

College of Liberal Arts and Science

Undergraduate and Graduate Programs of Study

The City College

The City University of New York

BULLETIN 1975 - 1976

Convent Avenue at 138th Street, New York, New York 10031

UNDERGRADUATE REGISTRATION

Undergraduate registration takes place on the North Campus at the beginning of each term. A detailed set of instructions is included in the schedule of classes which is issued by the Registrar's office about a month before the start of each term.

Each registrant is responsible for making out a program in accordance with the curriculum for his degree as outlined in this catalogue, and his program will be inspected to see that he has done so. To assist students in these problems, the Office of Curricular Guidance, Room 121, Shepard Hall, schedules regular conferences with students beginning in the lower freshman term to discuss courses and objectives. For a fuller description of this service, see page 350 of this catalogue.

Registration is scheduled so that graduating seniors register with the first group, followed by juniors and sophomores, and within each class precedence is established by alphabetical grouping. No student may register ahead of his group, and if he delays he may find that the sections of his choice have been filled. The registration process is completed when the student turns in his registration packet. The student is then provided with a set of course card stubs which are to be presented to the instructors, for identification. However a student is considered registered in a course even if he never attends and does not turn this identification stub over to the instructor.

Once registration is complete, a student may make changes and corrections only at some trouble and expense. Late registration and changes of program can be made through the Registrar's office on payment of the required fee. The dates and hours for changes of program are listed in the Schedule of Classes for the term.

Change of Degree Goal to Bachelor of Arts or Bachelor of Science

1. Students who wish to transfer to the Liberal Arts Curriculum (B.A. or B.S. degree) must have a CHANGE OF DEGREE form approved by the Office of Curricular Guidance, Room 121, Shepard Hall.

2. A student whose application has been approved must then consult with a Curricular Guidance Counselor in Shepard 121, to determine remaining degree requirements in the areas of English and Speech proficiency, Foreign Language, Mathematics, Physical Education, Core and Specialization.

3. Students who have reached the Upper Sophomore semester must file a Specialization Card (Elective Concentrat. on Card).

4. All candidates for a Bachelor of Arts or Bachelor of Science degree must have completed three years of a foreign language in high school, or must complete the equivalent in college.

5. The academic average (index) is carried over from the previous curriculum to the College of Liberal Arts and Science. In order for a degree to be granted, the student's combined average must be "C" or better.

6. All credits earned at City College count toward the 128 credits required for a B.A. or B.S. degree, and students may not relinquish any. Tuition fees must be paid for excess credits (usually all credits in excess of 132). This is true even where not all credits earned in another school are credited toward a degree in the College of Liberal Arts and Science.

7. See page 24 for a list of courses that are transferable to the College of Liberal Arts and Science.

BACCALAUREATE CURRICULUM

The College of Liberal Arts and Science offers courses of study leading to the Bachelor of Arts and Bachelor of Science degrees.

The curriculum consists of three groups of courses:

Group I—The Core Requirement

Group II—The Specialization Requirement

Group III—Free Electives

Students who complete at least two years of laboratory science and one year of calculus will be candidates for the Bachelor of Science degree. All others will be candidates for the Bachelor of Arts degree, except that any student who wishes may choose to receive the Bachelor of Arts degree rather than the Bachelor of Science degree. Thus the student who began as a science major and who decided subsequently to switch to an area in social science or humanities may choose to receive the Bachelor of Arts degree. This choice must be made by the lower senior term.

GROUP I—THE CORE REQUIREMENT

1. Proficiency in *Mathematics* — Each student is required to demonstrate proficiency in Mathematics by satisfying at least one of the following requirements:
 - a. Successful completion of one year of elementary algebra and one year of plane geometry in high school, *or*
 - b. Placement in Math. 55 or higher on the placement examination in mathematics, *or*
 - c. Successful completion of Math. 50.2, *or*
 - d. Successful completion of Math. 54.

