UNIVERSITY OF MINNESOTA
Graduate School
Minutes of the Executive Committee
Wednesday, November 24, 1965
11:30 A.M Campus Club

Present: Professors James J. Jezeski, George Seltzer, Warren E. Ibele, Maynard C. Reynolds; Drs. Leslie Zieve, R. Drew Miller; Deans Thomas W. Chamberlin, Francis M. Boddy, Millard L. Gieske; Dean Bryce Crawford, Jr., presiding; Mrs. Shirley McDonald, secretary.

1. Proposed Programs

A. M.S. & Ph.D. in Hydrogeology - Proposal is before the Physical Sciences Group Committee.

B. M.S. in Organic Chemistry - Duluth - Professor Ibele reported that the Physical Sciences Group Committee favors approval of the program but with the strong recommendation that another research-oriented organic chemist be added to the staff as soon as possible. Professor Ibele explained that Physical Chemistry and Inorganic Chemistry are so interrelated that they can support one another, while Organic Chemistry is a more separate area and would, therefore, benefit by the added strength another organic chemist could supply.

The Executive Committee agreed that the program should be initiated and approved the M.S. in Organic Chemistry, calling attention to the above stipulation. Dean Crawford will transmit the recommendation to the appropriate administrative personnel at Duluth.

C. M.S. & Ph.D. in Veterinary Surgery and Radiology
M.S. & Ph.D. in Veterinary Obstetrics & Gynecology - Dr. Zieve reported that the Medical Sciences Group Committee would like to have additional information about these programs before making a recommendation. An account of typical programs involved in each area and how they would differ from other programs in the Veterinary fields would be useful to the committee in its deliberations. Dean Gieske will write the appropriate departments and ask that they supply more particulars as to programs, faculty, and the like.

Professor Jezeski said that the Agricultural Sciences Group Committee did recommend adoption of the programs since one of their committee members, in the area of Veterinary Medicine was able to explain the proposed programs in greater detail. The item will be carried forward.

D. The Minor in Biomedical Science - This proposal has been favorably received by the Medical Sciences and Physical Sciences Group Committees. This minor involves a joint program in cardiovascular training between Surgery and Mechanical Engineering. The surgeon working on his Ph.D. would complete a certain

number of credits in Mechanical Engineering and would receive a minor in that field, while the Engineering Ph.D. student completing a portion of his work in the biomedical area would get his minor in Biomedical Sciences.

The Executive Committee voted and approved that the minor in Biomedical Science be established. A copy of the complete proposal is filed with the permanent file of these minutes.

3. Mechanical Engineering Programs in Rochester - The proposal that graduate work in Mechanical Engineering by closed circuit TV at Rochester be initiated Winter Quarter 1966 has been reviewed by a subcommittee. Professor Ibele, for the subcommittee, reported: (1) that students taking these courses must be admitted to the Graduate School by regular admissions procedures; (2) that the courses will be regular day school offerings; (3) that, although this experiment has been requested by the IBM Company, the program will be open to other qualified graduate students; (4) that the students make frequent visits to the Minneapolis Campus to confer with advisers on programs, Plan B papers, etc.; (5) that if students are enrolled under Plan A, they must be in residence on the Minneapolis Campus for the thesis research. Any "off-campus" thesis research, Dean Crawford pointed out, occurs only in those rare instances where a facility or laboratory is not available at Minnesota. Such cases require prior approval and must meet all of the other conditions required for thesis research as well.

   Since this program is, in actuality, the same one offered on Campus, no Executive Committee approval is required. A copy of the Subcommittee's report is filed with the permanent file of these minutes.

4. Joint Registration between the Graduate School and General Extension Division - Dean Gieske reported that Admissions and Records, the Graduate School, and the Extension Division are completing work on mechanics for joint registration. (refer to Executive Committee Minutes, Nov. 2, 1965, item 2b). He has also prepared a draft for copy for the Extension Division Bulletin.

   Questions of admission, course approval, and Graduate Faculty appointment are clear. However, the amount of credit allowable through joint registration and the transfer of credit through Extension and Adult Special status still need to be considered. Dean Crawford asked Dean Gieske to draft a statement covering these questions for the Group Committees' use in their discussions.

5. Graduate Faculty Appointments at Duluth and Morris - Although there are no graduate programs at Morris, there has been a request that Graduate Faculty status be approved for a Morris faculty member so that he may teach an Extension course for which qualified students may petition for graduate credit. Professor Reynolds said that the Education Group Committee recommended approval, but suggested that there be a "total" discussion in the Executive Committee regarding the possibility of offering selective graduate courses at Morris through the Extension Division.

Dean Crawford then referred to the nominating process. While nominations are usually made by department heads or someone representing the Graduate Faculty in the field of the nomination, any member of the Graduate Faculty can make nominations. The Graduate School staff will attempt to inform department heads of such nominations before they are submitted to the Group Committees so that consultation with departmental Graduate Faculty can be effected if desirable.

6. Group Committee Structure - Dean Crawford distributed a summary showing approximate numbers of student programs, petitions, and faculty nominations acted upon by the various group committees between January and October, 1965. The summary will also be sent to all of the group committee members. The dean pointed out that while these figures cannot be completely accurate (because of recent changes in procedures in the G.S.) they can give some idea of the group committee work load. Fall quarter, 1965, may be more indicative and figures will be circulated as soon as they can be acquired.

Dean Crawford mentioned comments on the subject of Group Committee re-structuring he had received from Professors Renaud and Reynolds. The Language, Literature, and Art Group Committee emphasized the importance of the individual and interdepartmental aspects of the group committee work. Professor Reynolds made some suggestions on how the group committee work might be handled more efficiently in the Education area. He said that the volume of student programs and faculty nominations is so great in this group committee, that the committee does not have the time to monitor curriculum proposals as well as they would like. Another problem is the lack of representatives for certain fields. Perhaps a division of the workload between student papers and curriculum business might work more effectively. Or, the creation of a larger committee which would divide the work between subcommittees might help. Professor Reynold's letter will be duplicated and sent to the Executive Committee for use in their group committee discussions.

Professor Jezeski spoke about certain programs reviewed by the Agricultural Sciences Group Committee which could also be referred to other group committees for consideration; e.g., a Home Economics major with some emphasis also in the Social Sciences.

Professor Seltzer asked about policy in respect to certain group committee business. It would be helpful if "rules of thumb" for handling various phases of the work could be communicated to the group committees. Dean Gieske will draft a short statement covering general practices and present it for discussion at the January Executive Committee meeting. Professor Seltzer said that it would be more convenient for the graduate student on the West Bank if a supply of current Graduate School forms could be available there. The staff will check into this possibility.

7. Ph.D. Candidacy - A draft of a subcommittee (of the ad hoc Committee on Ph.D. Candidacy) report was distributed to the Executive Committee members. Copies of this draft were sent to the full ad hoc committee earlier. Copies will also be attached to these minutes.

   The points in this draft were not discussed by the Executive Committee, but it was emphasized that the draft does not represent a progress report, but indicates some of the directions in which the subcommittee is thinking. Dean Crawford asked that the group committees transmit any comments and ideas on the subject to Professor S. W. Fenton, chairman of the ad hoc committee, or to the Graduate School.

8. Permit to Register - Dean Crawford supplied the Executive Committee with copies of a letter from John Haugland in which he makes a number of suggestions in respect to a permit to register for each graduate student. The Graduate School staff will be working out methods by which such a permit can become a reality and a more definitive report will be forthcoming. Any suggestions coming out of the group committee discussions will be helpful.

9. Proposed Modifications in Requirements for Written Preliminary Examinations in Mineral and Metallurgical Engineering - A letter from Professor S. R. B. Cooke in which he spells out certain modifications in the requirements for the written preliminary examinations has been referred to the Physical Sciences Group Committee. Professor Ibele stated that there will be a recommendation after their next meeting. Since it is not necessary to have Executive Committee action, Professor Ibele will communicate the recommendation to the Graduate School and Professor Cooke.

The date for the next Executive Committee Meeting was set for December 21.

Respectfully submitted,

Shirley McDonald,
Secretary

December 1, 1965

November 30, 1965

Dean Thomas W. Chamberlin
Administration
University of Minnesota - Duluth
Duluth, Minnesota 55812

Dear Tom:

I'm writing to record, what you of course know from your sitting with the Executive Committee of the Graduate School, that approval was voted for an M.S. major in Organic Chemistry at Duluth. This is effective immediately, and should be helpful to the student already in residence who wishes to pursue this major.

There were some reservations brought out in the review of the proposal which I would like to pass on to you, so that you may take them into account in continuing to develop the programs at Duluth. The principal concern is that at the present time we have in the Duluth department only one faculty member with a research orientation in Organic Chemistry, and indeed he is a new man just beginning with us. It is in fact something of an imposition on Dr. Caple to ask him, in his first year at Duluth, to offer two organic courses, begin his own research program, and work with a Master's candidate. However, this will probably not be intolerable, and we must start somewhere. But in looking to the future, I do hope that it will be possible to increase the strength in the field of Organic Chemistry, and more particularly to add another organic faculty member with research orientation in the near future. It was pointed out that, the nature of chemistry in its several fields being what it is, the desirable mutual stimulation and support which can be shared among the physical and inorganic faculty — and shared also with the analytical members — does not include the organic chemist in anything like the same degree. Thus, while the three research oriented chemistry faculty members in physical, analytical, and inorganic chemistry do support each other, it does seem highly desirable that a second organic chemist be added to provide similar interaction within this somewhat more separate branch of chemistry.

I hope these thoughts and remarks will be helpful to you as you continue to develop increasing strength in the programs at Duluth. I must say that I think the way in which the chemistry programs have been developed over the last few years has been a model of intelligent planning and development, with appropriate interaction between the Duluth and Minneapolis campuses. I hope that we can continue to move forward in this pattern.

With all good wishes,

Sincerely yours,

Bryce Crawford, Jr.
Dean

BLC/jw

cc Provost Raymond W. Darland
Professor Stuart W. Fenton
Dr. William R. McEwen
Dr. Francis B. Moore
Professor William E. Parham

UNIVERSITY OF MINNESOTA
INSTITUTE OF TECHNOLOGY
MINNEAPOLIS 14

November 17, 1965

To: Dean Bryce Crawford

From: W. E. Ibele

Subject: Proposed M.S. (Plan A) in Organic Chemistry, Duluth

Attached is a memorandum authored by Prof. Ray Dodson setting forth in substance, the Group Committee's recommendations. The proposal was discussed at length and approval is recommended. The committee believes it essential however that the deficiencies noted continue to be associated with the recommendation for they represent an objective view of the present state of the program, its relationship to others, and suggest a direction for the necessary effort to build a stable program of quality.

In some form, our notation of deficiencies and recommendation should be communicated to the necessary administrative officer(s). Though we were led in our discussions and evaluation by Professor Dodson's thoughtful analysis, the comments made and the recommendation are those of the entire group committee and should be so communicated.

WEI/ref
Enclosure

November 15, 1965

Re: Master of Science (Plan A) in Organic Chemistry, Duluth Campus

The plan to introduce a Master of Science program (Plan A) in Organic Chemistry on the Duluth Campus, University of Minnesota, suffers from three serious deficiencies.

(1) The entire program is built around Dr. Ronald Caple, who joined the Chemistry Department at Duluth this past September. Dr. Caple has not, as yet, done any independent research, but the direction of any graduate research and the teaching of most of the graduate courses in Organic Chemistry will be his responsibility. Professor Moore does not feel that Dr. Cowles, who shares the responsibility for teaching Organic Chemistry, has demonstrated the ability to direct research in the field.

(2) Dr. Caple's teaching schedule for the first two years is rather heavy (6-7 courses per year, half of them graduate courses). Since he has no previous teaching experience and since he is expected to get his own research underway, this may prove to be a very heavy burden.

(3) The Chemistry Department of the University of Minnesota, Duluth, has M.S. programs in Physical Chemistry and in Inorganic Chemistry. At present, these areas are so interrelated that they can support each other. As planned, the M.S. program in Organic Chemistry is too isolated. Dr. Caple needs the stimulation and interaction of one other individual who is actively doing research in Organic Chemistry.

In spite of these criticisms, this M.S. program should be approved. At present, the Chemistry Department at Duluth has one graduate student in Organic Chemistry. While it would have been advantageous for them to move a bit more slowly on this program, it would be psychologically undesirable to veto this program, just when they feel they are getting started. A veto would also appear to be a vote of no confidence in Dr. Caple.

Approval is recommended with the ~~hope~~ recommended that Dr. Caple's teaching load ~~can~~ be reduced and that he will be supported by the addition of another organic chemist capable of doing research.

R. M. Dodson

OCT 2 8 1965

UNIVERSITY OF *Minnesota*

UNIVERSITY OF MINNESOTA, DULUTH · DULUTH 12

Office of the Academic Dean

October 27, 1965

Dean Bryce Crawford, Jr.
The Graduate School
321 Johnston Hall
University of Minnesota
Minneapolis, Minnesota 55455

Dear Dean Crawford:

The Duluth Campus Curriculum Committee has approved the enclosed proposal to add the area of Organic Chemistry to the Master of Science (Plan A) majors in Inorganic and Physical Chemistry for this campus. This is an extension of the present M. S. Chemistry program approved by the Graduate School in February 1964.

With the addition of Professor Ronald Caple to our staff, we feel that it is now appropriate to make this request. The necessary courses for this major were submitted for your approval on September 7, 1965.

I understand that this proposal has been adequately discussed with the faculty of the School of Chemistry on the Minneapolis Campus.

Provost Darland and I concurred in making this recommendation.

Sincerely,

T. Chamberlin

T. W. Chamberlin
Academic Dean

TWC/av
Enc.
cc: Provost R. W. Darland
Professor S. W. Fenton
Professor F. B. Moore
Mrs. Zephyra E. Shepherd

AN APPLICATION FOR THE EXTENSION OF THE PROGRAM FOR THE DEGREE OF MASTER OF SCIENCE (PLAN A) IN CHEMISTRY AT THE UNIVERSITY OF MINNESOTA, DULUTH TO INCLUDE THE AREA OF ORGANIC CHEMISTRY.

Department of Chemistry
Division of Science & Mathematics
August 25, 1965

OUTLINE OF CONTENTS

AN APPLICATION for the Extension of the Program for the Degree of Master of Science (Plan A) in Chemistry at the University of Minnesota, Duluth to Include the Area of Organic Chemistry.

I. General Statement Regarding the Proposed Extension

The M.S. degree program in chemistry, as approved by the University of Minnesota last year (see Appendix III for Parts I to VI of the original proposal), was restricted to majors in the areas of physical and inorganic chemistry, with a staff member in each of these areas being designated to serve as major adviser. In the application submitted for approval of this program, it was stated: "As other areas in the Chemistry Department feel that they can demonstrate readiness to undertake graduate research, application will be made to have the program extended." It was understood that the principal evidence for such readiness would be either the demonstration of a significant creative research effort on the part of the present staff in these areas or else the addition of new faculty qualified to direct graduate research.

This fall, Dr. Ronald Caple, an organic chemist, is joining our staff as an assistant professor. Dr. Caple obtained his Ph.D. from the University of Michigan under the direction of Dr. Wyman Vaughan and is presently completing a year's study as a National Science Foundation Postdoctoral Fellow with Dr. Stanley Cristol at the University of Colorado. Although he has not previously directed graduate students, he comes to us with very favorable references. Furthermore, he made an excellent impression on the occasion of a visit to the Minneapolis and Duluth Campuses. He understands clearly that one of his major responsibilities is the strengthening of research activity in organic chemistry and his qualifications are those of a person who, if he were appointed as a member of a department with an established graduate program in organic chemistry, would be designated as a graduate student adviser.

In view of Dr. Caple's appointment, it is felt that it would be appropriate to apply at this time for extension of the M.S. program in chemistry to include the area of organic chemistry.

II. Changes and Additions to the Present Program

The requirements with respect to prerequisites, foreign language, seminar, comprehensive written and final oral examinations are the same as in the present program in inorganic and physical chemistry (see Appendix III, Sections IV A, IV C, IV D, and IV E).

1. Research Area

As indicated in Section I, it is planned to initiate graduate research under the direction of Dr. Ronald Caple.

The following is an outline of his qualifications and research interests:

(a) Qualifications

(1) Academic Training

B.A., St. Olaf College, 1960
M.S., University of Michigan, 1962
Ph.D., University of Michigan, 1964. Major: Organic Chemistry
Research Director: Professor W. R. Vaughan
Dissertation: "Addition of Hydrogen Bromide to α - β Unsaturated Carboxylic Acids"

(2) Teaching Experience

Teaching Fellow, University of Michigan	1960-62
Instructor, Flint Senior College	1964 (1 Sem.)

(3) Research Experience

Postdoctoral Fellow (National Science Foundation) at University of Colorado, with Dr. S. J. Cristol	1964-65

(4) Publications

β-Bromo Acids. I. Stereochemistry and Mechanism of the Hydrobromination of α,β-Unsaturated Cyclohexenecarboxylic Acids, by Wyman R. Vaughan and Ronald Caple, J. Am. Chem. Soc., 86, 4928 (1964).
Above presented in part before the Division of Organic Chemistry, 146th National Meeting of the American Chemical Society, Denver, Colo., Jan. 19-24, 1964.

β-Bromo Acids. II. Solvolysis of Cyclic β-Bromo Acids, by Wyman R. Vaughan, Ronald Caple, Josef Csapilla, and Peter Scheiner, J. Am. Chem. Soc., 87, 2204 (1965).

Bridged Polycyclic Compounds. XXXIII. Thermal Rearrangement of Benzonorbornadiene, by Stanley J. Cristol and Ronald Caple, submitted for publication.

