two existing unmodified courses Nusc 442-3 and Nusc 485-3;

ii) two existing modified courses Chem 341-3 and Chem 446-2 which are now also re-numbered;

iii) four new courses Nusc 342-3, Nusc 346-2, Nusc 344-3 and Nusc 444-3.

... 2

Registrar's Note:- For NuSc (Chem Phys) read NUSC (CHEM PHYS)

| | | |
|---|---|---|
| Nuclear Science 341-3 | An Introduction to Radiochemistry | (Chem 341 revised) |
| Nuclear Science 342-3 | An Introduction to Nuclear Science | (New) |
| Nuclear Science 344-3 | Nucleosynthesis and Distribution of the Elements | (New) |
| Nuclear Science 346-2 | Radiochemistry Laboratory | (New) |
| Nuclear Science 442-3 | Properties of Nuclear Matter | (Existing) |
| Nuclear Science 444-3 | Special Topics in Nuclear Science | (New) |
| Nuclear Science 446-2 | Nuclear Chemistry Laboratory | (Chem 446 revised) |
| Nuclear Science 485-3 | Elementary Particle Physics | (Existing) |

In addition the existing courses Chem 482-3 (Directed Study) and Phys. 385-3 (Modern Physics) are also included in the minor.

It is proposed that the new programme offerings would begin in Spring 1980 and that the following pattern of offerings would be followed for the nuclear science courses:

| Spring | Summer | Fall |
|---|---|---|
| Nusc 342-3 | nil | Nusc 341-3 |
| 346-2 | | (344-3) |
| 444-3 | | 442-3 |
| 485-3 | | 446-2 |

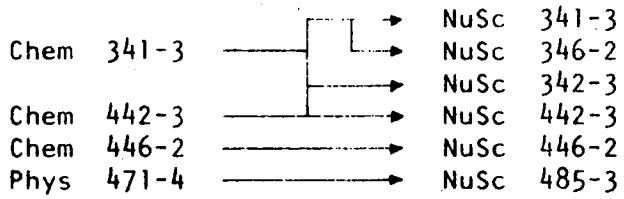
Of these Nusc 344-3 and Nusc 444-3 may be offered every second year depending on demand. Nusc 485-3 will be given by faculty from Physics and Chemistry in alternate years. It is anticipated that other faculty from Physics and from Biology may be involved from time to time in teaching in the nuclear science minor. The faculty from chemistry who will make a major contribution to teaching in this programme are Drs. D'Auria, Boal, Jones, and Korteling. The proposed minor will not involve the hiring of any new faculty since the interests of the present faculty in Chemistry and Physics span the theoretical and experimental material covered in these courses. The new laboratory course Nusc 346-2 will be offered in the same laboratory as Nusc 446-2.

# Proposal for a Minor Programme in Nuclear Science

## Nuclear Science Courses

| | | |
|---|---|---|
| Nuclear Science | 341-3 | An Introduction to Radiochemistry |
| Nuclear Science | 342-3 | An Introduction to Nuclear Science |
| Nuclear Science | 344-3 | Nucleosynthesis and Distribution of the Elements |
| Nuclear Science | 346-2 | Radiochemistry Laboratory |
| Nuclear Science | 442-3 | Properties of Nuclear Matter |
| Nuclear Science | 444-3 | Special Topics in Nuclear Science |
| Nuclear Science | 446-2 | Nuclear Chemistry Laboratory |
| Nuclear Science | 485-3 | Particle Physics |

## Relationship to Existing Courses




## The Minor Programme in Nuclear Science

Students must complete a minimum of 14 hours selected from the following courses:

NuSc 341-3
NuSc 342-3
NuSc 344-3
NuSc 346-2
NuSc 442-3
NuSc 444-3
NuSc 446-2
NuSc 485-3
Chem 482-3
Phys 385-3

## Nuclear Science Programmes

The following would be two examples of nuclear science programmes:

A. Programme for Biochemists and Biologists:

NuSc 341-3
NuSc 344-3
NuSc 346-2
NuSc 342-3
NuSc 444-3

B. Programme for Physicists and Honours Chemists (14 hours from):

NuSc 341-3
NuSc 342-3
NuSc 344-3
NuSc 442-3
NuSc 446-2
NuSc 485-3
NuSc 444-3
Phys 385-3

The detailed description of the courses is given in the following pages. Of these courses, NuSc 442-3 and NuSc 485-3 have already been approved by Senateand require no further action.* NuSc 341-3 and NuSc 446-2 involve changes in name and some of the course content. NuSc 342-3, NuSc 344-3, NuSc 346-2 and NuSc 444-3 must be created. The other courses in the minor, Chem 482-3 and Phys 385-3 will, of course, be unchanged.