A placement examination in mathematics will be given to all entering freshmen. Every student who is required to take mathematics in the college, or who chooses to do so, will be placed in his first college course on the basis of this examination.

2. Proficiency in *Foreign Language* — This requirement is fulfilled by the successful completion of 3 years of a single foreign language (or two years each of two foreign languages) in high school. Otherwise, a student must complete either the lower intermediate semester of one language, or Elementary 1 and 2 of two different languages. Refer questions to the Office of Curricular Guidance, Shepard Hall 121.
3. Proficiency in *written English* — Each student is required to demonstrate his ability to express himself clearly and effectively in written English. The procedures are these:
 - a. All entering freshmen will take a Placement Examination in written English. On the basis of this examination, students will be (1) required to enter the Basic Writing sequence at the level of their competence or (2) recommended to take English 40 or (3) exempted from all writing courses. The Basic Writing sequence consists of English 1, 2 and 3 or, for students for whom English is a second language, English 1.11, 1.12, 2.1, 2.2 and 3. Students who are placed in the Basic Writing sequence are required to complete it (in consecutive semesters) unless exempted by their instructor.
 - b. All students placed in Basic Writing or recommended to take English 40 are required to take a *Writing Proficiency Examination* at the time they complete English 3 or English 40. Students who pass the examination will have met the writing requirement of the college. Students who do not pass must take the examination again until they pass it. In order to be certain that their graduation will not be deferred, students should arrange to take the examination not later than the junior year. The schedule of examinations is listed in M-4, outside Room 949.
 - c. The only students exempted from the *Writing Proficiency Examination* are (1) those whose placement cards read "No English Required" (2) those who took a composition course before the fall of 1969 either at City College or elsewhere, or (3) those admitted to the Freshman Honors Program.
 - d. Students who entered City College before Spring 1971 and who have not taken English 3 or English 40 may register for one of those courses if they want help in preparing for the *Proficiency Examination*.
 - e. All transfer students are required to take the *Writing Proficiency Examination*.
 - f. Students who have failed the *Proficiency Examination* or who want to improve their written English may inquire in the Basic Writing Office, M-4, 935, about tutorial help.

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4. Proficiency in *spoken English*—Each student will be required to demonstrate an acceptable pattern of spoken English. (Also see page 347)
 - a. All entering students will take an *Achievement Examination* in spoken English. Students whose pattern of oral communication is below acceptable standards will be assigned to remedial classes. Others will be counseled, depending upon their performance and career objectives, on the advisability of taking specific Speech courses.
 - b. Students who, in any course in the College, are found to be deficient in spoken English are to be referred to the Department of Speech for remedial work.
5. *Physical Education*—Two courses will be required. The student may elect to take these courses on a *Pass or Fail* basis. These courses may be taken in addition to those other courses which a student may select on a pass or fail basis.
6. *Distribution Requirements*—Each student will take courses from the divisions listed below as follows:

Division A

Courses amounting to a minimum of 12 credits are to be taken from division "A". These courses are to be selected from at least two of the areas listed in this division.

Astronomy

Astronomy 1

Biology

Biology 3 or
Biology 5
Biology 9

Chemistry*

Chemistry 1, 2 or
Chemistry 3, 4 (and 8), or
Chemistry 16, 17
Chemistry 9

Earth and Planetary Sciences

Earth and Planetary Sciences 1 or 3
Earth and Planetary Sciences 5
Earth and Planetary Sciences 6
Earth and Planetary Sciences 7 or 17

Mathematics

Mathematics 1, (1.9), 2, 3 or
Mathematics 7, 8
Mathematics 43
Mathematics 61, (61.9), 62, 63
Mathematics 64 or 65

Oceanography

Oceanography 101, 102

Physics

Physics 1
Physics 2, 3, 4 or
Physics 5 (or 5.9), 6 or
Physics 7, 8, 8.5

Division B

Courses amounting to a minimum of 21 credits are to be taken from division "B". These courses are to be selected from at least three of the areas listed in this division.