Bridged Polycyclic Compounds. XXXIV. Acetolysis of cis and trans-β-Chlorodibenzobicyclo[2.2.2]octadienyl Thioethers, by Stanley J. Cristol, Ronald Caple, R. M. Sequeria, and L. Oliver Smith, Jr., submitted for publication.

Bridged Polycyclic Compounds. ------. Polar Addition of Deuterium Chloride and Acetic Acid-Od$_1$ and -d$_4$ to Benzonorbornadiene, by Stanley J. Cristol and Ronald Caple, to be submitted for publication.

(b) Research Interests and Thesis Topics

(1) Research Interests

The major adviser's research program is concerned with the utilization of enol intermediates in controlling the stereochemistry of certain organic reactions and elucidating certain mechanistic pathways. Although enol intermediates are available from many sources, this area of investigation will be restricted to enols resulting from the electrophilic addition of reagents of the type HX to conjugated (or homoconjugated) carbonyl systems and enols resulting from the bromination (acid and base catalyzed) of ketones. Of interest is the fate of the intermediate carbonium ion resulting from a 1,4 addition to certain bicyclic α,β-unsaturated ketones. The configuration of the products resulting

from ketonization of enol intermediates upon 1,4 (or 1,5) additions will be investigated (V.P.C., I.R., and N.M.R.). A kinetic study of the bromination of certain epimeric ketones will be pursued. Advantage can be taken of the fact that proton removal is rate determining in ketone brominations and hence relative rates (and activation parameters) reflect some factors controlling enol (or enolate) formation. Bromination experiments will also be investigated using deuterium labeled substrates (mass spectroscopy) to help determine relative importance of steric versus stereoelectronic factors in enolization of certain bicyclic ketones.

(2) Thesis Topics

In light of the above, some suggested topics for thesis research are:

(a) Stereochemistry of the Hydrobromination of 2-Benzoylnorbornenene

(b) The Relative Rates and Activation Parameters for Bromination (Acidic and Basic Catalysis, Aqueous Media) of the exo- and endo-2-Norbornyl Phenyl Ketones to Help Determine Factors Relating to the Ease of exo versus endo Proton Abstraction

(c) Steric versus Stereoelectronic Factors Controlling Enolization of 3-exo-Deuterio-2-benzonorbornenone

(d) Possible Entrance into Prismane Derivatives via a 1,5 addition to cis-Bicyclo [3.2.0] heptadienone

2. Graduate Course Offerings

(a) New Courses

In Appendix I is presented an outline of the course content of five graduate courses in organic chemistry. This material has been worked out in consultation with the Organic Chemistry Division

of the Department of Chemistry on the Minneapolis campus. Of the courses listed, Chemistry 111, 112 and 113 have previously been approved and are currently listed simply as "Advanced Organic Chemistry" in the Graduate School Bulletin. In the present outline, more specific titles for these three courses are presented in order to indicate how they stand in relation to the proposed new courses, Chemistry 114 and 115. In Appendix II, the complete course descriptions for the latter, as prepared for approval by the various curriculum committees, are presented. The course description for the research course in organic chemistry, designated Chemistry 203, is also included in Appendix II.

(b) Program of Major and Minor Courses

Major*		Minor	
Topics in Structural and Theoretical Organic Chemistry (Chem. 111)	3 cr.	Quantum Chemistry (Chem. 148)	3 cr.
Organic Reaction Mechanisms I (Chem. 112)	3 cr.	Molecular Structure (Chem. 149)	3 cr.
Organic Synthesis I, (Chem. 113)	3 cr.	plus at least one course logically related to the student's major work, to be selected from	
Organic Reaction Mechanisms II, (Chem. 114)	3 cr.	Advanced Inorganic Chemistry (Chem. 161)	3 cr.
Organic Synthesis II (Chem. 115)	3 cr.	Chemical Kinetics (Chem. 151)	3 cr.
Chemical Thermodynamics (Chem. 146)	3 cr.	Solutions of Electrolytes (Chem. 152)	3 cr.
	18 cr.	Transport Processes in Solution (Chem. 154)	3 cr.
		or appropriate courses from physics and mathematics	

* A satisfactory course in qualitative organic analysis (corresponding to Chem. 103 at U.M.D.) is presumed.

III. Facilities (see Appendix III, part VI)

1. Library

Since submission of our previous proposal, substantial progress has been made in obtaining back issues of journals to which we subscribe currently, in starting subscriptions to new journals, and in obtaining key reference books.

Our current subscription list to journals numbers forty-nine. This list does not include a number of periodicals containing articles in the field of chemical physics, which are available in the Physics Library (the Journal of Chemical Physics, Molecular Spectroscopy, etc.). In addition, we have brought several key references up-to-date and are continuing to add to them as new volumes are issued. Among these, of particular importance to a Master's program in organic chemistry are Beilstein and the Sadtler I.R. Spectra collections.

The space problem in the present chemistry library has been temporarily solved with the construction of some additional shelving. The new Life Science Building, for which funds have been appropriated by the Legislature, will release space in the present Science Building for a combined chemistry-physics library.

It should also be pointed out that the Chemistry Department has received the full cooperation of the Librarian and Provost with regard to the necessary expansion of our collection of reference works and journals required for the Master's program.

2. Laboratory Space

With the extension of our program into the organic area, it would be reasonable to expect a total of from six to eight graduate students within the next two years. (In our original proposal, we envisaged a

maximum of four students initially with a total enrollment of twelve to fifteen within the next five or six years. We will have five students next year.)

With the recent legislative approval of funds for a Life Science Building, adequate laboratory space for instruction and for research at the level indicated above is eventually assured. During the interim period of building construction and conversion of part of the present biology space for use by the Chemistry Department, the necessary space would be provided for as follows: At present, we have space available for four students (as outlined in our initial application). The required additional space would consist of Room S-402 (462 square feet, 104 feet of lab bench space) and Room S-320 (858 square feet, 104 feet of lab bench space). The use of Room S-320 would be a temporary measure since in our long-range planning, it is intended as a teaching laboratory. A grant application to the National Science Foundation for conversion of Room S-401 (546 square feet, 72 feet of laboratory bench space) is pending.

3. Equipment and Grants

At present, we have available a number of spectrophotometers, including a Beckman DB, a Beckman DU with ultraviolet and flame photometer accessories, a Beckman DK-2A, and a Beckman IR-10. We have a variety of pH meters, including two Beckman research models. Also available are a Beckman flat bed recorder, a Honeywell Brown Elektronik Recorder, an L & N Speedmax W Azar recorder, two L & N type K-3 potentiometers, a Rubicon Type B potentiometer, and an Aerograph Autoprep Model A-700 gas chromatograph. NMR spectra may be obtained on a service basis from the Minneapolis Campus.

With regard to specific research grants, Dr. Caple has obtained a grant from the Graduate School and has submitted research grant applications to the American Chemical Society (Petroleum Research Fund, type G) and Research Corporation.

APPENDIX I

OUTLINE OF ORGANIC COURSES FOR GRADUATE WORK IN ORGANIC CHEMISTRY

CHEM. 111. TOPICS IN STRUCTURAL AND THEORETICAL ORGANIC CHEMISTRY. 3 cr.

(a) Spectroscopy: Basic theory and general survey of applications with emphasis on determination of molecular structure.

(1) Infrared

(2) Ultraviolet

(3) Nuclear Magnetic Resonance

(4) Mass Spectroscopy

(b) Conformational Analysis: Conformational energetics.

(c) Electronic Structure: Lewis electronic structures, requirements and consequences of resonance, molecular orbital descriptions, prediction of aromaticity, pseudoaromaticity and non-aromaticity.

(d) Structural Effects: Inductive and field effects. Free energy relationships (Hammett equation).

CHEM. 112. ORGANIC REACTION MECHANISMS I. 3 cr.

(a) Nonkinetic Methods: Stereochemical studies, intermediates, labeling experiments.

(b) Kinetic Methods: Transition state theory, energy and entropy of activation, kinetic vs. thermodynamic control, free energy diagrams and resulting rate equations, steady state approximation, isotope effects, stereoelectronic control, general and specific acid catalysis, solvent effects.

(c) Displacement Reactions: Classical and modern theories, $S_{N}1$, $S_{N}2$, and S_{Ni}, kinetics, stereochemistry, solvolysis reactions and carbonium ion chemistry, anchimeric assistance, ion pair phenomena, internal return, classical vs. non-classical carbonium ions, steric effects, Swain and Grunwald correlations.

(d) Elimination Reactions: E1, E2n and E1cb, Elimination vs. displacement, Hofmann vs. Saytzeff eliminations, stereochemistry, pyrolytic eliminations, fragmentation reactions, decarboxylation reactions, ylid eliminations.

(e) Aromatic Substitution Reactions: Electrophilic and nucleophilic substitution reactions.

CHEM. 113. ORGANIC SYNTHESIS I: Study of reagents and reactions and their applications in organic synthesis. 3 cr.

(a) Carbonyl Chemistry: Synthetic routes, addition reactions of the carbonyl group, reactions involving substituent groups, unsaturated and polycarbonyl compounds.

(b) Diels-Alder reaction: Alder's Rules.

(c) Oxidation and Reduction Reactions: Various reagents and selectivity.

(d) Rearrangement Reactions: Nucleophilic rearrangements (migration to carbon, nitrogen and oxygen). Valence tautomerism (Cope rearrangements) and electrocyclic mechanisms.

CHEM. 114. ORGANIC REACTION MECHANISMS II. 3 cr.

(a) Addition Reactions: cis and trans additions, electrophilic and nucleophilic additions to C=C bonds, conjugated systems, stereoselective and stereospecific synthesis.

(b) Carbanions and Enolization: Keto-enol equilibra, condensation reactions.

(c) Reactions of Carboxylic Acids and Esters.

(d) Free-Radical Reactions: Configuration, displacement, addition and rearrangements.

CHEM. 115. ORGANIC SYNTHESIS II. 3 cr.

(a) Divalent carbon: Singlet and triplet states.

(b) Benzyne intermediates.

(c) Bicyclic Compounds and Strained Systems.

(d) Small, Medium and Large Rings: Transannular reactions.

(e) Photochemistry.

(f) Polymerization: Ionic and radical.

(g) Partial and Total Syntheses: Examples selected from the literature, Thorough study of approach and reasoning, the Cedrol-Cedrene synthesis, Longifolene synthesis.

APPENDIX II

COURSE DESCRIPTIONS AND CHANGES

DIVISION OF SCIENCE AND MATHEMATICS

C. C. No. 1

Departmental Approval 8-17-65

Division Approval 8-18-65

C. C. Approval 8-19-65

TO: Curriculum Committee
For Action and Transmission to Administrative Committee

FROM: Department of Chemistry

SUBJECT: Request to establish two new courses for use in the Graduate Program, and change the course titles of three present courses.

NOTE: Items I, Course Description, and II, Syllabus, will be given separately for each of the two courses. Items III, Library Resources, and IV, Reasons, apply collectively to both courses, and will therefore be set down once, after the individual descriptions and syllabi.

Title changes: In order to indicate how the present graduate courses stand in relation to the proposed new courses it is requested that

111. Advanced Organic Chemistry I
112. Advanced Organic Chemistry II
113. Advanced Organic Chemistry III

be changed to
111. Topics in Structural and Theoretical Organic Chemistry
112. Organic Reaction Mechanisms I
113. Organic Synthesis I

I. Course Description

Chemistry 114. Organic Reaction Mechanisms II. (3 cr; prereq. 112, 142, and graduate standing or #; 3 hrs lect) Caple, Cowles

II. Syllabus

No. of Lectures	Topics
8	Addition Reactions: cis and trans additions, electrophilic additions to C=C bonds, conjugated systems, stereoselective and stereospecific synthesis
8	Carbanions and Enolization: Keto-enol equilibria, condensation reactions
7	Reactions of Carboxylic Acids and Esters
7	Free-radical Reactions: Configuration, displacement addition and rearrangements.

Lectures, problem assignments and/or tutorial sessions will be used in teaching the course.

Textbooks will be chosen from the following:

J. D. Roberts and M. C. Caserio, Basic Principles of Organic Chemistry, Benjamin, 1964

E. S. Gould, Mechanism and Structure in Organic Chemistry, Holt, 1959

J. Hine, Physical Organic Chemistry, McGraw-Hill, 1962

I. Course Description

Chemistry 115. Organic Synthesis II. (3 cr; prereq. 113, 142, and graduate standing or #; 3 hrs lect) Caple, Cowles

II. Syllabus

No. of Lectures	Topics
4	Divalent Carbon: Singlet and triplet states
2	Benzyne Intermediates
3	Bicyclic Compounds and Strained Systems
3	Small, Medium and Large Rings: Transannular reactions
3	Photochemistry
5	Polymerization: Ionic and radical
10	Partial and Total Syntheses: Examples selected from the literature, thorough study of approach and reasoning, the cedrol-cedrene synthesis, the longifolene synthesis

Lectures, problem assignments and/or tutorial sessions will be used in teaching the course.

Textbooks will be chosen from among the following:

J. D. Roberts and M. C. Caserio, Basic Principles of Organic Chemistry, Benjamin, 1964

D. J. Cram and G. S. Hammond, Organic Chemistry, second Edition, McGraw-Hill, 1964

L. F. Fieser and M. Fieser, Advanced Organic Chemistry, Reinhold, 1961; Topics in Organic Chemistry, Reinhold, 1963

R. C. Fuson, Reactions of Organic Compounds, Wiley, 1962

III. Library Resources for the Proposed Two Courses

A. Books

Acheson, R. M., AN INTRODUCTION TO THE CHEMISTRY OF HETEROCYCLIC COMPOUNDS, Interscience, New York, 1960

Albert, A., HETEROCYCLIC CHEMISTRY, Oxford University Press, Oxford, 1959

Alexander, E. R., PRINCIPLES OF IONIC ORGANIC REACTIONS, Wiley, New York, 1950

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B. Ongoing Series

ADVANCES IN CARBOHYDRATE CHEMISTRY (M. L. Wolfram et. al., Eds.) Academic Press, complete after Volume 13

ADVANCES IN CHEMISTRY SERIES, American Chemical Society, complete

ADVANCES IN ORGANIC CHEMISTRY: METHODS AND RESULTS (R. A. Raphael et. al., Editors), Interscience, complete

ADVANCES IN PROTEIN CHEMISTRY (C. B. Anfinsen et. al., Editors) Academic Press, complete after Volume 13

ANNUAL REPORTS ON THE PROGRESS OF CHEMISTRY, The Chemical Society, complete after 1948

BEILSTEINS HANDBUCH DER ORGANISCHEN CHEMIE, Springer-Verglag, complete

BIOCHEMICAL PREPARATIONS, Wiley, complete

CHEMISTRY OF CARBON COMPOUNDS (E. H. Rodd, Editor), Elsevier, complete

DETERMINATION OF ORGANIC STRUCTURES BY PHYSICAL METHODS (E. A. Braude, F. C. Nachod, et. al., Editors) Academic Press, complete

DICTIONARY OF ORGANIC COMPOUNDS (I. M. Heilbron et.aal., Editors) Oxford University Press, complete

HETEROCYCLIC COMPOUNDS (R. C. Elderfield, Editor), Wiley, complete

METHODEN DER ORGANISCHEN CHEMIE (Houben-Weyl) (E. Müller, Editor), Georg Thieme Verlag, complete

METHODS OF BIOCHEMICAL ANALYSIS (D. Glick, Editor), Interscience, complete

ORGANIC ANALYSIS (J. Mitchell et. al., Editors), Interscience, complete

ORGANIC CHEMISTRY, AN ADVANCED TREATISE (H. Gilman, Editor), Wiley, complete

ORGANIC REACTIONS, Wiley, complete

ORGANIC SYNTHESES, Wiley, complete

PHYSICAL METHODS IN CHEMICAL ANALYSIS (W. G. Berl, Editor), Academic Press, complete

PROGRESS IN ORGANIC CHEMISTRY (J. W. Cook, Editor), Butterworths, complete

PROGRESS IN STEREOCHEMISTRY (W. Klyne et. al., Editors), Butterworths, complete

SUBSTANCES NATURELLES DE SYNTHESE (L. Velluz, Editor), Masson, complete

SYNTHETIC METHODS OF ORGANIC CHEMISTRY (W. Theilheimer, Editor), Interscience, complete

THE TERPENES (J. L. Simonsen et. al., Editors), Cambridge University Press, complete

C. Journals

The Library has received the following journals pertinent to organic chemistry since the dates given in parentheses.