* except for approval of the proposed changes to the calendar description and prerequisite statement of NUSC 442-3.

# SIMON FRASER UNIVERSITY

## MEMORANDUM

| | |
|---|---|
| C.L. Kemp, Chairman, Faculty of Science U.G.C.C. | From E.J. Wells, Chemistry |
| Subject NUSC Minor | Date 1979 03 27 |

I reply to one of the points raised in the F.U.G.C.C.'s discussion of our proposal for the Minor Programme in Nuclear Science.

Faculty Resources:

The Minor Programme proposed courses require the equivalent of 3/4 of a faculty teaching load per year from this Department, assuming that NUSC 485-3 is covered every other year by faculty from Physics. This load is more than accomodated by the reduction in frequency of offering from 79-3 on of our third year courses from twice to once per year:

| | |
|---|---|
| CHEM 361-3 | CHEM 332-3 |
| CHEM 362-3 | CHEM 341-3 |

This will result in the students gaining a wider selection of courses at the cost of a little more care in planning. In addition, individual faculty in Physics have expressed interest in offering occasionally NUSC 344-3, Nucleosynthesis, and NUSC 444-3, Special Topics, which would reduce the incremental load on Chemistry.

N Weath

for E.J. Wells

SENATE COMMITTEE ON UNDERGRADUATE STUDIES

NEW COURSE PROPOSAL FORM

1. Calendar Information

Department: Chemistry

**Abbreviation Code:** NUSC **Course Number:** 341 **Credit Hours:** 3 **Vector:** 3-1-0

**Title of Course:** An Introduction to Radiochemistry

**Calendar Description of Course:** Brief description of the nucleus and its decays and reactions; interaction of radiation with matter; nuclear instrumentation; radioisotopes in chemistry; activation analysis and related analytical techniques; other applications of nuclear techniques; nuclear reactors and nuclear fusion.

**Nature of Course** Lecture/tutorial

**Prerequisites (or special instructions):**

Normally sixty hours credit in Science, including first year calculus, physics and chemistry. Students with credit for CHEM 341-3 cannot take this course for further credit

**What course (courses), if any, is being dropped from the calendar if this course is approved:**

Chem 341-3

2. Scheduling

**How frequently will the course be offered?** Once annually

**Semester in which the course will first be offered?** 80-3

**Which of your present faculty would be available to make the proposed offering possible?**

Drs. D'Auria, Jones, Korteling

3. Objectives of the Course

To provide the student with a sound introduction to radioisotopes, their properties and applications in chemical studies.

4. Budgetary and Space Requirements (for information only)

**What additional resources will be required in the following areas:**

| | |
|---|---|
| **Faculty** | Nil |
| **Staff** | Nil |
| **Library** | Nil |
| **Audio Visual** | Nil |
| **Space** | Nil |
| **Equipment** | Nil |

5. Approval

**Date:** 22 Feb 79 July 16, 11

Dan R Birch

SEP 11 '79

**Department Chairman** **Dean** **Chairman, SCUS**

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

Nuclear Science 341-3 — An Introduction to Radiochemistry

Calendar Description:

Brief description of the nucleus and its decays and reactions; interaction of radiation with matter; nuclear instrumentation; radioisotopes in chemistry; activation analysis and related analytical techniques; other applications of nuclear techniques; nuclear reactors and nuclear fusion.

Prerequisite: Normally sixty hours credit in Science, first year calculus, physics and chemistry.