Alternative Studies**

Alternative Studies 110

Art

Art 2
Art 3
Art 8
Art 10

Asian Studies

Asian Studies 56
Asian Studies 57

Black Studies

Black Studies 1
Black Studies 11

Black Studies 31.1
Black Studies 31.2
Black Studies 51

Davis Center for Performing Arts
DCPA 10

Foreign Languages

Arabic 41, 42, 43, 44
Chinese 41, 42, 43, 44
Chinese 51, 52, 53, 54
French 61 (or 41, 42)
62 (or 43, 44)

*Students who have taken Chemistry 5, 6, or 7 may use the credit toward Division A.

**Students may use a maximum of one Alternative Studies course for four credits toward core distribution credit. Enrollment in these courses is limited. To enroll students must obtain permission in Shepard 221.

Baccalaureate Curriculum—23

Division B (Continued)

Foreign Languages (Continued)

French 63, 64
French 9 (or 7, 8)
German 1, 2, 3, 4, 5
Greek 41, 42
Hebrew, 51, 52
Hebrew 1, 2, 3
Italian 61 (or 41, 42)
62 (or 43, 44)
Italian 63, 64
Italian 9 (or 7, 8)
Japanese 51, 52, 53, 54
Latin 51 (or 41, 42), 52
Linguistics 1
Portuguese 61, 64
Russian 1, 2, 3, 4
Spanish 61 (or 41, 42) or 61.4
62 (or 43, 44) or 62.4
Spanish 63, 64
Spanish 9 (or 7, 8)
Swahili 41, 42, 43, 44
Yiddish 1, 2, 3, 4

History

History 101
History 102
History 103
History 104
History 105
History 106
History 107
History 108
History 109
History 110
History 130
History 111-129*

Jewish Studies

Jewish Studies 1
Jewish Studies 2
Jewish Studies 3

Literature—All courses listed below are given in English.

English 12.1
English 13.1
English 13.2
English 13.3
English 13.4
English 14.1
English 14.2

English 14.3
English 14.4
English 15.1
English 15.2
English 15.3
English 16.1
English 16.2
English 17.1
Chinese 31, 32
Comparative Literature 1
Classics 10
French 81
French 82
German 101
German 110
German 110
Humanities 4
Humanities 11
Italian 81
Italian 82
Russian 90
Russian 91
Spanish 81
Spanish 82
Spanish 83
Yiddish 22

Music

Music 5
Music 102
Music 104
Music 135
Music 140
Music 145

Philosophy

Philosophy 1, (1.9)
Philosophy 2
Philosophy 10
Philosophy 11

Puerto Rican Studies

Puerto Rican Studies 11.3

Slavic-American Studies

Slav 1

Speech

Speech 1
Speech 31
Speech 12 or 17
Speech 41
Speech 61 or 71

Division C

Courses amounting to a minimum of 9 credits are to be taken from division "C". These courses are to be selected from at least two of the areas listed in this division.

Alternative Studies**

Alternative Studies 120
Alternative Studies 260, 261

Anthropology

Anthropology 10

*A student may only take one of the 111-129 sequence of courses in History.

**Students may use a maximum of one Alternative Studies course for four credits toward core distribution credit. Enrollment in these courses is limited. To enroll students must obtain permission in Shepard 221.

Asian Studies
Asian Studies 1
Asian Studies 3
Asian Studies 51

Economics
Economics 1 or 2
Economics 3

Geography
Geography 100
Geography 102

Political Science
Political Science 1
Political Science 2

Political Science 3
Political Science 4

Psychology
Psychology 1

Puerto Rican Studies
Puerto Rican Studies 11.1
Puerto Rican Studies 11.2

Sociology
Sociology 5

Women's Studies
Women's Studies 3

SPECIAL COURSES OF STUDY

FRESHMAN HONORS PROGRAM

Selected entrants in the College of Liberal Arts and Science may be admitted to a special program which allows them to complete the work prescribed for the degree in one to two years, and to devote proportionately more time to advanced study. (Such students may also avail themselves of the provisions for advanced placement and exemption examinations).