1. Acta Chemica Scandinavica, v. 1 (1947)-
2. American Chemical Society, Journal of the American Chemical Society, v. 33-82 [83] (1910)-
3. Angewandte Chemie. International, Edition in English, v. 1 (1962)-
4. Biochemistry, v. 1 Jan. 1962; v. 3 (1964)-
5. Canadian Journal of Chemistry, v. [35] v. 38 (1957)-
6. Chemical Abstracts, v. 1 (1907)-
7. Chemical Communications, v. 1 (1965)-
8. Chemical Reviews, v. 16 (1935)-
9. Chemical Society Journal (London), 1920-
10. Proceedings of the Chemical Society, 1957-1964
11. Quarterly Reviews, v. 1-3, 5-
12. Chemical Titles, v. 1 (1960)-
13. Chemishe Berichte, v. 86 (1953)-
14. Chemistry and Industry, 1957-
15. Faraday Society, Discussions, No. 24 (1957)-
16. Faraday Society, Transactions, v. 43 (1947)-
17. Helvetica Chimica Acta, v. 33 (1950)-

18. I/EC, v. 1 (1909)-

19. Industrial and Engineering Chemistry, Fundamentals, v. 1 (1962)-

20. Industrial and Engineering Chemistry, Process Design and Development, v. 1 (1962)-

21. Industrial and Engineering Chemistry, Product Research and Development, v. 1 (1962)-

22. Journal of Biological Chemistry, v. 194 (1952)-

23. Journal of Chemical Education, v. 4 (1927)-; Cumulative index v. 1-25 (1924-1949)

24. Journal of Chromatography, v. 2, 5 and v. 10 (1959)-

25. Journal of Organic Chemistry, v. 18-23, [24-25], 26 (1953)-

26. Journal of Organometallic Chemistry, v. 1 (Oct. 1963)-

27. Justus Liebigs Annalender Chemie, v. 546-558, v. [629], 630 (1940)-

28. Nature, v. 165 (1950)-

29. Pure and Applied Chemistry, v. 1 (1960)-

30. Record of Chemical Progress, v. 16 (1955)-

31. Recueil des travaux chimiques des Pays - bas., v. 79 (1960)

32. Reviews of Pure and Applied Chemistry, v. 1 March (1951)-

33. Societe chimique de France, Bulletin, 1954, 1960-

34. Spectrochimica Acta, v. 21 (1965)

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36. Tetrahedron Letters, March 1959-

37. Zeitschrift für Chemie, v. 4 (1964)-

IV. Reasons for Offering the Courses

The two new courses, together with the present Chemistry 111, 112, and 113, will constitute the course work in organic chemistry which is necessary for a graduate student majoring in this area. The course content has been worked out in consultation with the Organic Chemistry Division of the Department of Chemistry on the Minneapolis campus.

DIVISION OF SCIENCE AND MATHEMATICS

C. C. No. 2

Departmental Approval 8-17-65

Division Approval 8-18-65

C. C. Approval 8-19-65

TO: Curriculum Committee
For Action and Transmission to Administrative Committee

FROM: Department of Chemistry

SUBJECT: Request for approval of new course.

I. Course Description

Chemistry 203. Research in Organic Chemistry (Cr ar. Normally 1 cr 1st quarter, 3 to 9 cr per quarter thereafter) Caple

II. Reason for Adding Course to Curriculum

This course is part of the required program for the Master of Science degree in chemistry (plan A), for students with a major concentration in organic chemistry.

APPENDIX III

ORIGINAL PROPOSAL FOR

MASTER OF SCIENCE DEGREE

A Proposal for the Degree of Master of Arts in Chemistry (Plan A) at the University of Minnesota, Duluth

Department of Chemistry
Division of Science & Mathematics

January 31, 1964

Outline of Contents

I. Introduction

The suggested program will be within the framework of general requirements of the Graduate School as outlined in the Graduate School Bulletin for Plan A (1962-64, pp. 7-11). Student research activity will be limited initially to the areas of physical and inorganic chemistry, with Professor J. C. Nichol and Associate Professor L. C. Thompson serving as major advisers.

Staff members of the Chemistry Department on the Duluth Campus feel there is a real need at the University of Minnesota for a graduate program designed specifically for those who would like to make a career of teaching chemistry. Many of the small liberal arts colleges, junior colleges, and state colleges are finding it difficult to obtain qualified instructors. The Department feels that it is uniquely qualified to provide a Master's Program to meet this need for the following reasons:

1. The students will have close contact with a faculty with many years of successful undergraduate teaching.
2. The students will have the opportunity to teach in a favorable environment in classes of moderate size. This, together with the close contact with the senior faculty will offer an excellent chance to observe and be a part of the teaching operation. They will therefore have a sound basis on which to reach a decision regarding teaching as a career.
3. Since this program does not provide for doctoral training, the students will not be in competition with Ph.D. candidates for the attention of the staff.

This program is arranged to handle these students in such a way that every opportunity is available for them to go on to more advanced study if they so desire. In addition, students who are pursuing a Master's Degree for other reasons will participate in this program.

The proposed program of a Master's Degree in a subject matter field is essential in maintaining the caliber of the staff at U.M.D. and in the continued development of this campus as part of the University.

Required course work for the major will include thermodynamics, kinetics, quantum theory, and molecular structure since these subjects are fundamental to the understanding of modern chemistry. A fifth course, solutions of electrolytes, will be required since, for the present, all candidates will be concentrating in research areas demanding a knowledge in this field. The remaining major courses are electives in the two areas of research. Minors may be either inside the Chemistry Department or outside the Department in mathematics or physics. We feel that this program will provide the student with a breadth of training which will enable him to decide intelligently what further course of action he will pursue. The departmental minor will be particularly useful for persons interested in a teaching career.

For a start we plan on a maximum of four students. When we feel that other research areas can demonstrate readiness to undertake graduate research, application will be made to extend the program. As an estimate, an increase to a total graduate enrollment of twelve to fifteen students seems reasonable during the next few years.

II. Research Fields

A. Physical Chemistry

1. Area of Interest: Electrophoresis, Diffusion and Conductance Studies of Electrolyte Solutions

2. Qualifications of Major Adviser: James C. Nichol

a. Academic Training

B.Sc., University of Alberta, 1943.
M.Sc., University of Alberta, 1945.
Major: Organic Chemistry. Research Director: Professor R. B. Sandin. Dissertation: Synthesis of Some Polynuclear Aromatic Hydrocarbons
Ph.D., University of Wisconsin, 1948.
Major: Physical Chemistry; Minor: Organic-Biochemistry. Research Director: Professor J. W. Williams. Dissertation: Isolation, Characterization and Immunological Studies with Gamma Globulins from Various Animal Sera.

b. Teaching Experience

University of Minnesota, Duluth (Asst. Prof. 1957-9; Assoc. Prof. 1959-62; Prof. 1962)	1957-
Willamette University (Assoc. Prof.)	1949-57
University of Alberta (Sessional Instructor)	1943-46

c. Research Experience

Project associate in chemistry, University of Wisconsin	1948-49, summers of 1954, 1956, 1957
Research Fellow in chemistry, Yale University	1953-54
Research Participant, Oak Ridge National Laboratory	summer of 1958

Present Research: Electrophoresis and Conductance of Compounds of Biological Interest, supported by University of Minnesota Graduate School 1958-59, USPHS 1959-64, and NSF USE 1960-63. (Director of NSF URPP program in chemistry at UMD 1961-63)

d. Publications:

Identification of Aryl Iodides, J. C. Nichol and R. B. Sandin, J. Am. Chem. Soc., 67, 1307 (1945).

Studies on the Structures of Some Dibenznaphthacenes, J. C. Nichol, G. D. Thorn, R. N. Jones, and R. B. Sandin, ibid., 69, 376 (1947).

Some Tetramethylanthracenes, J. C. Nichol and R. B. Sandin, ibid., 69, 2256 (1947).

The Rates of Dissociation of Some Tetraphenylxylylethanes, R. B. Grunert, J. C. Nichol, and R. B. Sandin, ibid., 69, 2254 (1947).

Biophysical Studies of Blood Plasma Proteins. VII. Separation of Gamma Globulin from Sera of Various Animals, J. C. Nichol and H. F. Deutsch, ibid., 70, 80 (1948).

Chemical Reactions in Moving Boundary Systems of Weak Electrolytes, R. A. Alberty and J. C. Nichol, ibid., 70, 2297 (1948).

Biophysical Studies of Blood Plasma Proteins. X. Fractionation Studies of Normal and Immune Horse Serum, H. F. Deutsch and J. C. Nichol, Journal of Biological Chemistry, 176, 797 (1948).

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Moving Boundary Systems Formed by Weak Acids and Bases. An Experimental Study, J. C. Nichol, J. Am. Chem. Soc., 72, 2367 (1950).

A New Cell Design for Precision Conductimetry, J. C. Nichol and R. M. Fuoss, J. Phys. Chem., 58, 696 (1954).

Bolaform Electrolytes. IV. Conductance of alpha, omega-Bispyridinium Polymethylene Bromides and beta, beta-Bisquaternary Substituted Diethyl Ethers in Methanol, J. C. Nichol and R. M. Fuoss, J. Am. Chem. Soc., 77, 198 (1955).

Series Solutions of the Dole Equations and Their Implications for Electrophoretic Analysis, J. C. Nichol and L. J. Gosting, ibid., 80, 2601 (1958).

Weak Electrolyte Moving Boundary Systems Analogous to the Electrophoresis of Two Proteins, J. C. Nichol, E. B. Dismukes, and R. A. Alberty, ibid., 80, 2610 (1958).

Electrophoretic Method for Desalting Amino Acids, J. C. Nichol, Science 129, 1549 (1959).

A Moving Boundary Study of a Sodium Phosphate-Sodium Iodide System, J. C. Nichol, Abstracts of Papers, 136th Meeting of American Chemical Society, Sept. 1960, p. 5s.

Intermittent Current Effects in Free Electrophoresis, J. C. Nichol, J. Phys. Chem., 66, 830 (1962).

Electrophoresis of Glutanate-Tartrate Mixtures in Acetate Buffers, L. B. Friedman and J. C. Nichol, J. Phys. Chem., 67, 1716 (1963). Based on NSF-USE research.

Complexes of the Rare Earths. IV. Electrophoretic Examination of the Hydrolysis Products of N-Hydroxyethylethylenediaminetriacetic Acid Chelates. L. C. Thompson and J. C. Nichol, Inorg. Chem., 2, 222 (1963).

e. Research Interests and Thesis Topics

(1) Research Interests

The major adviser's research program is concerned with the theory of free electrophoresis and its application to various problems, with some emphasis on those of biochemical interest. The nature of the problems which have been encountered is such that electrophoresis, conductance and diffusion effects are all involved and must be taken into account. Several problems are currently being investigated:

(a) Previous studies on intermittent current effects are being continued in an attempt, so far partially successful, to obtain a more exact treatment.

(b) Experiments with well-characterized dissociating systems are being carried out to see if experimental confirmation of electrodiffusion effects predicted by various workers and of the reaction boundaries

predicted by Gilbert can be obtained for such systems. Observation of significant electrodiffusion effects for weak electrolyte systems would be of particular interest, since, in principle, rate constants for the dissociation processes involved can be calculated from them.

(c) The general question of how much information regarding original concentrations, equivalent weights, mobilities, equivalent refractions, etc., can be obtained from experiments analogous to the electrophoresis of proteins in a buffer is being studied theoretically and experimentally, using well-characterized electrolytes. Closely related to this problem is that of the relationship of electrophoretic mobility to the structure of the ion constituents and their environment. Mobility and conductance studies on mixtures of electrolytes are being carried out which indicate significant ion association and solvation effects.

(2) Thesis Topics

In the light of the above, the following are suggested as examples of topics for M.A. thesis research.

(a) "Time-dependent Behavior of Electrolyte Diffusion Boundaries under the Influence of an Applied Potential"

(b) "Electrodiffusion and the Gilbert Effect in Well-Characterized Dissociating Systems"

(c) "Relationship of Electrophoretic Mobility to Structure and Environment"

B. Inorganic Chemistry

1. Area of Interest: Chemistry of the Rare Earths and Other Less Common Elements; Coordination Chemistry

2. Qualifications of Major Adviser: Larry C. Thompson

a. Academic Training

B.S., Willamette University, 1957.
Major: Chemistry; Minor: Mathematics
M.S., University of Illinois, 1959.
Major: Inorganic Chemistry
Ph.D., University of Illinois, 1960.
Major: Inorganic Chemistry; Minors: Physical Chemistry and Mathematics. Research Director: Professor Therald Moeller. Dissertation: Observations on the Rare Earths. Stability of Diethylenetriaminepentaacetic Acid Chelates.

b. Teaching Experience

University of Minnesota, Duluth (Asst. Prof. 1960-63; Assoc. Prof. 1963-)	1960-
University of Illinois, Teaching Assistant	1957-58
	summer of 1959

c. Research Experience

Present Research: Coordination Chemistry of the Rare Earths and Other Less Familiar Elements, supported by University of Minnesota Graduate School 1960-63, USPHS 1961-64, NSF-USE 1960-64, and Research Corporation 1963-64

d. Publications

Complexes of the Rare Earths. I. Iminodiacetic Acid, L. C. Thompson, Inorg. Chem., 1, 490 (1962).

Observations on the Rare Earths. LXXV. The Stabilities of Diethylenetriminepentaacetic Acid Chelates, L. C. Thompson and T. Moeller, J. Inorg. Nucl. Chem., 24, 499 (1962).

Complexes of the Rare Earths. II. N,N'-Ethylenediaminediacetic Acid, L. C. Thompson, J. Inorg. Nucl. Chem., 24, 1083 (1962).

Complexes of the Rare Earths. III. Mixed Complexes with N-Hydroxyethylethylenediaminetriacetic Acid, L. C. Thompson and Judith Ann Loraas, Inorg. Chem., 2, 89 (1963). Based on NSF URPP research.

Complexes of the Rare Earths. IV. Electrophoretic Examination of the Hydrolysis Products of N-Hydroxyethylethylenediaminetriacetic Acid Chelates, L. C. Thompson and J. C. Nichol, Inorg. Chem., 2, 222 (1963).

Complexes of the Rare Earths. V. Piperidine-2, 6-Dicarboxylic Acid, L. C. Thompson, J. Inorg. Nucl. Chem., 25, 819 (1963).

Complexes of the Rare Earths. VI. N-Hydroxyethyliminodiacetic Acid, L. C. Thompson and J. A. Loraas, Inorg. Chem., 2, 594 (1963).

Some Aspects of the Stabilities of Amino Polycarboxylic Acid Chelates of the Tri-Positive Rare Earth Metal Ions, T. Moeller, L. C. Thompson, and R. Ferrus, Rare Earth Research, E. V. Kleber, ed. The Macmillan Co., New York, 1961.

e. Research Interests and Thesis Topics

(1) Research Interests

The present research interest of the major adviser concerns an elucidation of the factors affecting the formation of complexes with the rare-earth ions (including yttrium and scandium). At present the major attack on this problem has been by means of measurements of the stability constants of the complexes formed by the rare earths with a variety of ligands. Of particular interest are the search for an explanation for the so-called "gadolinium break," an explanation for the anomalous behavior of yttrium in some systems, the relationship of scandium to the rare earths with regard to coordination chemistry, and the resolution of the question of the maximum coordination number for the rare earths. It is hoped that in the near future studies on these problems will

be supplemented by the use of such spectral tools as I.R. and U.V.

Another research interest is at present centered on the design and synthesis of chelating agents which are specific for a given metal ion or group of metal ions. Studies of this type use both the steric and bonding requirements of the ligands and metal ions and can involve magnetic, spectral and structural investigations of the resulting complexes.

(2) Thesis Topics

In the light of the above, some suggested topics for thesis research are:

(a) "Stabilities of the Rare Earth-Diglycolic and - Thiodiglycolic Acid Complexes"

(b) "Structural Study of the Mixed Chelate of Erbium with N-Hydroxyethyethylenediamine-triacetic Acid and Iminodiacetic Acid"

(c) "Study of the Compounds of the Rare Earths and Dimethyl Sulfoxide, Triphenylphosphine Oxide, etc."

(d) "Thermodynamics of the Formation of Rare Earth Complexes"

III. Selection of Students

Students for the program are to be selected by the screening committee which selects students for the graduate program in chemistry on the Minneapolis Campus, this committee to include a member from the U.M.D. chemistry faculty.

The qualifying examinations provided by the Department of Chemistry, Minneapolis Campus, will be used to determine areas of weakness in which remedial work (undergraduate courses) is advisable.

IV. Requirements for the Degree

A. Prerequisites

The courses will be taught at a level which assumes the following minimum preparation for the entering student:

1. Major in chemistry, including calculus physical chemistry, and junior-senior level inorganic chemistry.
2. One year of university physics, taught using calculus.
3. Two years of university mathematics, including a quarter of differential equations.

B. Course Requirements

1. Major

All graduate students will be required to take 3 credit courses in thermodynamics, chemical kinetics, quantum theory, molecular structure, and solutions of electrolytes, as described below in Section VII. Students electing research in physical chemistry will take a 3 credit course in transport processes in solution. Students electing research in inorganic chemistry will take a 3 credit course in advanced inorganic chemistry plus inorganic laboratory for 1 credit, if they have not previously had the latter.

2. Minor

Minor in chemistry

Either 9 credits in advanced organic chemistry or 6 credits in advanced organic chemistry and 3 credits in either advanced inorganic chemistry or transport processes in solution.

Minor in physics

Either Mechanics-Electricity-Magnetism, 9 credits (Phys 113-115-117) or Modern Physics, 9 credits (Phys 106-108-110)

Minor in Mathematics

Topics in applied mathematics (Math 101-102-103), 9 credits.

C. Language Requirement

A reading knowledge of German must be demonstrated within one year of the start of graduate work. The examination used on the Minneapolis Campus will be given at U.M.D. and graded with the examinations given in Minneapolis.

D. Seminar

Graduate students will be required to participate in the departmental seminar.

E. Examinations

A comprehensive written examination will be required at the end of the first three quarters in attendance. A final oral examination will be given no later than five weeks before the end of the quarter in which the student takes his degree. A member of the Department of Chemistry, Minneapolis Campus will serve on the examining committee.