Course Outline:

1. The Nucleus
   An introduction to Radioactive Decay
   Nuclear Reactions

2. Kinetics of Radioactive Decay

3. Interaction of Radiation with matter
   Radⁿ. Chemistry and Health Considerations

4. Radⁿ. Detectors and instrumentation
   Statistics and Counting

5. Radioisotopes in Chemistry
   Isotope Effects
   General principles in working with radioisotopes
   $^{14}C$ and $^{3}H$ as tracers in organic and biochemistry
   (labelling, counting, degradation.)
   Applications in inorganic systems—exchange reactions, chemistry of the transuranium elements (synthesis, isolation, properties).
   Applications of radioisotopes in medicine

6. Radiometric analysis
   Activation analysis
   Isotope dilution analysis
   X-Ray fluorescence analysis

cont'd

Nuclear Science 341-3 (cont'd)

7. Applications of Nuclear Techniques

   Chemical effects of nuclear reactions and radioactive decay

   Hot-atom chemistry

   Positrons as a chemical probe

   Chemical effects on half-lives

   Mössbauer spectroscopy

8. Nuclear Reactors and Nuclear Fusion

   General Principles

   Radioisotope methodology and the re-processing of fuel elements.

Textbook (recommended)

Introduction to Nuclear Physics & Chemistry
by B.G. Harvey, Prentice-Hall (1969).

SENATE COMMITTEE ON UNDERGRADUATE STUDIES

NEW COURSE PROPOSAL FORM

1. Calendar Information

Department: Chemistry

**Abbreviation Code:** NuSc **Course Number:** 342 **Credit Hours:** 3 **Vector:** 3-1-0

**Title of Course:** Introduction to Nuclear Science

**Calendar Description of Course:**

A review of nuclear properties and systematics. Properties of the nuclear force; shell model and structure of complex nuclei; nuclear decay via particle emission and spontaneous fission; experimental description of nuclear reactions; nucleon-nucleus and heavy ion reactions.

**Nature of Course** Lecture/tutorial

**Prerequisites (or special instructions):**

NuSc 341-3 or permission of the department; Math 253-4 recommended.

**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 annually

**Semester in which the course will first be offered?** ~~80-1~~ 81-1

**Which of your present faculty would be available to make the proposed offering possible?**

Drs. D'Auria, Boal, Jones, Korteling

3. **Objectives of the Course**

The course will serve as an introduction to nuclear phenomena in general. The material will be taught largely from the phenomenological point of view and will not require quantum mechanics.

4. **Budgetary and Space Requirements** (for information only)

**What additional resources will be required in the following areas:**

| | |
|---|---|
| **Faculty** | Nil |
| **Staff** | Nil |
| **Library** | Nil |
| **Audio Visual** | Nil |
| **Space** | Nil |
| **Equipment** | Nil |

5. **Approval**

**Date:** 22 Feb 79

Dan R Birch

Department Chairman

Dean

SEP 11 '78

Chairman, SCUS

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

Nuclear Science 342-3 — Introduction to Nuclear Science

Calendar Description:

A review of nuclear properties and systematics, properties of the nuclear force; shell model and structure of complex nuclei; nuclear decay via particle emission of nuclear reactions; nucleon-nucleus and heavy ion reactions.

Prerequisite: NuSc 341 or permission of the department; Math 253-4 recommended.

Course Outline:

1. Nuclear concepts and systematics

   elementary quantum concepts
   nuclear size and properties
   energetics
   nuclear spin, moments and other special properties
   radioactive decay

2. Nuclear structure

   introduction to:
   nuclear force
   shell model
   structure of complex nuclei
   other representations of nuclear matter (liquid drop, Fermi gas models)

3. Nuclear decay

   experimental descriptions of: (nuclear spectroscopy)
   alpha decay
   beta decay
   gamma decay
   nucleon emission
   spontaneous fission

4. Nuclear reactions

   experimental description of:
   elastic and inelastic scattering
   reaction cross section
   compound nucleus formation and decay
   direct reactions
   resonance reactions
   heavy ion reactions
   induced fission

5. Related topics of interest

   brief description of:
   elementary particles
   particle accelerators
   super-heavy elements
   nuclides far from stability

Textbook (recommended): Introduction to Nuclear Physics & Chemistry by B.G. Harvey, Prentice-Hall
or Introduction to Nuclear Physics by H. Enge, Addison Wesley