The program is administered by a committee which works closely with the students, becomes personally acquainted with them, helps them select their fields of concentration, and plans their programs: if circumstances warrant, the committee may authorize substitutions and other deviations from the recommended pattern of courses.

High school seniors of superior qualifications who are interested in this program should apply to Ms. Meta Plotnik, Assistant to the Dean, Shepard 110. The committee in charge of the program consists of Dean Fiellin and other faculty members selected from academic departments according to the interests of participating students.

In general students enroll in four major courses each year. The following are the core requirements for Freshman Honors Program Students. (Students are expected to complete these requirements by the time they graduate):

Group I—Select 3 Courses

Art 2, 3, 8, or 10 or Music 5, 102,
104, 135, 140, or 145
English 10
English 11
One or two Foreign Language
courses
Philosophy 4
Jewish Studies 10.1

Group II—Select 3 Courses

Anthropology 10.1
Anthropology 12.1
Economics 1.1
History 1.1
History 2.1
Political Science 1.1
Psychology 1.1
Sociology 5.1

Group III—

B.A. degree: one year of science or one year of calculus.
B.S. degree: two years of laboratory science and one year of calculus.

Note: A student may use one Alternative Studies course in place of one Freshman Honors course. For further information see Ms. Plotnik, S110.

Each student in the Freshman Honors Program will be permitted to take a maximum of one course per semester on a Pass-Fail basis beginning with his lower sophomore semester. These courses may be selected in addition to courses specifically offered on a Pass-Fail basis. The following courses may *not* be taken on a Pass-Fail Basis: (1) those courses that a student selects to fulfill his core requirement (from Groups I, II and III, see above) and (2) those courses that are the essential electives of his Specialization Program.

If, for any reason, a student leaves the Freshman Honors Program, any Honors courses that he may have taken are applicable to the appropriate division of the distribution requirement of the baccalaureate curriculum.

Note: Students in the Freshman Honors Program are not required to take Physical Education or the Proficiency Examinations in English or Speech.

FOUR-YEAR BACCALAUREATE-MASTER'S PROGRAM

The City College of New York has been authorized to offer a four-year baccalaureate-master's program in Economics, English, Mathematics and the Romance Languages. Students who are interested in the creation of other 4 year B.A.-M.A. Programs should speak with the chairman of the department involved. The purpose of the combined B.A.-M.A. (or B.S.-M.A.) program is to encourage mature, talented, and highly motivated students to pursue an intensive and flexible course of study culminating in the simultaneous award of the Bachelor's and Master's degrees. The program will combine the best elements of the undergraduate curriculum (exemption examinations, honors work, independent study) with master's level work in an integrated, individually designed course of study that will be built around the student's interest and abilities.

Within a four-year period, including summer study where necessary, a qualified student will be able to complete the requirements for both degrees. An intensive, rigorous, and carefully worked out

GROUP II—THE SPECIALIZATION REQUIREMENT

To meet the specialization requirement the student must take not less than twenty-four but may not be required to take more than forty-eight credits. His program must have the approval of a departmental or interdepartmental advisor. Students who wish to specialize in a program of study containing courses offered in two or more departments (but not part of one of the interdisciplinary programs) should have their programs approved by the Director of Curricular Guidance. The program must contain at least twenty-four credits of elective work (above the level of Group I) in a department or related departments or interdepartmental area. No course designated as a distribution-level course may be used by any student to fulfill specialization requirements.

Before the end of the sophomore year, each student must file an approved specialization card. The cards are available in Department Office and the Office of Curricular Guidance. Once an approved card has been filed the courses listed on it are a part of the degree requirements for the student; in order to change the specialization the student must file a revised, approved card.

GROUP III—FREE ELECTIVES

Since the number of credits required for graduation remains at 128 credits, the opportunity for free electives will be considerably expanded. In most cases there should be at least a full year which the student may spend on courses of his own choosing. All courses, both distribution-level and elective-level, may be taken as free electives.