V. Chronological Outline of Study and Research Program

The program for qualified students will be as follows:

Quarter	Course	Credit
Fall	Thermodynamics (Chem 146)	3
	Quantum Theory (Chem 148)	3
	Research	1-3
	Seminar	0 or 1
	Minor	3
		10-13
Winter	(Admission to candidacy and approval of thesis project)	
	Molecular Structure (Chem 149)	3
	Kinetics (Chem 151)	3
	Seminar	0 or 1
	Research	3
	Minor	3
		12-13
Spring	Solutions of Electrolytes (Chem 152)	3
	Seminar	0 or 1
	Research	3
and either		
	Transport Processes in Solution (Chem 154)	3
or		
	Advanced Inorganic Chemistry (Chem 161)	3
	Inorganic Chemistry Lab (Chem 133)	1
	Minor	3
		13-14

Summer	Comprehensive Examination	
	German Examination	
	Research	9
	Seminar	1 or 0
Fall	Research	9
	Defense of Thesis	
	Total Credits	54-57

VI. Facilities

A. Library

Our library has been expanded significantly in the past year, both with respect to new journals and back issues, because of the award of an NSF matching funds grant to the chemistry department, in the amount of $12,000, for this purpose. We now subscribe to about fifty basic journals.

Funds are available for the purchase of required non-journal literature (texts and references) associated with the suggested course work. Some funds in our current grants are available for the purchase of specialized books in the research areas.

B. Laboratory Space

Four laboratories providing 1250 square feet of space are available for use for graduate research. Another room 500 square feet in area is to be converted as soon as funds become available. An instrument laboratory is available for expensive instruments.

C. Research Equipment

Physical Chemistry

The main items of equipment are already available. These include

a Spinco Model H electrophoresis diffusion apparatus, a Jones conductance bridge, a modified toolmaker's microscope, a pH meter, a desk calculator and darkroom facilities.

Inorganic Chemistry

The instrumentation needed for the determination of stability constants is already available. An IR spectrometer is needed, and a matching-funds proposal has been made to NSF for purchase of a Perkin-Elmer 337. A recording visible-UV spectrophotometer is needed and will be provided by research grant funds recently awarded. A thermometric titration apparatus is available for determining heats of reaction. For the time being, NMR spectra can be obtained on a service basis from Minneapolis.

DIVISION OF SCIENCE AND MATHEMATICS

C. C. No. 1

Departmental Approval 8-17-65

Division Approval 8-18-65

C. C. Approval 8-19-65

TO: Curriculum Committee
For Action and Transmission to Administrative Committee

FROM: Department of Chemistry

SUBJECT: Request to establish two new courses for use in the Graduate Program, and change the course titles of three present courses.

NOTE: Items I, Course Description, and II, Syllabus, will be given separately for each of the two courses. Items III, Library Resources, and IV, Reasons, apply collectively to both courses, and will therefore be set down once, after the individual descriptions and syllabi.

Title changes: In order to indicate how the present graduate courses stand in relation to the proposed new courses it is requested that

111. Advanced Organic Chemistry I
112. Advanced Organic Chemistry II
113. Advanced Organic Chemistry III

be changed to
111. Topics in Structural and Theoretical Organic Chemistry
112. Organic Reaction Mechanisms I
113. Organic Synthesis I

I. Course Description

Chemistry 114. Organic Reaction Mechanisms II. (3 cr; prereq, 112, 142, and graduate standing or #; 3 hrs lect) Caple, Cowles

II. Syllabus

No. of Lectures	Topics
8	Addition Reactions: cis and trans additions, electrophilic additions to C=C bonds, conjugated systems, stereoselective and stereospecific synthesis
8	Carbanions and Enolization: Keto-enol equilibria, condensation reactions
7	Reactions of Carboxylic Acids and Esters
7	Free-radical Reactions: Configuration, displacement addition and rearrangements.

Lectures, problem assignments and/or tutorial sessions will be used in teaching the course.

Textbooks will be chosen from the following:

J. D. Roberts and M. C. Caserio, Basic Principles of Organic Chemistry, Benjamin, 1964

E. S. Gould, Mechanism and Structure in Organic Chemistry, Holt, 1959

J. Hine, Physical Organic Chemistry, McGraw-Hill, 1962

I. Course Description

Chemistry 115. Organic Synthesis II. (3 cr; prereq/ 113, 142, and graduate standing or #; 3 hrs lect) Caple, Cowles

II. Syllabus

No. of Lectures	Topics
4	Divalent Carbon: Singlet and triplet states
2	Benzyne Intermediates
3	Bicyclic Compounds and Strained Systems
3	Small, Medium and Large Rings: Transannular reactions
3	Photochemistry
5	Polymerization: Ionic and radical
10	Partial and Total Syntheses: Examples selected from the literature, thorough study of approach and reasoning, the cedrol-cedrene synthesis, the longifolene synthesis

Lectures, problem assignments and/or tutorial sessions will be used in teaching the course.

Textbooks will be chosen from among the following:

J. D. Roberts and M. C. Caserio, Basic Principles of Organic Chemistry, Benjamin, 1964

D. J. Cram and G. S. Hammond, Organic Chemistry, second Edition, McGraw-Hill, 1964

L. F. Fieser and M. Fieser, Advanced Organic Chemistry, Reinhold, 1961; Topics in Organic Chemistry, Reinhold, 1963

R. C. Fuson, Reactions of Organic Compounds, Wiley, 1962

III. Library Resources for the Proposed Two Courses

A. Books

Acheson, R. M., AN INTRODUCTION TO THE CHEMISTRY OF HETEROCYCLIC COMPOUNDS, Interscience, New York, 1960

Albert, A., HETEROCYCLIC CHEMISTRY, Oxford University Press, Oxford, 1959

Alexander, E. R., PRINCIPLES OF IONIC ORGANIC REACTIONS, Wiley, New York, 1950

Badger, G. M., THE STRUCTURES AND REACTIONS OF THE AROMATIC COMPOUNDS, Cambridge University Press, Cambridge, 1954

Baker, J. W., HYPERCONJUGATION, Oxford University Press, Oxford, 1952

Banthrope, D., ELIMINATION REACTIONS, American Elsevier, New York, 1963

Bauman, R. P., ABSORPTION SPECTROSCOPY, Wiley, New York, 1962

Barnett, E. B., MECHANISM OF ORGANIC CHEMICAL REACTIONS, Blackie, London, 1956

Bellamy, L. J., THE INFRARED SPECTRA OF COMPLEX MOLECULES, second edition, Wiley, New York, 1958

Brooks, B. T., Boord, C. E., Kurtz, S. S., Jr., and Schmerling, L., THE CHEMISTRY OF PETROLEUM HYDROCARBONS, 3 volumes, Reinhold, New York, 1954-5

Brooks, B. T., THE CHEMISTRY OF THE NONBENZENOID HYDROCARBONS, second edition, Reinhold, New York, 1950

Brown, H. C., HYDROBORATION, Benjamin, New York, 1962

Budzikiewicz, H., C. Djerassi and D. H. Williams, INTERPRETATION OF MASS SPECTRA OF ORGANIC COMPOUNDS, Holden-Day, San Francisco, 1964

Bunton, C. A., NUCLEOPHILIC SUBSTITUTION AT A SATURATED CARBON ATOM, American Elsevier, New York, 1963

Cairns, T., SPECTROSCOPIC PROBLEMS IN ORGANIC CHEMISTRY, Heyden and Son Ltd., London, 1964

Calvin, M., Heidelberger, C., Reid, J. C., Tolbert, B. M., and Yankwich, P. F., ISOTOPIC CARBON, Wiley, New York, 1949

Cheronis, N. O. and Ma, T. S., ORGANIC FUNCTIONAL GROUP ANALYSIS BY MICRO AND SEMIMICRO METHODS, Wiley, New York, 1964

Coates, G. E., ORGANOMETALLIC COMPOUNDS, Wiley, New York, 1964

Colthup, N. B., Daly, L. H., and Wiberley, S. E., INTRODUCTION TO INFRARED AND RAMAN SPECTROSCOPY, Academic Press, New York, 1964

Conn, G. K. T., and Avery, D. G., INFRARED METHODS, Academic Press, New York, 1960

Davies, M., Editor, INFRARED SPECTROSCOPY AND MOLECULAR STRUCTURE, American Elsevier, New York, 1963

de Mayo, P., Editor, MOLECULAR REARRANGEMENTS, Interscience Publ., Vols. 1 & 2 (in 16 sections), New York, 1963

Dewar, M. J. S., HYPERCONJUGATION, The Ronald Press Co., New York, 1962

Djerassi, C., STEROID REACTIONS: AN OUTLINE FOR ORGANIC CHEMISTS, Holden-Day, San Francisco, 1962

Djerassi, C., OPTICAL ROTATORY DISPERSION, McGraw-Hill, New York, 1960

Eliel, E. L., STEREOCHEMISTRY OF CARBON COMPOUNDS, McGraw-Hill, New York, 1962

Ferguson, L. N., THE MODERN STRUCTURAL THEORY OF ORGANIC CHEMISTRY, Prentice-Hall, New York, 1963

Fieser, L. F., and Fieser, M., NATURAL PRODUCTS RELATED TO PHENANTHRENE, Third Edition, Reinhold, New York, 1949

Fieser, L. F., and Fieser, M., ORGANIC CHEMISTRY, Third Edition, Reinhold, New York, 1956

Fieser, L. F., and Fieser, M., ADVANCED ORGANIC CHEMISTRY, Reinhold, New York, 1961

Fieser, L. F., and Fieser, M., TOPICS IN ORGANIC CHEMISTRY, Reinhold, New York, 1963

Flory, P. J., PRINCIPLES OF POLYMER CHEMISTRY, Cornell University Press, Ithaca, 1953

Foerst, W., Editor, NEWER METHODS OF PREPARATIVE ORGANIC CHEMISTRY (English trans.), Interscience, New York, 1948

Frost, A. A., and Pearson, R. G., KINETICS AND MECHANISM, second edition, Wiley, New York, 1961

Fuson, R. C., REACTIONS OF ORGANIC COMPOUNDS, Wiley, New York, 1962

Gaylord, N. G., REDUCTION WITH COMPLEX METAL HYDRIDES, Interscience, New York, 1956

Gillam, A. E. and Stern, E. S., AN INTRODUCTION TO ELECTRONIC ABSORPTION SPECTROSCOPY, Arnold, London, 1954

Ginsburg, D., Editor, NON-BENZENOID AROMATIC COMPOUNDS, Interscience, New York, 1959

Gould, E. S., MECHANISM AND STRUCTURE IN ORGANIC CHEMISTRY, Holt, New York, 1959

Hammett, L. P., PHYSICAL ORGANIC CHEMISTRY, McGraw-Hill, New York, 1940

Hershenson, H. M., ULTRAVIOLET AND VISIBLE SPECTRA INDEX, Vols. I and II, Academic Press, Vol. I, 1955; Vol. II, New York, 1959

Hine, J., DIVALENT CARBON, The Ronald Press, New York, 1964

Hine, J., PHYSICAL ORGANIC CHEMISTRY, second edition, McGraw-Hill, New York, 1962

Hückel, W., THEORETICAL PRINCIPLES OF ORGANIC CHEMISTRY, 2 volumes, Elsevier, Amsterdam, 1955

Ingold, C. K., STRUCTURE AND MECHANISM IN ORGANIC CHEMISTRY, Cornell University Press, Ithaca, 1953

I. U. P. A. C., NOMENCLATURE OF ORGANIC CHEMISTRY, Butterworths, London, 1957

IUPAC, THEORETICAL ORGANIC CHEMISTRY, IUPAC, Butterworths, London, 1959

Jackman, L. M., APPLICATIONS OF NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY IN ORGANIC CHEMISTRY, Macmillan, New York, 1960

Kamlet, M. J., Editor, ORGANIC ELECTRONIC SPECTRAL DATA, Wiley, New York, 1960, Vol. I

Karrer, P., ORGANIC CHEMISTRY (English trans.), fourth edition, Elsevier, Amsterdam, 1950

Katritzky, A. R. and Lagonski, J. M., HETEROCYCLIC CHEMISTRY, Wiley, New York, 1960

Kharasch, N., et al., INDEX TO REVIEWS, SYMPOSIA AND MONOGRAPHS IN ORGANIC CHEMISTRY, Macmillan, New York, 1962

Kharasch, M. S. and Reinmuth, O., GRIGNARD REACTIONS OF NONMETALLIC SUBSTANCES, Prentice-Hall, Englewood Cliffs, 1954

King, G. W., SPECTROSCOPY AND MOLECULAR STRUCTURE, Holt, Rinehart and Winston, New York, 1964

Kirchner, F. K., edited by W. Foerst, NEWER METHODS IN PREPARATIVE ORGANIC CHEMISTRY (Vol. II translated from the German), Academic Press, New York, 1963

Leffler, J. E., THE REACTIVE INTERMEDIATES OF ORGANIC CHEMISTRY, Interscience, New York, 1956

McClellon, A. L., TABLES OF EXPERIMENTAL DIPOLE MOMENTS, W. H. Freeman, San Francisco, 1963

Meloan, Clifton E., ELEMENTARY INFRARED SPECTROSCOPY, Macmillan, New York, 1963

Migrdichian, V., ORGANIC SYNTHESIS, 2 volumes, Reinhold, New York, 1957

Nakanishi, K., INFRARED ABSORPTION SPECTROSCOPY, Holden-Day, San Francisco, 1962

Newman, M. S., Editor, STERIC EFFECTS IN ORGANIC CHEMISTRY, Wiley, New York, 1956

Patterson, A. M., Capell, L. T., and Walker, D. F., THE RING INDEX, second edition, American Chemical Society, Washington, 1960

Pauling, L., NATURE OF THE CHEMICAL BOND, third edition, Cornell University Press, Ithaca, 1960

Phillips, J. P. and Nachod, F. C., ORGANIC ELECTRONIC SPECTRAL DATA, Vol. IV, Wiley, New York, 1963

Pigman, W. W., CARBOHYDRATES, Academic Press, New York, 1957

Pimentel, G. C., THE HYDROGEN BOND, Freeman, San Francisco, 1960

Pople, J. A., Schneider, W. G., and Bernstein, H. J., HIGH RESOLUTION NUCLEAR MAGNETIC RESONANCE, McGraw-Hill, New York, 1959

Potts, W. J., Jr., CHEMICAL INFRARED SPECTROSCOPY, Vol. I., Wiley, New York, 1963

Rabinowitch, E., SPECTROSCOPY AND PHOTOCHEMISTRY, Macmillan, New York, 1964

Randall, H. M., INFRARED DETERMINATION OF ORGANIC STRUCTURES, Van Nostrand, Princeton, 1949

Rao, C. N. R., CHEMICAL APPLICATIONS OF INFRARED SPECTROSCOPY, Academic Press, New York, 1963

Roberts, J. D., MOLECULAR ORBITAL CALCULATIONS, Benjamin, New York, 1961

Roberts, J. D., NUCLEAR MAGNETIC RESONANCE, McGraw-Hill, New York, 1959

Rochow, E. G., Hurd, D. T., and Lewis, R. N., THE CHEMISTRY OF ORGANOMETALLIC COMPOUNDS, Wiley, New York, 1957

Royals, E. E., ADVANCED ORGANIC CHEMISTRY, Prentice-Hall, Englewood Cliffs, 1954

Schmidt, A. X., and Marlies, C. A., PRINCIPLES OF HIGH-POLYMER THEORY AND PRACTICE, McGraw-Hill, New York, 1948

Shriner, R. L., Fuson, R. C., and Curtin, D. Y., THE SYSTEMATIC IDENTIFICATION OF ORGANIC COMPOUNDS, fourth edition, Wiley, New York, 1956

Sidgwick, N. V., revised by Taylor, T. W. J. and Baker, W., THE ORGANIC CHEMISTRY OF NITROGEN, Oxford University Press, Oxford, 1937

Siggia, S., QUANTITATIVE ANALYSIS VIA FUNCTIONAL GROUPS, Wiley, New York, 1954

Silverstein, R. M., and Bassler, G. C., SPECTROMETRIC IDENTIFICATION OF ORGANIC COMPOUNDS, Wiley, New York, 1963

Smyth, C. P., DIELECTRIC BEHAVIOR AND STRUCTURE, McGraw-Hill, New York, 1955

Stone, F. G. A., and West, R., ADVANCES IN ORGANOMETALLIC CHEMISTRY, Academic Press, New York, 1963, Vol. I

Streitwieser, A., Jr., MOLECULAR ORBITAL THEORY FOR ORGANIC CHEMISTS, Wiley, New York, 1961

Thornton, E. R., SOLVOLYSIS MECHANISMS, The Ronald Press Co., New York, 1964

Todd, A., PERSPECTIVES IN ORGANIC CHEMISTRY, Interscience, New York, 1956

Ungnade, H. E., Editor, ORGANIC ELECTRONIC SPECTRAL DATA, Wiley, New York, 1960, Vol. II

Wagner, R. B., and Zook, H. D., SYNTHETIC ORGANIC CHEMISTRY, Wiley, New York, 1953

Waters, W. A., THE CHEMISTRY OF FREE RADICALS, second edition, Oxford University Press, Oxford, 1948

Waters, W. A., PHYSICAL ASPECTS OF ORGANIC CHEMISTRY, fourth edition, Van Nostrand, Princeton, 1950

Weygand, C., ORGANIC PREPARATIONS (English trans.), Interscience, New York, 1945

Wheland, G. W., ADVANCED ORGANIC CHEMISTRY, third edition, Wiley, New York, 1960

Wheland, G. W., RESONANCE IN ORGANIC CHEMISTRY, Wiley, New York, 1955

Wheeler, O. H. and Kaplan, L., Editors, ORGANIC ELECTRONIC SPECTRAL DATA, Wiley, New York, 1963, Vol. III

Wiberg, K. B., PHYSICAL ORGANIC CHEMISTRY, Wiley, New York, 1963

B. Ongoing Series

ADVANCES IN CARBOHYDRATE CHEMISTRY (M. L. Wolfram et. al., Eds.) Academic Press, complete after Volume 13

ADVANCES IN CHEMISTRY SERIES, American Chemical Society, complete

ADVANCES IN ORGANIC CHEMISTRY: METHODS AND RESULTS (R. A. Raphael et. al., Editors), Interscience, complete

ADVANCES IN PROTEIN CHEMISTRY (C. B. Anfinsen et. al., Editors) Academic Press, complete after Volume 13

ANNUAL REPORTS ON THE PROGNESS OF CHEMISTRY, The Chemical Society, complete after 1948

BEILSTEINS HANDBUCH DER ORGANISCHEN CHEMIE, Springer-Verglag, complete

BIOCHEMICAL PREPARATIONS, Wiley, complete

CHEMISTRY OF CARBON COMPOUNDS (E. H. Rodd, Editor), Elsevier, complete

DETERMINATION OF ORGANIC STRUCTURES BY PHYSICAL METHODS (E. A. Braude, F. C. Nachod, et. al., Editors) Academic Press, complete

DICTIONARY OF ORGANIC COMPOUNDS (I. M. Heilbron et.aal., Editors) Oxford University Press, complete

HETEROCYCLIC COMPOUNDS (R. C. Elderfield, Editor), Wiley, complete

METHODEN DER ORGANISCHEN CHEMIE (Houben-Weyl) (E. Müller, Editor), Georg Thieme Verlag, complete

METHODS OF BIOCHEMICAL ANALYSIS (D. Glick, Editor), Interscience, complete

ORGANIC ANALYSIS (J. Mitchell et. al., Editors), Interscience, complete

ORGANIC CHEMISTRY, AN ADVANCED TREATISE (H. Gilman, Editor), Wiley, complete

ORGANIC REACTIONS, Wiley, complete

ORGANIC SYNTHESES, Wiley, complete

PHYSICAL METHODS IN CHEMICAL ANALYSIS (W. G. Berl, Editor), Academic Press, complete

PROGRESS IN ORGANIC CHEMISTRY (J. W. Cook, Editor), Butterworths, complete

PROGRESS IN STEREOCHEMISTRY (W. Klyne et. al., Editors), Butterworths, complete

SUBSTANCES NATURELLES DE SYNTHESE (L. Velluz, Editor), Masson, complete

SYNTHETIC METHODS OF ORGANIC CHEMISTRY (W. Theilheimer, Editor), Interscience, complete

THE TERPENES (J. L. Simonsen et. al., Editors), Cambridge University Press, complete

C. Journals

The Library has received the following journals pertinent to organic chemistry since the dates given in parentheses.