SENATE COMMITTEE ON UNDERGRADUATE STUDIES

NEW COURSE PROPOSAL FORM

1. Calendar Information

Department: Chemistry

Abbreviation Code: NuSc Course Number: 344 Credit Hours: 3 Vector: 3-1-0

Title of Course: Nucleosynthesis and Distribution of the Elements

Calendar Description of Course: This course is intended to explore in detail the formation and distribution of the chemical elements in the early universe, in present stellar environments, in the solar system and through cosmic ray interactions. The nuclear reactions required in these systems to explain present elemental abundances and isotopic ratios will be presented. Radiometric chronology techniques, providing the time frame of reference, will also be discussed quantitatively.

Nature of Course: Lecture/tutorial

Prerequisites (or special instructions):

Normally sixty hours credit in Science, including first year calculus, physics and chemistry.

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 annually

Semester in which the course will first be offered? 80-3

Which of your present faculty would be available to make the proposed offering possible? Drs. Boal, D'Auria, Korteling and Jones

3. Objectives of the Course

The course will provide an overview of current models for the synthesis of the elements and their distribution in the universe, and will complement NuSc 341-3 and NuSc 342-3.

4. Budgetary and Space Requirements (for information only)

What additional resources will be required in the following areas:

| | |
|---|---|
| Faculty | Nil |
| Staff | Nil |
| Library | Nil |
| Audio Visual | Nil |
| Space | Nil |
| Equipment | Nil |

5. Approval

Date: 22 Feb 79

Dan R Birch

E.J. Wells

Department Chairman

Dean

SEP 11 79

Chairman, SCUS

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

Chem 344-3 — Nucleosynthesis and Distribution of the Elements

Calendar Description:

This course is intended to explore in detail the formation and distribution of the chemical elements in the early universe, in present stellar environments, in the solar system and through cosmic ray interactions. The nuclear reactions required in these systems to explain present elemental abundances and isotopic ratios will be presented. Radiometric chronology techniques, providing the time frame of reference, will also be discussed quantitatively.

Normally sixty hours credit in

Prerequisite: Science, including first year calculus, physics and chemistry.

Course Outline:

1. Review of basic concepts of nuclear science
   - Radioactive decay and nuclear instability
   - Nuclear Reactions
2. Elemental abundances and isotopic ratios in the universe
   - Methods
   - Isotope Effects
   - The Earth
   - Meteorites and the Moon, Mars and Venus
   - Stellar Atmospheres
   - Cosmic Rays
3. Elemental Production in the Early Universe
   - "Big Bang' Models and Evidence
   - Nucleosynthesis
   - Light nuclei and isotopic ratios
4. Stellar Nucleosynthesis
   - Stellar Evolution
   - Hydrogen, Helium, Carbon burning
   - The R and S processes
   - Explosive nucleosynthesis
   - Neutrinos from Space
5. Nuclide Production by Cosmic Rays
6. Radionuclides in the Environment
7. Radiometric Chronology Techniques
   - The Age of the Universe
   - Early Solar System
   - Early History of the Earth
   - Minerals and Meteorites
8. Isotope ratio Studies
9. The man-made elements
10. Superheavy elements

Recommended Reading List

Books (in Library)

D.D. Clayton, *Principles of Stellar Evolution and Nucleosynthesis*, McGraw-Hill, 1968.

L.H. Aller, *The Abundance of the Elements*, Interscience Pubs., New York, 1961.

S. Weinberg, *The First Three Minutes: A Modern View of the Origin of the Universe*, Basic Pub., 1976. (not in library)

B.S.P. Shen, *High Energy Nuclear Reactions in Astrophysics*, Benjamin, Inc., 1976.

Articles

D.D. Clayton, *The Origin of the Elements*, Phys. Today, 22 (1969) 28.

P.H. Fowler, *Evolution of the Elements*, Proc. Ray. Soc. Ser., A329 (1972) 1.

D.N. Schramm and R.V. Wagoner, *Element Production in the Early Universe*, Ann. Rev. Nucl. Science 27 (1977) 37.

G.W. Wetherill, *Radiometric Chronology of the Early Solar System*, Ann. Rev. Nucl. Science, 25 (1975) 283.