Remark 1. In the fulfillment of the requirements of Group III, students in the College of Liberal Arts and Science may elect any course offered by the College (subject to stated prerequisites) and also any of the following courses offered by the professional schools:

Architecture 211, 212, 213. Also: Courses in Drawing, Perspective, Shadows, and History of Architecture
Chemical Engineering 100
Civil Engineering 100, 110, 114, 120
Computer Sciences 100, 105, 107, 120, 110, 150, 160, 224, 242, 246, 248, 250, 298.4, 298.7, 298.8
Electrical Engineering 101, 102, 104, 105, 106, 124, 141
Graphics 7
Mechanical Engineering 94, 100, 101, 104, 110
Nursing 11
Spanish 51.2, 52.2 (Core Div. B)
Speech 4 (Core Div. B)

The Committee on Course and Standing may at its discretion, and for special reason, grant permission to a student of the College to register for any course offered by any School (besides the courses just listed) and to receive credit toward a liberal arts degree for such a course. The general practice is to allow not more than six credits earned in this way.

Remark 2. Students who are preparing for teaching at the secondary level and who elect to remain in the College of Liberal Arts and Science may receive credit for the full education sequence through practice teaching toward their respective degrees. This sequence includes the following:

Education 32-32.1, 36-36.1, 37, 39, 212, 240/220 series, 263.

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- JOSEPHINE COHN (Adjunct)—B.S., York, 1971.
 WALTER DAUM — B.S., Chicago, 1961; M.S., 1961.
 PAUL FENSTER — B.S., The City College, 1966; M.S., New York University, 1968.
 AHUVA B. GENACK (Adjunct)—B.A., Hunter, 1963; M.A., Columbia, 1965.
 PAUL GENTILE (Adjunct)—B.S., The City College, 1973; M.A., 1975.
 PHYLLIS GETZLER — B.S., Pennsylvania, 1959; M.S., Columbia, 1961.
 CHARLOTTE GRAHAM (Adjunct)—B.S., The City College, 1967; M.A., 1970.
 JOEL GREENSTEIN (Adjunct)—B.S., The City College, 1969; M.S., 1971.
 SUSAN HAHN (Adjunct)—B.A., The City College, 1973; M.A., Yeshiva, 1975.
 HARVEY HALPERT (Adjunct)—B.S., Brooklyn, 1973.
 WILLIAM C. HARRIS (Adjunct)—B.S., The City College, 1974.
 BERNICE HECKER (Adjunct)—B.S., The City College, 1959; M.A., 1974.
 IGNACIO D. HERSSSEIN (Adjunct)—B.S., The City College, 1972; M.A., 1972.
 OLENKA HUBICKYJ (Adjunct)—B.S., The City College, 1975.
 FERN HUNT (Adjunct)—B.A., Bryn Mawr, 1969; M.S., New York University, 1971.
 VINCENT JACKSON (Adjunct)—B.S., The City College, 1965; M.A., 1967.
 ALEXANDER KALPAXIS (Adjunct)
 AARON J. KATZ (Adjunct)—B.S., Brooklyn, 1974.
 EDWARD KOLODNY (Adjunct)—B.S., The City College, 1956; M.A., Brooklyn, 1959.
 JAMES KOURLAS (Adjunct)—B.S., The City College, 1973.
 ROCHELLE LEON—B.S., The City College, 1968; M.S., New York University, 1970.
 JAMES MAGRONE (Adjunct) B.S., The City College, 1974.
 ISAAC MASHITZ (Adjunct)—B.S., Brooklyn, 1971; M.S., New York University, 1973.
 ROBERT A. MILLER—B.S., New York Polytechnic, 1965; M.S., 1966.
 WALTER MILLER (Adjunct)—B.S., Yale, 1973.
 DOUGLAS MOLE (Adjunct)—B.A., Queens, 1973.
 DANIEL MOSENKIS—B.S., The City College, 1964; M.S., Wisconsin, 1966.
 JOAN NEUHAUS (Adjunct)—B.A., The City College, 1972; M.A. in Math. Ed., 1974.
 ROBERT NEWMAN (Adjunct)—B.S., The City College, 1968.
 MEYER J. PEIKES (Adjunct)—B.S., Brooklyn, 1974.
 FREDERICK REESE (Adjunct)—B.S., Polytechnic Institute of Brooklyn, 1971.
 CHUK KWAN WONG REZNY (Adjunct)—B.S., The City College, 1973; M.A., 1975.
 DARLENE SCHAEFER (Adjunct)—B.S., York, 1974.
 VICTOR SCHIMMEL—B.A., The City College, 1969.
 DAVID SCHWINGER—B.A., Queens, 1967; M.A., Columbia, 1968.
 JAYNE C. SHERMAN (Adjunct)—B.A., The City College, 1971.
 SOPHIE SQUIRES (Adjunct)—B.E.E., The City College, 1953; M.A., Brooklyn, 1966.
 PAUL L. SONYI (Adjunct)—M.A., Budapest (Hungary), 1938; Ph.D., 1944; M.A., Fordham, 1960.
 ELISABETH STADLER-HRBACEK (Adjunct)—B.S., The City College, 1974; M.A., 1975.
 DANIEL STEINITZ (Adjunct)—B.Sc., Hebrew University (Israel), 1967; M.S., New York University, 1970.
 JOEL STORCH (Adjunct)—B.S., The City College, 1971; M.S., Columbia, 1972.
 HENYA SWIATYCKI (Adjunct)—B.A., The City College, 1971.
 EVELYN TAM (Adjunct)—B.S., The City College, 1973; M.A., 1975.
 ROBERT D. WAGNER (Adjunct)—B.S., The City College, 1965; M.S., New York University, 1967.