1. Acta Chemica Scandinavica, v. 1 (1947)-
2. American Chemical Society, Journal of the American Chemical Society, v. 33-82 [83] (1910)-
3. Angewandte Chemie. International, Edition in English, v. 1 (1962)-
4. Biochemistry, v. 1 Jan. 1962; v. 3 (1964)-
5. Canadian Journal of Chemistry, v. [35] v. 38 (1957)-
6. Chemical Abstracts, v. 1 (1907)-
7. Chemical Communications, v. 1 (1965)-
8. Chemical Reviews, v. 16 (1935)-
9. Chemical Society Journal (London), 1920-
10. Proceedings of the Chemical Society, 1957-1964
11. Quarterly Reviews, v. 1-3, 5-
12. Chemical Titles, v. 1 (1960)-
13. Chemishe Berichte, v. 86 (1953)-
14. Chemistry and Industry, 1957-
15. Faraday Society, Discussions, No. 24 (1957)-
16. Faraday Society, Transactions, v. 43 (1947)-
17. Helvetica Chimica Acta, v. 33 (1950)-

18. I/EC, v. 1 (1909)-

19. Industrial and Engineering Chemistry, Fundamentals, v. 1 (1962)-

20. Industrial and Engineering Chemistry, Process Design and Development, v. 1 (1962)-

21. Industrial and Engineering Chemistry, Product Research and Development, v. 1 (1962)-

22. Journal of Biological Chemistry, v. 194 (1952)-

23. Journal of Chemical Education, v. 4 (1927)-; Cumulative index v. 1-25 (1924-1949)

24. Journal of Chromatography, v. 2, 5 and v. 10 (1959)-

25. Journal of Organic Chemistry, v. 18-23, [24-25], 26 (1953)-

26. Journal of Organometallic Chemistry, v. 1 (Oct. 1963)-

27. Justus Liebigs Annalender Chemie, v. 546-558, v. [629], 630 (1940)-

28. Nature, v. 165 (1950)-

29. Pure and Applied Chemistry, v. 1 (1960)-

30. Record of Chemical Progress, v. 16 (1955)-

31. Recueil des travaux chimiques des Pays - bas., v. 79 (1960)

32. Reviews of Pure and Applied Chemistry, v. 1 March (1951)-

33. Societe chimique de France, Bulletin, 1954, 1960-

34. Spectrochimica Acta, v. 21 (1965)

35. Tetrahedron, v. 1 (1957)-

36. Tetrahedron Letters, March 1959-

37. Zeitschrift für Chemie, v. 4 (1964)-

IV. Reasons for Offering the Courses

The two new courses, together with the present Chemistry 111, 112, and 113, will constitute the course work in organic chemistry which is necessary for a graduate student majoring in this area. The course content has been worked out in consultation with the Organic Chemistry Division of the Department of Chemistry on the Minneapolis campus.

DIVISION OF SCIENCE AND MATHEMATICS

C. C. No. 2

Departmental Approval 8-17-65

Division Approval 8-18-65

C. C. Approval 8-19-65

TO: Curriculum Committee
For Action and Transmission to Administrative Committee

FROM: Department of Chemistry

SUBJECT: Request for approval of new course.

I. Course Description

Chemistry 203. Research in Organic Chemistry (Cr ar/ [Normally 1 cr 1st ~~quarter~~ qtr, 3 ~~to~~ 9 cr per ~~quarter~~ qtr thereafter]) Caple

II. Reason for Adding Course to Curriculum

This course is part of the required program for the Master of Science degree in chemistry (plan A), for students with a major concentration in organic chemistry.

October 26, 1965

TO: The Mechanical Engineering Graduate Committee

FROM: The Subcommittee on Television Graduate Study

SUBJECT: Recommendations for Initiating a Day School Graduate Program Involving Television Course Offerings

This subcommittee met on October 21 to formulate recommendations for the Mechanical Engineering Graduate Committee to initiate televised graduate study during the Winter quarter 1966. The Department is committed to this program, and the current interest is to endow it with the necessary control and definition to ensure that graduate school standards are not compromised. The immediate program will supply televised graduate offerings to Rochester, Minnesota, where this coverage has been requested principally by IBM. However, to establish adequate controls, we must envision extension of these facilities to include other portions of the state, such as South Minneapolis and Northfield. This means that the controls applied to the program should be adaptable to such other situations as might materialize.

Two features of this program, defined early in the negotiations, should be kept in mind: (1) The graduate offerings are to be day school courses, and (2) The admission standards for students accepted into this graduate program are to be no different from existing on-campus graduate school programs. All additional aspects of the program, both in terms of its structure and staff participation, should be guided by these standards.

The television offerings should be tailored to permit the student to complete as much course work as possible for his Master's Degree off campus. However, this program currently may be unable to offer a spectrum of courses wide enough to fill each individual's needs and interests. Consequently, the program offerings must be evolved to fill the greatest curriculum demands subject to approval by the Department.

A preliminary question raised in our discussion was the manner in which residency requirements would be met by the television program. Although this aspect must be defined, Dr. Jordan indicated that this decision is up to the Graduate School, and should not be our immediate concern.

The two major considerations during our first meeting were: (1) the amount of on-campus contact to be required of the student enrolled in the program, and (2) the immediate curriculum to be offered by the Department of Mechanical Engineering.

There was unanimous agreement that if a student selected a Plan A Master's Degree program, he would be required to conduct all experimental aspects of his thesis on campus as is currently required. Additionally, the thesis topic should be under the control and sanction of his advisor and, although it might be affiliated with his industrial interests, should be selected such that the advisor can capably guide the student in his on-campus experimental research. Consequently, we should not exclude the Plan A program, but should insist that experimental research be prosecuted on campus. In the event that the thesis is analytic in nature, or if the student selects Plan B, it will be the advisor's prerogative to insist upon sufficient personal on-campus contact with the student to offer guidance and to monitor results.

The suggestion that we require each student engaged in a Plan B paper effort to make a minimum of two visits to the campus per quarter for consultation with his advisor was favorably received, and we recommend it to the Graduate Committee. Additionally, we recommend that every student make at least one visit to the campus per quarter. If he is taking only course work, this might best be accomplished at the beginning of the quarter. Reviewing our experience gained in teaching ME 129, Vibration Engineering, on television to Rochester, Minnesota, during the Fall quarter of 1964, it appears wise to permit the individual course instructor the privilege of requiring a campus visit by any student who is performing marginally in his course. This may be necessary to adequately establish his understanding of the subject matter, to offer individual tutelage, and to recommend that he take appropriate action to remedy his situation.

In review of point 1, then, we believe that it is unwise to require frequent or extended formally specified visits to the campus. Instead, campus contact will be enforced through: (a) at least quarterly visits by each student, (b) a minimum of twice-per-quarter visits if the man is negotiating a Plan B paper, (c) campus-conducted experimentation involving a Plan A thesis, and (d) required campus visitation of marginal students as requested by instructors and advisors.

Relative to point 2 - the specific curriculum to be offered - we are confronted with the requirement to define a coherent set of courses beginning this Winter and continuing into the next academic year. We recommend that two courses be televised each quarter, beginning this Winter, to provide the student with sufficient opportunity to progress with his program at a satisfactory pace. Two courses should not be difficult to realize, because the television facility now in operation permits televising with students in the classroom. Placing appropriate courses in the television studio, then, should not be difficult if the student complement does not exceed thirty.

To select a roster of courses, we must know both student background and interests. In addition, if we are to inaugurate a formal program, it is wise to orient all potential students with the total Departmental graduate staff, their research activities and interests, and Departmental facilities. Therefore, we recommend that the Department of Mechanical Engineering request that a visitation by all interested students in the program be arranged at a specified time before mid-November. All students would come to the campus at a common time to be introduced to the graduate staff of the Department, to be given a tour of facilities, and to speak individually with staff members. This meeting should define student backgrounds, both academically and in their professional capacities, and should identify to us what courses are in demand. We will then be equipped to make a judgment as to required prerequisite courses and Departmental courses to be placed on the television roster. It might be wise to ask the sponsoring organization (such as IBM) for an identification of each participant's position and professional responsibilities such as they are willing to provide.

If this meeting is to be held in mid-November, we recommend that the Graduate Committee of the Department formalize its thinking in terms of Divisional interests and Divisional course committments to the program if they are requested by visiting students. Of course, the final decision as to course committments must be made after the mid-November visitation, but in order to advise wisely, at least concerning Departmental course offerings, the graduate staff should be cognizant of other staff interests and willingness to offer material. Perhaps these points can be resolved in a Graduate Committee meeting of the Department prior to a student visitation.

The final roster of proposed Departmental television course offerings should be evolved by November 30 to give the students, staff, and administration adequate notification.

The specifics of the new television facilities available in the Aeronautic Engineering Building will be requested of Professor Holte by this subcommittee to familiarize our Departmental staff with the details of the television classroom atmosphere. If desired by the Graduate Committee, a tour will be arranged for all members at a convenient time.

The Subcommittee on Television
Graduate Study

S. Arora
W. Ibele
R. Jordan
T. Murphy
D. Frohrib, Chairman

DAF/kk

AD HOC SUBCOMMITTEE ON PH.D. CANDIDACY

SUBJECT: Abstract of Discussion of Ad Hoc Committee

DATE: November 8, 1965

PRESENT: Dean Bryce Crawford, Jr.; Dean Francis M. Boddy; Professor Stuart Fenton; Professor John Darley; Assistant Dean Millard Gieske

The subcommittee discussed the need for the new formal method of reviewing and evaluating graduate students and particularly the Ph.D. programs, progress, and candidacy.

I. The Goal

The subcommittee agreed that it was necessary to encourage or require all departments or areas to establish a procedure for the departmental evaluation of each of their graduate students in residence. Each department would determine its own procedures for such a review, but each would be required to record the results with the Graduate School. The difficulty with respect to present evaluation procedures is their wide variance, with evaluation being done mainly (or only) by the individual advisor. The result is that widely different standards of evaluation frequently exist within the same department. Adding to the diversity are the differing general procedures that are followed from one department to another.

The Graduate School would have all departments and colleges follow a common general practice of evaluation of every current graduate student. Central to this goal is the development of a common system of departmental review. The departmental review would serve as a guide to the graduate student, the adviser, the department, and the Graduate School. All parties to the process of the Ph.D. degree would be apprised of the progress which the student was making so that planning a proper and orderly termination of study, with or without a degree, would be facilitated. Under such a review procedure new guide lines of advice could be established, with encouragement and/or warning to the student and the adviser in whatever degree was appropriate.

II. The Reports

The subcommittee expressed the need for a new Graduate School report form which all departments would be required to make. Possible categories of the evaluation on the report form might include:

1. Knowledge and Use of Research Techniques

   Excellent Good Fair Poor

2. Scholarly Methodology

   Excellent Good Fair Poor

3. Contributions to and Evaluation in Seminars

   Excellent Good Fair Poor

The appropriateness of what particular evaluation to use would likely vary from one department to another. In some of the Physical Sciences, laboratory research and techniques would be entirely appropriate; while in History or some Social Sciences the seminar method of evaluation would be most useful.

The Graduate School form could include also some type of recommendation or evaluation of each student such as: If present levels of competence and performance are continued, normal progress toward the degree is:

1. Clearly indicated
2. Very probably
3. Probable
4. Doubtful
5. Extremely unlikely

In any case the departments would be required to continuously evaluate the record, potential, and the progress of the individual student, formally reporting it to the Graduate School.

Frequency of Reports. Two report periods per year were suggested by Dean Crawford; one on December 1, and the second on June 1. The committee felt that these should begin sometime after the third or fourth quarter of residency. For example, if the student was admitted in the fall quarter, then his first evaluation would come during the third quarter (the next June 1). The reports would be a vehicle through which the student and the adviser would be informed of progress made toward the goal of the Ph.D. Negative reports could serve as the basis for the Graduate School either warning the student or placing him upon scholastic probation.

III. The Oral Preliminary Examination and Candidacy

Additional discussion centered on the differing standards and attitudes that prevail toward the preliminary oral examination. One view that existed within the academic community was that the preliminary oral was the second to last final step on the road to the Ph.D. and that the student who passed this hurdle was admitted to a kind of Junior Ph.D. The rubrics of the Graduate School tended to reinforce this view by virtue of the fact that it was at this time the student formally became a "candidate" for the Ph. D. (as established for $20 fee purposes).

Candidacy. Professor Fenton criticized this "traditional" view and suggested in its place a much earlier preliminary oral examination. Considerable discussion centered around how soon the preliminary oral examination could and should be held. One suggestion was to admit a student to candidacy at a much earlier date upon the recommendation of the department to the Graduate School ("Upon recommendation of the major department and the concurrence of the minor department the student is admitted to candidacy.")

IV. The Ph.D. Program

Still another suggestion was the desire that the three-year Ph.D. program be required to be filed at a much earlier date. Professors Darley and Fenton both were critical of the preliferation of courses that some departments and many students felt compelled to

offer, and also with the practice of submitting programs which were nearly complete with grades. One possible device that was suggested to obviate this practice was to require that the Ph.D. program be filed not earlier than the third and not later than the fourth quarter of residency.

Possible policy procedures toward the "unfortunates" was also considered. The "unfortunates" would be terminated, where they were very weak, at the end of the first year. In the more marginal cases termination would likely follow at the end of the second year. There was no agreement in the subcommittee with respect to the awarding of Master's degrees for these terminations where appropriate.

V. The Master's Degree and the Ph.D.

One concern expressed by Dean Boddy was that in the discussion to this point the subcommittee has neglected to consider those departments which accepted and encouraged both Master's and Ph.D. programs. Many departments accepted graduate students for the Master's degree, and following the awarding of the Master's recommend either that the student can or should go on to the Ph.D. or should terminate.

Where this occurs it frequently happens that a Master's degree requires four to five quarters of residency. In these cases the "Ph.D." progress reports might not cover these students. Their evaluation would not begin until after a decision had been reached concerning the appropriateness of their pursuing a Ph.D.

VI. The Liberal Arts Major

One other area of discussion that was not pursued centers upon the Liberal Arts student with a minimum exposure to a major in terms of the total amount of course concentration, with a broad selection in many departments of the Liberal Arts. In these cases, the time table for departmental evaluation by examination (the preliminary examination) might fall later due to the fact that the graduate student required both a broader and more intensive exposure to the field in his early quarters of graduate study.

In cases such as these the rigidity of a preliminary examination time-table might prove to be illogical. For example, a student who as an undergraduate was exposed to say 15 credits in a major, would have considerably different preparation than one who had accumulated some 45 or so hours of coursework in his major.

Conclusion

There was a definite need to shift the burden of evaluating the progress of students toward the Ph.D. from the shoulders of the individual adviser to the collectivity of the department. Dean Crawford defined the first order objective to be the implementation of a new review mechanism which was feasible in common for use by all departments and colleges in the Graduate School.

Biomedical Science - Minor
JUN - 8 1965

UNIVERSITY OF *Minnesota*

Hospital P. O. #495

MEDICAL SCHOOL
DEPARTMENT OF SURGERY • MINNEAPOLIS, MINNESOTA 55455

June 8, 1965

Dr. Bryce Crawford
Dean, Graduate School
University of Minnesota

Dear Bryce:

Enclosed is a copy of an application for a Graduate Training Grant, the purpose of which is to begin modestly the development of a program in Bio-Medical Engineering.