J. Selbin, *The Origin of the Chemical Elements, 1*, J. Chem. Ed., 50 (1973) 306; *The Origin of the Chemical Elements 2, ibid.* 50 (1973) 381.

C. Ralfs and H.P. Trantvetter, *Experimental Nuclear Astrophysics*, Ann. Rev. Nucl. Science, 28 (1978) 115.

R.C. Clayton, *Isotopic Anomalies in the Early Solar System*, 28 (1978) 501. ??

M.M. Shapiro and R. Silberberg, *Heavy Cosmic Ray Nuclei*, Ann. Rev. Nucl. Science 20 (1970) 323.

SENATE COMMITTEE ON UNDERGRADUATE STUDIES

NEW COURSE PROPOSAL FORM

1. Calendar Information

Department: Chemistry

Abbreviation Code: NUSC Course Number: 346 Credit Hours: 2 Vector: 0 1 0

Title of Course: Radiochemistry Laboratory

Calendar Description of Course: Introduction to the techniques of radiochemistry; proportional and Geiger counters; sample preparations and half-life measurement; synthesis and separation of labelled compounds; β and γ-ray spectroscopy; choice of more advanced experiments, illustrating the use of radioisotopes and nuclear techniques.

Nature of Course Laboratory

Prerequisites (or special instructions):

Prerequisite: NuSc 341-3

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 annually

Semester in which the course will first be offered? ~~80-1~~ 81-1

Which of your present faculty would be available to make the proposed offering possible? Drs. D'Auria, Jones, Korteling

3. Objectives of the Course

This laboratory course is designed to complement NuSc 341-3. It will provide the student with particular examples of the techniques described in NuSc 341-3.

4. Budgetary and Space Requirements (for information only)

What additional resources will be required in the following areas:

| | |
|---|---|
| Faculty | Nil |
| Staff | Nil |
| Library | Nil |
| Audio Visual | Nil |
| Space | Nil |
| Equipment | $15,000 |

5. Approval

Date: 22 Feb 79

Dan R Birch

Department Chairman

Dean

Chairman, SCUS

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

Nuclear Science 346-2 — Radiochemistry Laboratory

Calendar Description:

Introduction to the techniques of radiochemistry; proportional and Geiger counters; sample preparations and half-life measurements; synthesis and separation of labelled compounds; $\beta$ and $\gamma$-ray spectroscopy; choice of more advanced experiments.

Prerequisite: NuSc 341-3

Course Outline:

Basic Experiments

1. Counting Statistics
2. Characteristics of a proportional and Geiger counter
3. Sample preparations for $\beta$ and $\gamma$-counting—self absorption and scattering phenomena
4. Study of transient and secular equilibrium—half life measurements
5. Synthesis and separation of labelled compounds (paper and column chromatography)
6. Simple $\beta$ and $\gamma$-ray spectroscopy

Further experiments from which a choice may be made:

7. Study of the kinetics of exchange reactions
8. Elucidation of a reaction mechanism—liquid scintillation counting
9. Separation of nuclear isomers
10. Neutron activation analysis and Relative Neutron capture cross sections
11. Mössbauer spectroscopy
12. X-Ray fluorescence spectroscopy
13. Radiation decomposition of chemical compounds—the Fricke dosimeter

Textbook:

An appropriate laboratory manual would be prepared and made available.

SENATE COMMITTEE ON UNDERGRADUATE STUDIES

NEW COURSE PROPOSAL FORM

Calendar Information

Department: Chemistry

Abbreviation Code: NUSC Course Number: 444 Credit Hours: 3 Vector: 3-0-0

Title of Course: Special Topics in Nuclear Science

Calendar Description of Course: Advanced topics in Nuclear Science, to be chosen from one of the following areas: 1. Reactions involving heavy ions at intermediate and high energy; 2. Applications of nuclear science in biochemistry and the medical field; 3. Advanced applications of nuclear techniques in chemistry; positron annihilation, muons and pions as chemical probes, Mössbauer spectroscopy; 4. Nuclear reactors; 5. Studies of nuclides far from stability.

Nature of Course Lecture/tutorial

Prerequisites (or special instructions): NuSc 342-3 or NuSc 442-3 or permission of the department.