SPENTA WADIA (Adjunct)—B.Sc., St. Xavier's College (Bombay), 1971; M.Sc., Indian Inst Technology, 1973.

YAAKOV WARSHAVCHIK (Adjunct)—B.S., Brooklyn, 1974.

NORMAN L. WEINER (Adjunct)—B.S., The City College, 1960; M.A., 1962.

Research Assistants

STEPHEN TSE B.S., St. Peter's, 1966; M.S., Polytechnic Institute of Brooklyn, 1970.

LYNN WAXBERG B.S., The City College, 1968; M.Ed., Boston, 1970.

PLACEMENT

A placement examination in mathematics will be given to all entering freshmen. Every who is required to take mathematics in the college, or who chooses to do so, will be placed in college course on the basis of this examination.

ADVISEMENT PROCEDURES

Students who need advice on pre-baccalaureate courses should consult Professor J. Mil 902), Ms. P. Getzler (S-1, 902), or Dr. E. Sharp (S-1, 914). Those seeking advice on CORE or on higher level courses open to non-majors should see Professor L. Kaminetzky (S-1, 91

All mathematics majors must consult a departmental specialization advisor before cor the sophomore year. A student transferring from another major at The City College or from college after the sophomore year must consult a departmental advisor as soon as possible.

Specialization advisors: Prospective graduate school candidates should see Professor N ret (S-1, 903); prospective high school teachers of mathematics should see Professor W. V All other mathematics majors should see Professor L. Kaminetzky (S-1, 917) or Professor M man (S121). Their schedules are posted inside the Mathematics hut (S-1).

The graduate student advisor is Professor N. Shilkret (S-1, 903).

AVAILABLE SERVICES

The Mathematics Laboratory (S208) offers free tutoring and special study aids to st pre-baccalaureate and freshman level courses. The Laboratory hours are posted outside S20 side the Mathematics hut (S-1).

STUDENT ORGANIZATIONS

The Mathematics Society is the undergraduate mathematics organization. It meets reg listen to lectures by students, faculty members, and guests from other institutions. Occasi student journal is published.