I believe we can agree that achieving a fusion of certain of the disciplines involved in the fields of human biology and engineering appears to offer one rational approach to emphasizing more quantitative analysis in medical research. Therefore, the establishment of training programs which potentially contain the strengths of hybridization and which could yield investigators able to work comfortably with the tools (or problems) of the newly acquired discipline, appears to be a reasonable step in this direction. Or so it seems to a number of us who are identified in this project and thus we request approval for those administrative procedures related to the purposes outlined in this grant request.

Moreover, while indicating that I do hope this general concept will have your support, I also assure you of the availability of Dr. Blackshear, Dr. Bernstein, or me--if any of us can be of assistance by answering questions or otherwise facilitating the processing of this request.

Yours very truly,

Richard L. Varco, M. D.
Professor of Surgery

RLV/kr
original sent to Dean Howard also

Department of
HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE

(LEAVE BLANK)

APPLICATION FOR GRADUATE TRAINING GRANT
UNDER THE PUBLIC HEALTH SERVICE ACT

ATTENTION:

Date June 1, 1965

- ☐ NATIONAL INSTITUTE OF ARTHRITIS AND METABOLIC DISEASES
- ☒ NATIONAL HEART INSTITUTE
- ☐ NATIONAL CANCER INSTITUTE
- ☐ NATIONAL INSTITUTE OF NEUROLOGICAL DISEASES AND BLINDNESS
- ☐ NATIONAL INSTITUTE OF DENTAL RESEARCH
- ☐ DIVISION OF GENERAL MEDICAL SCIENCES
- ☐ DIVISION OF NURSING RESOURCES PHS
- ☐ NATIONAL INSTITUTE OF ALLERGY AND INFECTIOUS DISEASES
- ☐ _____

AREA (see Instruction Sheet): Cardiovascular

Application for a training grant is hereby made by the institution named below for the subject and purpose indicated. The amount requested is based on estimated requirements for a one year period, but not limited in availability to such period. (See Instructions.)

PERIOD	AMOUNT REQUESTED (from page 2, item 18)
January 1, 1966 through June 30, 1967	$166,899

PURPOSE (check appropriate SINGLE item)

- A ☒ Establishing new training program
- B ☐ Expanding present training program
- C ☐ Improving present training program
- D ☐ Continuing grant-supported training program

NAME AND TITLE OF TRAINING PROGRAM DIRECTOR Eugene F. Bernstein, M.D. Assistant Professor of Surgery	MAILING ADDRESS OF TRAINING PROGRAM DIRECTOR University of Minnesota Hospitals Minneapolis, Minnesota 55455
NAME OF INSTITUTION University of Minnesota	ADDRESS OF INSTITUTION Minneapolis, Minnesota 55455
NAME OF DEPARTMENT Surgery and Mechanical Engineering	ADDRESS OF DEPARTMENT University of Minnesota Minneapolis, Minnesota 55455
NAME AND TITLE OF DEPARTMENT HEAD Owen H. Wangensteen, M.D.	MAILING ADDRESS OF DEPARTMENT HEAD University of Minnesota Hospitals Minneapolis, Minnesota 55455
NAME AND TITLE OF FINANCIAL OFFICER Mr. Clinton T. Johnson Ass't. Vice President, Business Adm.	MAILING ADDRESS OF FINANCIAL OFFICER University of Minnesota Minneapolis, Minnesota 55455
NAME AND TITLE OF OFFICIAL AUTHORIZED TO SIGN FOR INSTITUTION Mr. Clinton T. Johnson Ass't. Vice President, Business Adm.	MAILING ADDRESS OF OFFICIAL AUTHORIZED TO SIGN FOR INSTITUTION University of Minnesota Minneapolis, Minnesota 55455

AGREEMENT

It is understood and agreed by the applicant: (1) that funds granted as a result of this request are to be expended for the purposes set forth herein; (2) that the grant may be revoked in whole or in part at any time by the Surgeon General of the Public Health Service in the event that the funds are not utilized in accordance with the purposes set forth in this application; (3) that the training center will comply with the current requirements established by the Surgeon General to qualify for training grants; and (4) that, if any invention arises or is developed in the course of the work aided by any grant received as a result of this application, the applicant institution will either (a) refer to the Surgeon General for determination, or (b) determine in accordance with its own policies, as formally stipulated in a separate supplementary agreement entered into between the Surgeon General and the grantee institution, whether patent protection on such invention shall be sought and how the rights in the invention, including rights under any patent issued thereon, shall be disposed of and administered, in order to protect the public interest.

PERSONAL SIGNATURE _____

(This agreement must carry the actual signature of the official authorized to sign for institution.)

(Sign original only in ink)

(LEAVE BLANK)

These dates to be the same as period on page 1.

1A. Budget Proposed for the Year January 1, 19 66 through June 30, 19 67

CATEGORY AND ITEM (Use additional blank sheets, if needed)	BUDGET REQUESTED * FROM P.H.S.	BUDGET OTHER SOURCES
PERSONNEL (Itemize)		
See detailed Personnel Budget on attached Continuation Page	$115,332	
TRAINING STIPENDS		
CATEGORY TOTAL	$115,332	
PERMANENT EQUIPMENT (Itemize)		
1. 8 channel, direct writing recorder for physiological measurements - Beckman Offner or Sanborn	8,500	
2. Blood Flow Microscopy Lab. Equipment	14,000	
CATEGORY TOTAL	$ 22,500	
CONSUMABLE SUPPLIES (Itemize)		
Miscellaneous supplies and small equipment	7,500	
CATEGORY TOTAL	$ 7,500	
TRAVEL		
(Student and Faculty) One trip/Fellow and Staff/year	2,250	
CATEGORY TOTAL	$ 2,250	
OTHER EXPENSE (Itemize)		
Tuition for 3 Trainees @ $900/year	4,050	
Publications, Visiting Faculty (including travel, maintenance, and honoraria)	4,500	
CATEGORY TOTAL	$ 8,550	
SUBTOTAL	$156,132	
INDIRECT COSTS (Not to exceed 8% of subtotal) 8% Overhead on $134,582	10,767	
1B. TOTAL FOR ~~THE YEAR~~ 18 mos.	$166,899	

1C. ESTIMATE OF FUTURE REQUIREMENTS

FIRST ADDITIONAL YEAR $ $138,666 THIRD ADDITIONAL YEAR $ $175,652

SECOND ADDITIONAL YEAR $ $180,901 FOURTH ADDITIONAL YEAR $ $185,523

PHS-2499 REV. 10-56 *Calculated for 18 months

APPLICANT'S COPY

PERSONNEL (Itemized)		Requested From PHS*	Other Sources
Faculty	% Time		
1. Mechanical Engineering Staff			
Perry L. Blackshear, Prof., Mech. Eng.	(25%)		Institution
Ernst R. G. Eckert, Prof., Mech. Eng.	(12½)		"
Edward A. Fletcher, Prof., Mech. Eng.	(12½)		"
Darrell A. Frohrib, Lecturer, Mech. Eng.	(12½)		"
Richard J. Goldstein, Ass't. Prof., Mech. Eng.	(12½)	$24,000	"
Warren E. Ibele, Prof., Mech. Eng.	(12½)		"
Richard C. Jordan, Prof., Mech. Eng.	(10%)		"
Russell S. Nyquist, Ass't. Prof., Mech. Eng.	(12½)		"
Kenneth T. Whitby, Assoc. Prof., Mech. Eng.	(12½)		"
2. Engineering Surface Chemist** Ass't. Prof.	(100%)	18,000	None
3. Physiology, Assistant or Associate Prof.	(50%)	10,500	Institution
4. Eugene F. Bernstein, M.D., Ph.D. Assistant Professor of Surgery	(50%)	12,000	"
5. Aldo R. Castaneda, M.D., Ph.D. Assistant Professor of Surgery	(25%)	6,000	"
Technical=			
1. Technician		5,400	None
2. Secretary		4,500	None
3. Engineering Research Assistant		9,000	None
Fringe Benefits and Insurance (8% of Non-Student salaries ($80,400)		6,432	
Trainees***			
1. 1 postdoctoral Surgical Fellow (@ $6,000)		9,000	None
2. 2 predoctoral Engineering Fellows (@ $3,500)		10,500	None
CATEGORY TOTAL		$115,332	

*Calculated for the 18 month period requested
**To be recruited especially for training program
***See accompanying list of individual trainees

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Continuation page

DO NOT TYPE IN THIS SPACE-BINDING MARGIN

	SECOND YEAR	THIRD YEAR	FOURTH YEAR	FIFTH YEAR
Salaries and Stipends	* $23,000	$25,000	$25,000	$25,000
	* 12,000	15,000	15,000	15,000
	* 8,500	10,000	12,500	15,000
	* 9,000	15,000	16,000	16,000
	* 5,000	6,000	7,000	8,000
	13,000	21,000	21,000	21,000
	10,500	14,000	14,000	14,000
	* 3,600	3,600	3,600	3,600
	* 3,000	3,000	3,000	3,000
	6,000	12,000	12,000	12,000
Travel	2,500	3,000	3,000	3,500
Other Expense	3,000	3,000	3,000	3,000
Permanent Equip.	10,000	5,000	5,000	5,000
Misc. Supplies	10,000	15,000	15,000	15,000
Fringe Benefits on non-student salaries	5,128	6,208	6,568	6,848
Subtotals - - -	$124,228	$156,808	$161,668	$165,948
8% Overhead - - -	9,938	12,544	12,933	13,275
	$134,166	$169,352	$174,601	$179,223
Tuition	4,500	6,300	6,300	6,300
TOTALS - - - - -	$138,666	$175,652	$180,901	$185,523

*Non-student salaries

JUSTIFICATION FOR SPECIAL BUDGETARY ITEMS

Permanent Equipment:

Present plans for the Biomedical-Engineering laboratory do not permit us to accurately predict our needs beyond the 18 month period initially requested. However, it is anticipated that major items of research equipment will be requested from research support grants, and that the equipment funds requested herein beyond the initial 18 months will be necessary for student research projects and training demonstrations.

First 18 Months:

1. An 8 channel, direct writing recorder for physiological measurements Beckman-Offner or Sanborn - with appropriate accessories for measuring pressures, EKG, EEG, respiratory function, blood flow, etc. A compatible Magnetic Tape Recording System has been requested in a research grant supplement (HE-08981-02S). $8,500

2. Laboratory Equipment for a Microscopic Study of Flowing Blood

The objective of this laboratory is to aid in understanding the behavior of red cells and other formed elements in the neighborhood of a solid wall. The equipment presently employed for this purpose includes an adequate light source, microscope and camera for recording stationary states and visually observing slow transients.

The additions contemplated will make possible the use of high speed photography and stroboscopical illumination. The new equipment will be fabricated or assembled on a developmental basis - its final form cannot be foreseen at this time. The budget is accordingly made up of those initial items for which cost estimates are available plus a sum to cover estimated further costs.

Blood Flow Microscopy Lab Equipment	Estimated Cost
1. A vibration mounting and adapter for high speed motion picture camera	$1,500
2. A stroboscopic light source	5,000
3. Parts for flow regulating equipment	1,500
4. Additional microscopic accessories (image amplification, laser illumination) estimated	6,000
TOTAL	$14,000

(LEAVE BLANK)

2. List support for this training program from all sources, including the Public Health Service. Specify the source in each case.

SOURCE	AMOUNT	PERIOD OF SUPPORT
PREVIOUS (within last five years)		
NONE		
CURRENT		
Development of a Mechanical Heart Source: USPHS	$51,577	6/22/64-8/31/65
PENDING		
Development of a Mechanical Heart (Supplement) Source: USPHS	$48,147	7/1/65-6/30/66

TRAINING PLAN AND SUPPORTING DATA

On the continuation pages provided, give details of the proposed training plan and other necessary data in accordance with the outline below. Number each page consecutively. Additional continuation pages, if needed, may be requested from the appropriate Institute.

Before preparing this portion of the application, see the instruction sheet from the specific Institute to which you are applying.

I. PROPOSED PROGRAM

A. Purpose: provide a complete but concise statement of the training needs that the proposed training program will fulfill.

B. Training Plan:

1. Describe the current training program (if any) at your institution in this area of training.
2. Describe the proposed training program for which support is requested.
3. Provide a list of the categories of professional personnel and the estimated number of persons within each category for whom training will be provided annually.

II. STAFF AND FACILITIES

A. Staff: Provide brief biographical sketches of all professional staff having major responsibilities in this training program.

B. Facilities: Describe the training facilities at your disposal.

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CARDIOVASCULAR TRAINING GRANT PROPOSAL IN BIOMEDICAL AND MECHANICAL ENGINEERING SCIENCES

1. Research Plan

A. Specific Aim

The purpose of this grant request is to formalize and expand the rather modest mutual cardiovascular training program currently in progress between certain units of the Institute of Technology and the College of Medical Sciences at the University of Minnesota. The direct object of the requested support is the development of individuals who are familiar with, and able to do effective cardiovascular research in both areas.

B. Introduction to the Proposal

Such a program involving joint inter-disciplinary training for physicians and engineers appears inevitable. For the immediate application of available engineering techniques to the solution of current cardiovascular problems, as well as the development of what is likely to become a new and important branch of engineering, this kind of training facility will be critical to progress in understanding and dealing with human biology and disease. In turn, a more ready familiarity with medical language and related areas of applied medical research will open the prepared engineering mind to major opportunities for research contributions. This program is specifically aimed at the development of individually competent investigators, rather than as a supportive or service function of either branch's research endeavors.

This proposal is aimed at prolonged and intensive training of a small, thoughtfully selected group of well-prepared and highly motivated men--who are more likely to respond to close, personal supervision and individualized program planning. A minimum of two, and more commonly, three years of study is suggested--to permit the development of men who, though retaining their primary identity as Surgeons and Engineers, will be able to think and work comfortably, knowledgably and independently in the supplementary field of their choice. Too, during the early years of the program, members of both the Surgery and Engineering Staffs must be considered as students in their opposite disciplines.

Therefore, we propose that the Engineering graduate student be introduced to problems in medicine by formal courses in the College of Medical Sciences. In particular, these will include: courses and graduate seminars in Physiology, seminars in Experimental Surgery and Surgical physiology, and direct participation (joint efforts) with a medically-oriented graduate advisor in a cardiovascular research project. Reciprocally, the M. D. will receive instruction in basic engineering, both in the laboratory during co-operative investigations, and through formal, albeit modified, engineering courses in Fluid and Solid Mechanics, Heat and Mass Transfer, Thermodynamics, and Systems Analysis.

A healthy and workable alliance between Mechanical Engineering and Surgery has emerged during the past 18 months of co-operative effort to develop a mechanical heart--a project which is receiving N. I. H. support. The ability of these Engineers to bring basic scientific training and modern technology to the

fluid mechanical and mass transfer problems implicit in prolonged blood pumping has already provided the basis for joint progress in: (1) defining the relative importance of those fluid mechanical factors responsible for blood trauma (e. g. shear, pressure and wall interactions); (2) identifying the limits of biological tolerance to hemolysis, destroyed RBC ghosts, and the blood loss associated with such continued pumping, and (3) designing and constructing initial models of specialized pumps based on this information.

Graduate students in both Engineering and Surgery are already intellectually involved in these and other related projects (Appendix A). An expression of this commitment is indicated by the fact that these investigations will be the basis for their Ph. D. or M. S. Theses. We believe it is even more important, however, that real progress has been made in establishing an enthusiastic working partnership based on common purpose and mutual respect. In fact, this alignment has recently been expanded to include individual members of the Department of Chemical Engineering, Biochemistry and Laboratory Medicine (Hematology), thereby adding experts in particle technology, surface chemistry, membrane physiology, protein chemistry and blood ultrastructure to the group.

The present proposal of more formal and expanded training program in Biomedical Engineering would both utilize current course work, seminars and symposia, and in addition, develop new Engineering teaching procedures by analogy (Appendix C). Too, it will support a greater student enrollment than can now be handled with the limited financial resources at hand, provide for the acquisition of graduate degrees involving Biomedical Engineering by qualified individuals, and permit the direct affiliation of this program with the Department of Physiology, wherein the engineer may acquire basic knowledge, terminology, and laboratory techniques as they apply to the experimental animal. For many years, surgical trainees have acquired such training in the Department of Physiology, during a period of 12-24 months, ~~and~~ commonly acquiring a Master of Science in Physiology in the course of these studies.

C. The Proposed Program

The purpose of the training program is to create an environment in which engineers and surgeons are able to communicate, work on problems of common interest and perhaps discover new approaches to these problems. Because engineers will be potential Ph. D. candidates and the surgeons will be men of equivalent ability and extensive training, programs will be individualized.

Special courses are to be developed in which an understanding of the engineering subject is aided by recourse to demonstration and analogy. These courses are to be offered with the background of the experimental surgeon in view and will not require formal, special prerequisites but will anticipate sufficient interest on the part of those enrolled that by self-study, working competence in the necessary basic areas is required. These will be graduate level courses. A surgeon who completes 24 credits in the formal and problems courses as part of his Ph. D. program will be credited with a minor in Mechanical Engineering science. An engineering Ph. D. candidate who completes 24 credits of course

approved by the surgical faculty will be credited with a minor in Biomedical Science.

It is anticipated that certain factors will be common to each program: There will be an advisor from the Department of Surgery and from the Department of Mechanical Engineering for each student, and each student will attend the seminar series, in which he will be encouraged to participate in special research projects involving students and faculty in both disciplines.

The seminar series will be varied in content and format and will adapt to best serve the program as it matures. The seminar series will consist of lectures, demonstrations, and discussions designed to familiarize the participants with the techniques and goals of the two disciplines represented (Appendix B). As interests awaken and problem recognition advances, the participants can be expected to embark on pertinent research activities of limited scope. Thus, it is expected that with time, the fraction of seminars devoted to formal lectures will diminish and the fraction devoted to a discussion of research activity will increase.