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? As required

Semester in which the course will first be offered? 81-1

Which of your present faculty would be available to make the proposed offering possible? Drs. Boal, D'Auria, Jones, Korteling, and Dr. Arrott (Physics)

Objectives of the Course

The course will provide the serious strudent with an opportunity of pursuing areas of particular interest to him at a more advanced level. The topics will cover frontier aspects of nuclear science in chemistry, physics and biology.

4. Budgetary and Space Requirements (for information only)

What additional resources will be required in the following areas:

| | |
|---|---|
| Faculty | Nil |
| Staff | Nil |
| Library | Nil |
| Audio Visual | Nil |
| Space | Nil |
| Equipment | Nil |

5. Approval

Date: 22 Feb 79

Department Chairman

Dean

Chairman, SCUS

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

Nuclear Science 444-3 — Special Topics in Nuclear Science

Calendar Description:

Advanced topics in Nuclear Science to be chosen from among the following areas: 1. Reactions involving heavy ions at intermediate and high energies; 2. Applications of Nuclear Science in biochemistry and the medical field; 3. Advanced applications of nuclear techniques in chemistry: positron annihilation, muons and pions as chemical probes, perturbed angular correlations, Mössbauer spectroscopy; 4. Nuclear reactors; 5. Studies of nuclides far from stability.

Prerequisite: NuSc 342-3 or NuSc 442-3
or permission of the department.

SENATE COMMITTEE ON UNDERGRADUATE STUDIES

NEW COURSE PROPOSAL FORM

1. Calendar Information

Department: Chemistry

Abbreviation Code: NUSC Course Number: 446 Credit Hours: 2 Vector: 0-0-4

Title of Course: Nuclear Chemistry Laboratory

Calendar Description of Course:

Nuclear spectroscopy and advanced nuclear instrumentation; techniques of alpha, beta and gamma ray spectroscopy; choice of more advanced experiments.

Nature of Course Laboratory

Prerequisites (or special instructions):

Prerequisite: NuSc 342-3 or NUSC 442-3 must precede or be taken concurrently. NUSC 346-2 is also recommended. Students with cred. for CHEM 446-3 cannot take this course for further credit

What course (courses), if any, is being dropped from the calendar if this course is approved: Chem 446-3

2. Scheduling

How frequently will the course be offered? Once annually

Semester in which the course will first be offered? ~~80-3~~ 81-3

Which of your present faculty would be available to make the proposed offering possible? Drs. D'Auria, Jones, Korteling

3. Objectives of the Course

This laboratory course will illustrate the principles presented in NuSc 342-3 and several advanced experimental techniques in nuclear science will be explored.

4. Budgetary and Space Requirements (for information only)

What additional resources will be required in the following areas:

| | |
|---|---|
| Faculty | Nil |
| Staff | Nil |
| Library | Nil |
| Audio Visual | Nil |
| Space | Nil |
| Equipment | $25,000 |

5. Approval

Date: 22 Aug 79

Dan R Birch

Department Chairman

Dean

SEP 11 79

Chairman, SCUS

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

Nuclear Science 446-2 — Nuclear Chemistry Laboratory

Calendar Description:

Nuclear spectroscopy and advanced nuclear instrumentation; techniques of alpha, beta and gamma-ray spectroscopy; choice of more advanced experiments.

Prerequisite: NuSc 342-3 or NUSC 442-3 must precede or be taken concurrently. NUSC 346-2 is also recommended.

Basic Experiments

1. Gamma Spectroscopy (General)
2. Alpha Spectroscopy (General)
3. Beta Spectroscopy (General)

Elective Experiments

4. Energy loss by charged particles
5. Lifetimes of nuclear states
6. Coincidence measurements
7. Conversion electron ratios
8. Compton scattering
9. Rutherford scattering
10. A choice of other experiments which may vary from semester to semester

Textbook:

An appropriate laboratory manual would be prepared and made available.