SPECIALIZATION REQUIREMENTS

Students who plan to major in mathematics will be expected to complete either eight co mathematics or a total of 27 credits in mathematics and collateral courses beyond the level of matics 3 and 8. These must include either Mathematics 13, 14 or 23, 24, 25, either 26 or 27, ther 30 or 33. Additional courses should be selected from the following according to the stude jective:

Graduate (Ph.D.) work: Additional courses from among 10, 11, 15, 17, 18, 20, 21, 22, 29, 31 35, 36, 37, 38, 40, 80, 81, 82.

Secondary Education: Additional courses from among 12, 22, 28, 31, and 93 (or 21).

Industrial or applied mathematics: Additional courses from among 9 (or 10), 15 (or 91 or 1 18, 21 (or 93), 22, 28, 29, 35, 38, 40. Collateral courses may be selected with the approval of t uty Chairman from the offerings of departments other than Mathematics; however no mor credits will be credited to the 27 required of a mathematics major.

Actuarial Science: Additional courses should include 21, 22, and 28. Other desirable electiv 10, 29, 38, and 40. Students are encouraged to take one or more actuarial examinations whil graduates.

The privilege of taking an advanced undergraduate course is dependent upon the earn minimum grade of "C" in each prerequisite course taken; exceptions can be made only with t ten permission of the Deputy Chairman. A mathematics major must maintain a "C" averag mathematics courses.

A mathematics major is advised to select one of French, German, or Russian as a language. He should understand that if he continues through doctoral work, he will generally be required to have a reading knowledge of two of these languages.

There are also available, by invitation, honors seminars on various subjects. With prior consent of the Deputy Chairman, the student may elect advanced work from among the following master's level courses: 1715, 1722, 1732, 1733, 1734, 1735, 1737, 1738, 1739, 1741, 1780, 1781, 1782.

Any mathematics course, elementary or advanced, may be passed by exemption examination. A student who feels that he already knows a significant portion of a course, or that he could master the major part of a course by self-study, should consult the Deputy Chairman on how to prepare for the exemption examination and how to arrange to take it.

OPERATIONS RESEARCH

In addition to a major in mathematics, the Department has also set up a major in Operations Research. Students wishing to do graduate work in Operations Research should, in general, follow the course suggestions listed for students wishing to do graduate work in mathematics. In addition, they should consult an advisor to discuss relevant courses in applied mathematics, statistics and computer sciences. Students who do not expect to do graduate work may substitute Math. 113 and 114 or Math. 91 and 92 for Math. 23, 24 and 25. In addition, students in this group will be required to take Math. 9 (or 10), 16, 22, 26 (or 27), 28, 93 (or 21), Computer Sciences 100, 242. (See School of Engineering Bulletin for a description of Computer Sciences courses.)

SECONDARY EDUCATION

Students planning to teach mathematics in high school may qualify on several levels, and should consult the specialization advisor for details. In all cases certain mathematics and education courses are required. In the College of Liberal Arts and Science, the student must complete either eight courses in mathematics or 27 credits of advanced mathematics courses beyond the level of Math. 3 or 8. This may be accomplished either as a regular mathematics major, which keeps open the option of serious graduate work in mathematics, or as a secondary education mathematics major. The first choice must include a full sequence in advanced calculus (Math. 13, 14, or 23, 24, 25), Math. 26 (or 27), and Math. 30 (or 33), plus additional advanced courses to make a total of 8 courses or of 27 credits. The second choice requires Math. 23 (or 13), 26 (or 27), 30 (or 33), and 31, plus additional advanced courses to make a total of 8 courses or of 27 credits.

PRE-BACCALAUREATE COURSES

An entering freshman who has not previously passed both one year of elementary algebra and one year of plane geometry in high school must pass either Mathematics 50.2 or Mathematics 54 or receive placement in Mathematics 55 in order to earn the baccalaureate degree. A student who has passed both elementary algebra and plane geometry in high school is not required to take any college mathematics unless his department or area of specialization requires mathematics.