The balance of the program can be conveniently discussed separately for the surgeons and the engineering graduate students.

Surgeons

A surgeon working for the Ph. D. in Surgery with a minor in the Mechanical Engineering Sciences will be expected to take 24 to 27 credits in Engineering over a 24 to 36 month period. At present, it is believed that as many as 9 of these credits can and should be in the special seminar series described above. This point of view may change as the program matures. The balance of the credits are to be selected from 100-200 series courses approved for graduate credit by the Graduate School and recommended by the engineering advisor. These will include new courses that have been modified specifically for mature, high-ability students, and will not require the customary prerequisites. The surgeon will have the option of taking either the standard courses or the new courses (the new courses stress insight into the fundamental principles involved, as opposed to detailed knowledge of the subject matter). Initially, seven such courses will be offered (Appendix C). If these are effective, their number will increase. It is customary in the Mechanical Engineering Department to recognize courses according to content rather than departmental designation, such that the courses available to the surgeon can be drawn from other departments and will be limited only by the surgeon's willingness to acquire the necessary prerequisites. If the surgeon desires to take advantage of the special courses modified by Mechanical Engineering, he may acquire his 24 credits without any additional make-up course work.

A surgeon's typical 3 Year Program in Biomedical and Mechanical Engineering sciences research with a minor in Mechanical Engineering sciences is appended. An additional three years of clinical surgery is then the basis for acquiring a Ph. D. degree in Surgery.

First Year --

1.	Biomedical Engineering Seminar	3 credits
2.	Research Laboratory-all 4 quarters-about 50% time, credits as arranged.	
3.	Differential and Integral Calculus	10 credits
4.	Human Physiology	10 credits
5.	Physiologic Measurements	3 credits
6.	Fluid Mechanics for Non-Engineers or	3 credits
7.	Thermodynamics for Non-Engineers	3 credits

Second Year --

1.	Biomedical Engineering Seminar	3 credits
2.	Research Laboratory - about 50% time	
3.	Differential equations	5 credits
4.	Biophysics of Circulation, or Hemodynamic Measurements	3 credits
5.	Physiology Cardiovascular Seminar	1 credit
6.	Heat Transfer for Non-Engineers	3 credits
7.	Mass Transfer for Non-Engineers	3 credits

Third Year --

1.	Biomedical Engineering Seminar	3 credits
2.	Research Laboratory - at least 50% of time	
3.	Hemodynamic Measurements or Biophysics of Circulation	3 credits
4.	Systems Analysis for Non-Engineers	3 credits
5.	Particle Technology or	3 credits
6.	Solid Mechanics Design Seminar	3 credits
7.	Elective courses in Engineering or Physiology	Credits arranged.
8.	Thesis based on Research Work.	

Engineering Graduate Students

Upon the advice of the advisor of the Department of Surgery, the engineering graduate student will be encouraged to take courses pertaining to the biological sciences presently offered in various departments, but with emphasis upon those offered in the Department of Physiology of the Medical School. These again will be expected to consist of 100-series courses presently approved by the Graduate School. The engineer will be expected to acquire the necessary background to qualify for these courses. Again, it should be stressed that rapport established by participating in the seminar series and working on projects in which mechanical engineers and surgeons share their interests will be the heart of this program.

A typical three-year plan for the Ph. D. in Mechanical Engineering with a minor in Biomedical Science would be, in addition to the thesis,

(5)

Continuation page

First year

Heat Transfer	9 credits
Thermodynamics	9 credits
Physiology	10 credits
Seminar in Biomedical Engineering	3 credits
Research Laboratory	Credits arranged

Second Year

Energy Transport in Chemically Reacting Gases	3 credits
Mass Transport in Chemically Reacting Gases	3 credits
Atomization Vaporization and Mixing	3 credits
Chemistry of Combustion	6 credits
Biochemistry	10 credits
Seminar in Biomedical Engineering	3 credits
Research Laboratory	Credits arranged

Third Year

Magneto Hydrodynamics	9 credits
Fluid Mechanics	9 credits
Biophysics	9 credits
Seminar in Biomedical Engineering	3 credits
Research Laboratory	Credits arranged

Total Credits

In Major	50
In Minor	29
Common	9

D. Implementation

It is expected that the first year will be spent in familiarizing the members of the Mechanical Engineering faculty and those participating members of the School of Surgery with the opportunities and the aims of the proposed training program. During the first year the chief vehicle for communication will be the seminar series, in which it is hoped the most promising areas for cross discipline cooperation can be discovered and initially exploited. During this initial year the special courses to be prepared by the Mechanical Engineering staff will be developed and some may be given on a trial basis. By the beginning of the second year it would be possible to implement the objectives of the program by means of formal courses, as well as by involving the trainees more intimately in the seminar series described earlier.

Initially, the program will use existing laboratory facilities in Mechanical Engineering and in the School of Medicine to carry through the research project courses in which the surgeons and the engineers jointly participate. At present this space consists of two laboratories in Mechanical Engineering having a total

floor area of 1800 ft^2 (equipped with excellent fluid mechanical instrumentation, but only partially equipped for studying blood flow), and three well-equipped laboratories in the Medical School facility with a total floor area of 550 ft^2. As need arises, this space may be expanded. It is anticipated that the flow of ideas generated by the joining of disciplines will make new instrumentation and additional facilities necessary as additional definite proposals materialize.

The special versions of the courses designed to enrich high caliber, mature graduate students without extensive engineering and mathematical background will require the use of laboratory demonstrations and instruction by analogy. Some of this material is presently available, as, for example, a library of excellent films for use in the instruction of fluid mechanics and samples of fluid mechanical instrumentation. The other courses will require some demonstration paraphernalia. (It is suggested that Senior graduate students in engineering be called upon to design this equipment and present the demonstrations during the courses.) The faculty listed in Appendix A has been consulted at some length. They have indicated their willingness to participate actively in the development of the individual courses, in the seminar series, and are particularly enthusiastic about participating in the Project. In each case, course outlines have been prepared and in each case enough thought has been given to make the objectives of the modified courses seem within the realm of reason.

Fellowships for Participants

Although qualified graduate students from both disciplines will be welcomed to participate in the program, it is suggested that fellowships be offered for those engineers and surgeons who plan on participating to the extent of receiving the minor in the respective discipline. Because of their more extensive preparation, the surgical residents will receive a higher stipend than the engineers.

E. Discussion

Three questions appear to be pertinent: (1) Why should surgeons be interested in engineering, particularly mechanical engineering? (2) Why should mechanical engineers be interested in the problems of experimental surgeons? and (3) Why should this particular training program be offered at the University of Minnesota?

(1) Why should Surgeons be Interested in Mechanical Engineering Science?

The first question can be explored easily by considering the example of cardio-pulmonary bypass and the significant relationship to the engineering disciplines most closely related to it.

Cardiac Bypass. Heart bypass is perhaps most closely related to the science of fluid mechanics, which is a well-developed field with research and instruction at widely varying levels of sophistication.

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How could a course in fluid mechanics be of value to a surgeon? Perhaps the important benefit would be development of a fluid mechanical intuition - an understanding of pressure-velocity relationships governing flow in complex circulatory separation, recirculation transition to turbulence, and when to look for cavitation. In addition to this fluid mechanical intuition, the surgeons would develop an awareness of the instrumentation techniques available in this field, and their possible applications in the human circulatory system. He would learn the mechanics of flow handling equipment, such as pumps, flow regulators, and pressure regulators.

Pulmonary Bypass and Oxygenators. In lung bypass, knowledge of heat and mass transfer is very important. Here, too, the surgeon should develop a heat and mass transfer intuition, an awareness of the contributory fluid mechanical and thermodynamic factors. He should be able to estimate surface area requirements for transfer surfaces. Familiarity with the enormous body of heat and mass transfer literature directly applicable to physiological problems, once the physiological counterparts of the existing solutions are identified, could be of inestimable value.

Artificial Organ Construction. Here, knowledge of solid mechanics is important, and the development of a solid mechanical intuition. For example, force load tolerances in relation to distortion, suitability of materials for the particular mechanical applications, and tolerance of thermal and mechanical cycling by different materials are problems which confront the surgeon. Here, too, he will learn of the materials available and their classification.

The Overall System. Two engineering disciplines, knowledge of which might lead to improvement of the overall extracorporeal system are thermodynamics and systems analysis. In thermodynamics the surgeon will learn more of the laws of conservation of mass and energy, and the second law of thermodynamics and their applicability to temperature control and the maintenance of hypothermia. "Systems analysis" refers to the study of advanced mathematical techniques in engineering systems. Here again the direct advantage to the surgeon will be an enriched intuition. He will learn what to expect from the system and how to evaluate the system in terms of what he expects from it.

The above examples illustrate how knowledge of basic mechanical engineering science is important to extracorporeal systems and the surgeon. In addition, there exist pertinent areas of specialization within the Department of Mechanical Engineering at the University of Minnesota, as for example, the area of particle technology. Here a highly developed technology, designed primarily to predict the behavior of aerosols, can be applied directly to study of the behavior of formed elements in the blood and their interaction with the walls of artificial organs, as well as the physiological flow system. In summary, the surgeon must be interested in engineering, particularly mechanical engineering, because mechanical engineering science can enrich his intuition, can introduce him to useful instrumentation and control techniques, and offers systems evaluation methods for rating his experimental circulatory system.

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(2) Why Should Mechanical Engineers be Interested in the Problems of Experimental Surgeons?

Throughout the evolution of science and engineering, notable advances have been achieved through the collaboration of two or more disciplines. However, only in recent years has it been recognized that such interdisciplinary activities may not only be rewarding but necessary for the attainment of certain goals. Today, not only are the medical scientists seeking the aid of physical scientists and engineers in the development of data collection and analysis devices and in the development of artificial organs and therapeutic equipment but the engineers are, in turn, finding that the elegant designs of nature can serve as models in suggesting and solving a broad spectrum of engineering problems.

The modern mechanical engineer is indeed challenged by these problems and recognizes the mutual benefits to be derived through his involvement. The mechanical engineering student in a four-year program is exposed to approximately a year and one-half of basic mathematics, physics, and chemistry, and approximately a year of basic engineering science, such as thermodynamics, heat transfer, and fluid and solid mechanics. He studies approximately three-quarters of a year in the humanities and social sciences, and three-quarters of a year in the integration of basic and engineering science into engineering systems with a practical end objective. He encounters a rich variety of engineering problems in varying fields. For example, in a course in combustion the student is required to apply his proficiency in mass transfer to such basically related problems as (a) the diffusion of oxygen to a burning fuel droplet, (b) the influence of flow velocity on respiration in fish gills, (c) the mass transfer factors influencing the design of a membrane oxygenator, (d) the ablation rate of a rocket exhaust nozzle, and (e) mass transfer probes for detecting cardiac shunts.

Since the engineer is faced with the problem of finding practical solutions, he is continuously faced with drawing parts of the solution from all fundamental information available. In searching for needed information, he frequently finds that gaps remain. For example, the relationship between the oxygen concentration gradients and oxygen flux in blood, particularly near walls, is at present poorly formulated. The mechanical engineer recognizes theoretical and experimental work that needs to be done falling within his domain of competency that will help him solve the membrane oxygenator problem and facilitate solving future related engineering calculations as well. He further recognizes that in solving this problem he will contribute to a better understanding of mass transfer in particulate suspensions in general.

From such experiences arises the conviction that:

1. Basic engineering science is directly applicable to many bio-medical problems.

2. The engineer profits from the application of his scientific tools to a variety of practical problems by (a) a better understanding of the tools under study and (b) recognizing the basic similarities that exist in outwardly diverse systems.

3. The engineer recognizes that in the solution of problems related to biology, he draws additional technical information that can contribute to the advancement of his own scientific disciplines too.

Finally, it has long been recognized that one of the most stimulating learning experiences for an engineer is to work with a man familiar with and perhaps somewhat fanatic about a complex system. For example, one of our most popular engineering professors is a man who is enthusiastically and intensely concerned with the internal combustion engine. The student who comes to him with a suggested engine modification is amazed, pleased and finally fascinated as he hears the multiplicity of consequences his proposed change would bring to bear upon the rest of the system. As a result, the student gains much better insight into the interaction of the various parts of such a complex machine. We now also find that our engineering students who are placed in close association with the experimental surgeons are enjoying this same sort of learning experience - the same fascination.

The challenges that lead the engineer to develop his scientific disciplines are found in abundance in the surgical-engineering area. The teachers (experimental surgeons) who are familiar with this complex system are available to orient, stimulate and fascinate. Clearly the engineer, particularly the mechanical engineer, can flourish here.

(3) Why Should This Particular Training Program be Offered at This Particular University?

First of all, there is a long history of cooperation between the Medical School and the Physical Sciences at Minnesota. The physiologists have encouraged their students to take courses in the physical sciences, coupled with the Institute of Technology encouraging its students to take courses in the biological sciences. The existence of joint research projects, as the one presently supported by the National Institute of Health in the development of an artificial heart, is in itself good evidence of this willingness to cooperate. Clearly an eagerness to cross discipline lines in pursuit of problem solutions is evident in this Institution and in these Departments.

In summary, this particular university has competent people who have backgrounds with which to continue the proposed program but, more important, the University itself is pervaded by a willingness and enthusiasm to master all of its forces necessary to solve problems which cross departmental and school lines.

F. Participants

1. For Engineering

Drs. R. C. Jordan and P. L. Blackshear, Jr. will be responsible for the organization and supervision of the Mechanical Engineering Program. Liaison will be maintained between the cooperating groups by Dr. Perry Blackshear, Professor of Mechanical Engineering. Information concerning those members of the Mechanical Engineering faculty who have expressed a willingness to participate in the program are appended. It is expected that as the balance of the Mechanical

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Engineering staff become familiar with the biomedical problems, this list of participants will grow.

2. For Surgery

Drs. Richard Varco and Eugene Bernstein will be responsible for the organization and supervision of the Experimental Surgical Program. A weekly seminar in Surgical Physiology has been part of our Departmental Schedule for many years - providing a format for the presentation and discussion of suitable surgical research problems. In addition, weekly meetings of our own multidiscipline research group will continue, and be available to these students. Formal courses in Experimental Surgery are not included in the present plan - since practical experience and detailed exposure to a precise problem are presently deemed to be superior techniques for achieving investigative confidence in biological systems.

G. Facilities for Research

At the present time the joint Engineering-Surgery Research Project, related to the development of an artificial heart, is utilizing three laboratory areas within the Department of Surgery totalling 550 sq. ft. These include an airconditioned, modern, well equipped experimental surgical laboratory, and two additional modern chemistry laboratory areas. These, in addition to adequate animal housing facilities, have provided sufficient space for the projects presently in progress. In addition, two laboratories in Mechanical Engineering, with a total floor area of 1800 sq. ft., and well equipped for engineering measurements, are available for projects related to this training grant. These combined areas would be the primary laboratory teaching and research facilities for the student and faculty participants within the scope of this grant request. Within the same building as the surgical and chemistry laboratory space is a modern Biomedical Library, with provisions for graduate student office and study space.

In addition to these facilities, the entire array of Mechanical Engineering laboratories--the Heat Transfer Laboratory, Particle Technology Laboratory, Combustion Laboratory, and Industrial Engineering Laboratory--by virtue of the participation of their respective directors, will be available to the program and its participants for particular projects. These combined facilities should provide extensive and varied instrumentation opportunities for the medical and engineering trainees.

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Past Training Record

While this application represents a new training grant request for the Department of Surgery at the University of Minnesota, this Department has had a long and active interest in training academic surgeons who possess a working background in basic science. During the past 35 years, these training programs have been based upon close working relationships with the basic medical sciences, and particularly with the Department of Physiology. An indication of the number and quality of the trainees who have been attracted to, and produced by, this Department may be obtained from the following list of 15 University Surgical Departmental Chairmen and 19 additional Associate or Full Professors of Surgery in other University Medical Centers, who have graduated from this program.

In addition, the Cardiovascular Training Grant (HTS-5144) has helped support the training of a large number of recognized clinical cardiovascular surgeons. It is the intention of the present training grant to supplement, rather than compete with, the already existing Cardiovascular Surgical Training Grant. The present application proposes in depth training of research oriented individuals, with an emphasis on training in engineering for surgeons, and the development of biologically and surgically-oriented engineers. We feel that this does not at all compete adversely with the interests of the previous grant, which has as its express intention the development of well-trained cardiovascular surgeons.