SENATE COMMITTEE ON UNDERGRADUATE STUDIES

CHANGE OF CALENDAR DESCRIPTION AND PREREQUISITE ONLY

1. Calendar Information

Department: Chemistry

Abbreviation Code: NUSC Course Number: 442 Credit Hours: 3 Vector: 3-1-0

Title of Course: Properties of Nuclear Matter

Calendar Description of Course:

Theoretical approach to the nucleus and its reactions; shell model of nuclear energy levels; collective motion of the nucleus; theory of nuclear decay processes; systematics of nuclear reactions; introduction to the quantum theory of scattering; exotic atoms.

Nature of Course

Prerequisites (or special instructions):

Chem 361-3 or Phys 385-3; NuSc 342-3 is recommended

What course (courses), if any, is being dropped from the calendar if this course is approved: This is a calendar description revision only. No new course is being introduced, nor is the course content being changed.

2. Scheduling

How frequently will the course be offered?

Semester in which the course will first be offered? ~~F 73~~

Which of your present faculty would be available to make the proposed offering possible?

3. Objectives of the Course

4. Budgetary and Space Requirements (for information only)

What additional resources will be required in the following areas:

Faculty

Staff

Library

Audio Visual

Space

Equipment

5. Approval

Date: 22 Feb 79

Dan R Birch

SEP 11 79

E.J. Wells

Department Chairman

Dean

Chairman, SCUS

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

Nuclear Science 442-3 — Properties of Nuclear Matter

Calendar Description: Theoretical approach to the nucleus and its reactions; shell model of nuclear energy levels; collective motion of the nucleus; theory of nuclear decay processes; systematics of nuclear reactions; introduction to the quantum theory of scattering; exotic atoms.

Prerequisites: Chem 361-3 or Phys 385-3. NuSc 342-3 is recommended.

Course Outline:

1. Mathematical preliminaries
   - relativistic energy expressions
   - spin formalism
2. Introduction to elementary particles
   - baryon number, isospin, etc.
   - particle masses and classification
   - vector addition of isospin
3. Nuclear sizes and energies
4. Review of Schrödinger Equation
   - separation of angular variables
   - angular momentum
   - spherical harmonics
   - particle in a square well
5. Nucleon-nucleon force
   - charge independence
   - some model potentials
   - one particle exchange potentials
6. Nuclear masses
   - semi-empirical formulae
   - role of various interactions
7. Shell Model
   - harmonic oscillator solutions and square wells
   - energy levels and spin assignments
   - *rough* description of wave functions
   - rotations and vibrations in nuclei
   - collective motion in even-even nuclei
8. Nuclear decay
   - strong interactions and quarks
   - electromagnetic decays
   - introduction to the weak interaction and β-decay

cont'd

9. Strong Interaction decays

   review of tunnelling phenomena
   nucleon emission
   alpha emission
   fission

10. Electromagnetic decays

   multipole moments
   decay rates and comparison with experiment

11. Nuclear reactions

   energetics and Q-values
   partial wave analysis and reaction cross section
   nuclear resonances
   optical model

12. Exotic atoms

   muonic atoms
   pionic atoms
   muonium

Textbook (required):

   Introduction to Nuclear Physics
   by H. Enge, Addison Wesley.

Nuclear Science 485-3 Particle Physics

Calendar Description:

Will not be listed until 1980-81 term.

Prerequisites: Chem 361-3 or Phys 385-3 or permission of the Department. PHYS 415-3 is a recommended prerequisite.

Course Outline:

1. Symmetry Principles and Conservation Laws: space-time symmetries and PCT Theorem; internal symmetries, strangeness, charm, beauty, etc.; conservation of electric charge, baryon number, etc.; particles and anti-particles.

2. The electromagnetic interaction. The Golden rule. Photon emission and absorption. Electromagnetic scattering of Leptons. Photon-hadron interactions. Introduction to QED.

3. Weak interactions. β-Decay phenomenology. Fermi's theory of weak interactions. A survey of weak processes. Leptonic, semi-leptonic and hadronic weak decays. Weak currents of Leptons, Cabibbo angle. A brief introduction to gauge theories. Neutral weak currents.

4. The strong interaction physics. Pion-Nucleon scattering. Properties of Nucleon-Nucleon force. Hadronic processes at high energies, scaling. Quark model and SU(N) classification schemes. Mass formulas.

Textbook required:

Sub-Atomic Physics, by M. Frauenfelder, E. Henley.