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A. HEADS OF DEPARTMENTS

1. Campbell, Dr. Gilbert S. (Prof. & Chm.)
Department of Surgery
University of Arkansas School of Medicine
Little Rock, Arkansas

2. Dennis, Dr. Clarence (Prof. & Chm.)
Department of Surgery
State University of New York Downstate Medical Center
Brooklyn 3, New York

3. DeWall, Dr. Richard A. (Prof. & Chm.)
Department of Surgery
Chicago Medical School
Chicago, Illinois

4. Egdahl, Dr. Richard H. (Prof. & Chm.)
Department of Surgery
Boston University School of Medicine
Boston, Massachusetts

5. Hallgrimsson, Dr. Snorri (Prof. & Chm)
Surgical Department
Faculty of Medicine
University of Reykjavik, Landspitalinn
Reykjavik, Iceland

6. MacLean, Dr. Lloyd D. (Prof. & Chm.)
Department of Surgery
McGill University Faculty of Medicine
Montreal, Quebec, Canada

7. Merendino, Dr. K. Alvin (Prof. & Chm.)
Department of Surgery
University of Washington School of Medicine
Seattle, Washington

8. Miller, Dr. Fletcher A. (Prof. & Chm.)
Department of Surgery
Creighton University School of Medicine
Omaha, Nebraska

9. Moore, Dr. George E. (Director)
Roswell Park Memorial Institute
Buffalo 3, New York

10. Paine, Dr. John R. (Prof. & Co-Chm.)
University of Buffalo School of Medicine
100 High Street
Buffalo 3, New York

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HEADS OF DEPARTMENTS

11. Peltier, Dr. Leonard F. (Prof. & Chm. -Orthop.)
University of Kansas School of Medicine
Kansas City, Kansas

12. Raffucci, Dr. Francisco
Department of Surgery
University of Puerto Rico School of Medicine
San Juan, Puerto Rico

13. State, Dr. David (Prof. & Chm.)
Department of Surgery
Albert Einstein School of Medicine of Yeshiva University
New York City, New York

14. Thal, Dr. Alan P. (Prof. & Chm.)
Department of Surgery
Wayne State University College of Medicine
Detroit, Michigan

15. Zimmermann, Dr. Bernard (Prof. & Chm.)
Department of Surgery
West Virginia School of Medicine
Morgantown, West Virginia

B. PROFESSORS OF SURGERY

1. Ansell, Dr. Julian (Prof. & Chm. -Urology)
Department of Surgery
University of Washington School of Medicine
Seattle, Washington

2. Baronofsky, Dr. Ivan D. (Clinical Prof.)
University of Southern California
Office Address: 7910 Forest Street
San Diego, California

3. Barnard, Dr. Chris (Prof. & Head, Cardiopulmonary Unit)
University of Cape Town Faculty of Medicine
Cape Town, South Africa

4. Bowers, Dr. Warner (Prof. & Director, Graduate School of Medical Sciences)
New York Medical College
New York City, New York

5. Brackney, Dr. Edwin L.
Department of Surgery
Medical College of Georgia
Augusta, Georgia

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PROFESSORS OF SURGERY

6. Clatworthy, Jr., Dr. H. William (Prof. & Head, Pediatric Surgery)
Ohio State University College of Medicine
Columbus, Ohio

7. Enquist, Dr. Irving E.
Department of Surgery
State University of New York Downstate Medical School
Brooklyn 3, New York

8. Ferguson, Dr. Donald
University of Chicago, The School of Medicine
950 E. 59th Street
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9. Friesen, Dr. Stanley
Department of Surgery
University of Kansas School of Medicine
Kansas City, Kansas

10. Karlson, Dr. Karl E.
Department of Surgery
State University of New York Downstate Medical School
Brooklyn 3, New York

11. Kuo, Dr. Tsung-Po (Chief)
Department of Surgery
Kaohsiung Medical College
Kaohsiung, Taiwan

12. Lewis, Dr. F. John
Department of Surgery-Northwestern University
303 E. Chicago Avenue
Chicago 3, New York

13. Mason, Dr. Edward E.
Department of Surgery
State University of Iowa College of Medicine
Iowa City, Iowa

14. Schrader, Dr. Guillermo (Chief, Thoracic & Cardiovascular Surgery)
Hospital Militar
Bogota, Colombia, South America

15. Warden, Dr. Herbert E.
Department of Surgery
West Virginia School of Medicine
Morgantown, West Virginia

C. ASSOCIATE PROFESSORS OF SURGERY

1. Gott, Dr. Vincent L.
   Department of Surgery
   Johns Hopkins University School of Medicine
   Baltimore, Maryland

2. Read, Dr. Raymond
   Department of Surgery
   Wayne State University College of Medicine
   Detroit, Michigan

3. Shumway, Dr. Norman E.
   Department of Surgery
   Stanford University School of Medicine
   Palo Alto, California

4. Spellman, Dr. Mitchell
   Department of Surgery
   Howard University School of Medicine
   19th E. Streets S. E.
   Washington 3, D. C.

Appendix A

Personnel Presently Involved in Joint Engineering - Surgery Research Program

A. STAFF

Bernstein, E.F.	Asst. Prof.	Surgery	Artificial Heart
Brunning, Richard	Instructor	Lab. Med.	Hematology; Electron Microscopy
Blackshear, Perry L.	Professor	Mech. Eng.	Mass Transfer
Castaneda, Aldo R.	Asst. Prof.	Surgery	Cardiovascular Surgery
Dorman, Frank D.	Res. Assoc.	Mech. Eng.	Instrumentation and Techniques
Keller, Kenneth E.	Asst. Prof.	Chem. Eng.	Transport processes
Varco, Richard L.	Professor	Surgery	Cardiovascular Surgery
Wetlaufer, Donald	Assoc. Prof.	Biochem.	Protein Chemistry

B. ACTIVE CONSULTANTS

Loken, Merle K.	Asst. Prof.	Radiol.	Isotope Technology
Scriven, L. E.	Assoc. Prof.	Chem. Eng.	Surface Chemistry
Sundberg, R. Dorothy	Professor	Lab. Med.	Hematology, Blood Cell Morphology
Whitby, Kenneth T.	Assoc. Prof.	Mech. Eng.	Particle Technology

C. GRADUATE STUDENTS

Indeglia, Robert	Ph.D. Cand.	Surgery	To start July 1, 1965
Maybach, Eric	M.S. Cand.	Mech. Eng.	In 1st Year Med. School
Singh, Avtar	Ph.D. Cand.	Mech. Eng.	Microscopic Fluid Mechanics
Steinbach, Joseph	M.S. Cand.	Mech. Eng.	Macroscopic Fluid Mechanics
Wessling, Frank	Ph.D. Cand.	Mech. Eng.	Transport Processes

D. UNDERGRADUATE STUDENTS

Goodall, David	3 Yrs. Mech. Eng.	To start Med. School, Sept. 1965
Holeen, James	Mech. Eng.	
Perrin, Dwayne	Mech. Eng.	

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Appendix B

TOPICS OF FIRST YEAR'S SEMINAR PROGRAM

A. General Introductory Material

1. Biologic organization and development
2. Cellular physiology and structure
3. Control of biologic phenomena
4. Outline of the pertinent engineering sciences - R. L. Jordan, Jr.

B. Specific Areas of Interest

1. Artificial Organs

a) Heart	E. F. Bernstein
b) Lung	J. P. Lillehei
c) Kidney	W. O. Griffen, Jr.
d) Blood vessel	A. R. Castaneda

2. Surgical Techniques

a) Asepsis	R. L. Varco
b) Cutting or destruction: Lasers, ultrasound, cold	
c) Repair: Tissue adhesives	R. M. Indeglia
d) Limb and joint prosthetics	

3. Anesthesia

a) Critical function monitoring	J. J. Buckley
b) Controlled respiratory assistance	H. D. Westgate

4. Basic Physiology

a) Pulsatile blood flow	R. L. Evans
b) Clotting and thrombosis	H. Gans
c) Body heat exchange processes	R. R. Engel

Appendix C

The following is a set of seven courses that are being designed for the purpose of familiarizing non-engineers with the basic scientific disciplines of Mechanical Engineering. The courses will permit the student to treat the subject matter in a quantitative fashion; however, the primary emphasis will be upon basic concepts and illuminating examples such that the student will have acquired something of an "engineering intuition".

Thermodynamics of Biological Systems
(Biological Thermodynamics)

I. Introduction

- A. The role of thermodynamics in biology
- B. Fundamental concepts: the thermodynamic system and its description, properties, state, thermodynamic coordinates
- C. Measurement and properties, dimensions and units

II. The Laws of Thermodynamics

- A. Work transport - changes in state
- B. Heat transport - changes in state
- C. Thermodynamic equilibrium and thermodynamic coordinates
- D. Equation of state
- E. The first law of thermodynamics for closed and open systems
- F. The second law of thermodynamics for closed and open systems
- G. Entropy, reversibility and irreversibility

III. Thermodynamic Functions

- A. Equilibrium conditions in open systems
- B. Gibb's and Helmholtz functions
- C. Mixtures and equilibrium
- D. Standard state

IV. Equilibrium and Chemical Reactions

- A. Description of reacting system
- B. Thermodynamics of equilibrium reaction
- C. Equilibrium constant for chemical reactions

V. Thermodynamics of Reactions

- A. Collision theory of reactions, kinetic theory
- B. Application to biological systems
- C. Absolute rate theory
- D. Diffusion controlled reactions

Continuation page

Introduction to Fluid Mechanics for Non-Engineers

I. Characteristics of Liquids and Gases. Equilibrium Conditions.

II. Kinematics of Fluid Flow. The Dynamics of Frictionless Fluids.

III. Motion of Real Fluids, Turbulence, Resistance, Technical Applications.

An Introduction to Heat Transfer for Non-Engineers

I. Conduction

A. Fundamentals

1. Heat - Definition
2. Fourier's Law of heat conduction
3. Energy conservation - The first law of thermodynamics

B. Steady State Heat Conduction

1. Flux plots
2. Analogues
3. Sources and sinks

C. Transient Heat Conduction

1. Lumped constant
2. Simple dimensional analysis
3. Charts for solutions of representative problems
4. Effect of inhomogenieties
5. Effect of phase change

II. Convection

A. General Concepts

1. The heat transfer coefficient
2. Elements of boundary layer theory

B. Fully Developed Flow

1. Laminar
2. Turbulent

C. Developing Region

1. Laminar Graetz problems
2. Turbulent Graetz problems

III. Biological Applications

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Continuation page

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An Introduction to Mass Transfer for Non-Engineers

I. Diffusion in a Stationary Medium

A. Fundamentals

1. Ficks law of ordinary diffusion
2. Thermal diffusion
3. Pressure diffusion
4. Body force diffusion

B. Some familiar examples of the four diffusion fluxes

C. Diffusion coefficients

D. The analogy with heat transmission

E. Conservation of matter

F. Available solution for diffusion in a stationary medium without chemical reaction

1. Transient 1 dimensional
2. Transient 2 dimensional
3. Steady state

II. Diffusion in flowing systems

A. Analogy with heat transfer

1. A resume of important solutions
2. The influence of interfacial velocities

B. Influence of chemical reaction

1. Some simple solutions using analogy with heat transfer
2. Illustrations of the general approach

III. Quantitative Examples of Mass Transfer in Biological Systems

Proposed Seminar Topics in Bio-Solid Mechanics Design

The topics outlined below represent principles of solid mechanics which have important design applications in bio-mechanical research. They may pertain to diversified phases of medical endeavor. The seminars would be directed toward an understanding of important concepts and their use in generating engineering design solutions, rather than emphasizing advanced analysis. This approach should suggest potential investigation areas in bio-mechanics which will profit from a joint medical-engineering perspective.

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Page 11

Continuation page

I. A Definition of Solid Mechanics and the Sources of its Engineering Principles

   A. Constitutive, equilibrium, and constraint relationships

II. Difficulties Encountered in the Exact Description of Physical Body Deformation Under Load

   A. The phenomenological approach to the description of material properties in macroscopic bodies
   B. The nature of simplified engineering theories of body deformation under load

      1. Representative examples of the engineering theories and their accuracy in various situations

III. The Role of Statics in Solid Mechanics Design

   A. The definition of a statical system
   B. Structures and their classifications
   C. Methods and difficulties of analyzing statical systems
   D. Good design practice in load distribution within statical systems

IV. Kinematics and Kinetics in Solid Mechanics Design

   A. Definitions
   B. Degrees of freedom of motion in coupled systems
   C. Mechanisms as kinematic motion-varying components
   D. The error in neglecting dynamic effects
   E. Elastic waves in distributed systems
   F. The nature and prediction of transient response

V. Synthesis and Optimization of Solid Mechanics Systems

   A. Objectives of synthesis
   B. Differences and similarities between engineering analysis and synthesis
   C. Problems of synthesizing systems based upon input-output relationships
   D. Computer synthesis

      1. Analogue
      2. Digital

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Proposed Course in Systems Analysis

The following are topics that potentially would constitute a systems analysis course for advanced medical students. Please understand that this outline was prepared with only very limited research. In order to have a fully prepared course on systems analysis it will be necessary to do much more planning and development.

Because of the high level of the students involved in such a course, I do not feel that using a teaching assistant (as we had previously discussed) for developing it would be appropriate. On the contrary, this course should be developed by the very finest academic personnel available. For that reason, I would recommend that the development of a course in systems analysis be funded to the extent of a half time faculty member with the rank of assistant professor or above for a period of one academic year.

It appears that I have digressed somewhat from the outlining of the course; it is as follows:

I. A Philosophy of Engineering Design

- A. Definition of Engineering Design
- B. Design by evolution
- C. Design by innovation

II. Engineering Design and the Environment

- A. Interaction of design and environment
- B. The socio-ecological system

III. The Morphology of Design

- A. Feasibility study
- B. Preliminary design
- C. Detailed design
- D. Planning the production process

IV. The Nature of Product Design Decisions

- A. What is a design decision
- B. The need for objective decision procedures
- C. Bounding the problem - strategies

V. Elements of Decision Theory

- A. States of nature
- B. The decision matrix

C. Predictions of state
D. Functional relationships

VI. The Decision Making Process with Risk

A. Dominance
B. Expected values
C. The design mix
D. Sensitivity
E. Utility

VII. The Decision Making Process with Certainty

A. Analytical resolution
B. Linear programming
C. The decision rule

VIII. Qualitative Decision Methods

A. Preference measures
B. Ranking and transitivity
C. Quality
D. Resultant quality
E. Dimensional analysis
F. A standard for comparison
G. Quality characteristics
H. Thresholds

IX. Simulation Methods

A. Compressing time
B. Time and sequence dependencies
C. Decision flow chart
D. Monte carlo
E. Sensitivity testing

X. Reliability in Product Designs

A. Concepts and definitions of reliability
B. Types of failures
C. Combined failures
D. Exponential and poisson distributions
E. Reliability of systems
   1. Series
   2. Parallel
   3. Stand-by
F. Component failure rates at system stress levels
G. Measurement of component and system reliability

XI. System Maintenance, Availability and Dependability

A. Expected number of in-service failures
B. System utilization factors
C. In-service repair
D. Redundant Systems
E. Equations for system availability and dependability

Beginning fall quarter the course, "Principles of Particle Technology", heretofore offered as a single course fall quarter, will be offered as two course sequence, fall and winter quarters. Pertinent information is as follows:

Course: M.E. 183-184 - Principles of Particle Technology

Instructor: K. T. Whitby

Description: Definition, theory, and measurement of particle properties, particle statistics, fluid dynamic, optical, electrical, thermal behavior of particles, particle transport, gas cleaning and particle processing.

Course Emphasis: Course emphasis is on basic principles with the theory being illustrated by more detailed analysis of gas cleaners, particle size measurement and particle transport.

Text: At present there is no really suitable text for the course. The "Mechanics of Aerosols" by N. A. Fuks a translation of a Russian book is currently being used.

Because of the lack of a really suitable text, considerable use must be made of reading assignments in various books, of supplementary ditto material and of the available chapters of a book now being written.

Syllabus - M.E. - 183

I. Introduction

A. Importance in process industries, gas cleaning, mining, etc.
B. Characteristics of matter in particulate state.
C. Intensive and extensive properties of the single particle.

II. Small particle statistics and measurement

A. Concept of a distribution.
B. Moments, weightings, means and their calculation.
C. Distribution functions and their mathematical and physical significance.

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Continuation page

D. Numerical integration of arbitrary distributions with an arbitrary function. Calculation of optical densities.
E. Calculation of particle area, volume, etc.
F. Measurement of geometric particle properties - Measurement of size distribution by light microscope.

III. Small particle dynamics

A. Flow regimes, turbulent, viscous, slip, molecular.
B. One and two dimensional eqn's. of motion.
C. Particular solutions for viscous and potential flow.
   1. Terminal velocity, distance to deaccelerate, inertial impaction.
   2. Numerical solutions for intermediate flow region.
D. Particle diffusion, slip correction.
E. Theory of filtration.
   1. Inertial impaction, interception and diffusion.
   2. Collection by an array of elements, overall efficiency on a dust of arbitrary distribution.
F. Other inertial collectors and separators.
   1. Cyclones
   2. Impactors
   3. Air classifiers
   4. Impact grinders
G. Sedimentation and elutriation size analysis.
   1. Theory of homogeneous and layer methods.
   2. Methods.
H. Gas cleaning systems. Aerosol equilibrium in a closed space with generation, recirculation etc.

Syllabus - M.E. - 184

IV. Optical behavior

A. Light scattering theory.
B. Lambert-Beer Law, optical density.
C. Light transmission through hetrogeneous aerosols, numerical solutions.
D. Optical phenomena, blue sky, red sunset, etc.

V. Electrical Behavior

A. Particle charging by friction, ions, fields, etc.
B. Behavior of a charged particle in an electrical field.
C. Poissons eqn' and some solutions, space charge.
   1. Decay of ions in a closed space, turbulent jet and flow system.
   2. Ion-aerosol systems.
D. The electrostatic gas cleaner.
   1. Theory of single and two stage types.
   2. Application.

Continuation page

VI. Behavior in thermal fields.

- A. Equations.
- B. Thermal precipitators, wall staining.

VII. Behavior in sound fields.

- A. Sound energy relations.
- B. Dynamics in a sound field.
- C. Applications.

VIII. Flow through fixed beds.

- A. Basic equations, corrections to flow models.
- B. Application to soils, liquid filters, etc.

IX. Particle transport.

- A. Low concentration - atmospheric diffusion.
- B. Medium concentration - pneumatic conveying.
- C. High concentration - Fluidization.

X. Particle Processing.

- A. Formation, Communication and condensation.
- B. Separation and classification.
- C. Aggregation and other special processes.

XI. Sprays and Atomization.

- A. Formation of sprays.
- B. Mass transfer, evaporation.