50.1. Introduction to Algebra. Arithmetic with signed numbers, polynomials and factoring, fractions, solution of linear equations in one and two variables. 4 lec.-rec., 1 lab. hr. wk.; no cr. Prereq.: Placement by the Mathematics Department.

50.2. Algebra and Geometry. Selected topic in algebra, geometry, statistics, modern mathematics. 4 lec.-rec., 1 lab. hr. wk.; no cr. Prereq.: Math. 1 or placement by the Mathematics Department.

54. Essentials of Algebra and Geometry. Polynomials and factoring; fractions; solution of linear equations; exponents; radicals; description, measurement and relationships of plane and solid geometric figures. 4 lec.-rec., 1 lab. hr. wk.; no cr. Prereq.: Placement by the Mathematics Department.

55. Further Essentials of Algebra. Solution of quadratic equations; logarithms; functions; systems of equations; determinants; mathematical induction; sequences and series; binomial theorem. 4 lec.-rec., 1 lab. hr. wk.; 1 cr. Prereq.: Math. 54 or placement by the Mathematics Department.

56. Trigonometry and Pre-calculus. Functions and graphs. Essentials of trigonometry, law of sines and law of cosines, inverse trigonometric functions, trigonometric identities. Introduction to calculus. 4 lec.-rec., 1 lab. hr. wk.; 3 cr. Prereq.: Math. 55 or placement by the Mathematics Department.

INTRODUCTORY COURSES

The courses which may be presented for CORE distribution requirements in Division A are Math. 1, 1.9, 2, 3, 7, 8, 43, 61, 61.9, 62, 63, 64, 65.

There are three calculus sequences offered: Math. 7, 8, Math. 1, 2, 3, and Math. 61, 62. The first two sequences are similar; the principal difference is that Math. 1, 2, 3 cover the material at a slower pace. Math. 61, 62 present a survey of calculus for students not wishing to study advanced mathematics courses, and this sequence is recommended for biology, economics, pre-dental, pre-medical, and psychology majors. Either Math. 7, 8 or Math. 1, 2, or Math. 61, 62 are required of all candidates for the Bachelor of Science degree. Placement in any of the above sequences is based upon the Placement Examination.

Math. 3 or 8 (but not 62) is a pre- or co-requisite for all advanced undergraduate courses.

A student will not receive credit for an introductory course if he has already taken or is currently taking an advanced undergraduate mathematics course unless he has departmental permission.

1. Analytic Geometry and Calculus I. Derivatives, rules of differentiation; antiderivatives; areas; plane analytic geometry, vectors, conic sections, graph sketching. 4 hrs. wk.; 3 cr. Prereq.: Either trigonometry, advanced algebra and placement by the Mathematics Department or Math. 56. Credit will not be given for both Math. 1 and 61. (Core-A)

1.9. Analytic Geometry and Calculus I. This course is the same as Math. 1 but with two additional hours a week devoted to reviewing topics from algebra and geometry directly related to calculus. 6 hrs. wk.; 3 cr. Prereq.: Placement by the Mathematics Department. (Core-A)

2. Analytic Geometry and Calculus II. Trigonometric, logarithmic and exponential functions; methods of integration; limits; maximum and minimum problems; differentials; parametric representation of curves; center of gravity; improper integrals; polar coordinates. 4 hrs. wk.; 3 cr. Prereq.: Math. 1 or 1.9. (Core-A)

3. Analytic Geometry and Calculus III. Solid analytic geometry; partial derivatives; multiple integrals with applications; infinite series; Taylor's theorem. 4 hrs. wk.; 4 cr. Prereq.: Math. 2. (Core-A)

7. Analytic Geometry and Calculus A. Derivatives, rules of differentiation; antiderivatives; areas; plane analytic geometry, vectors, conic sections; graph sketching; trigonometric, logarithmic and exponential functions; methods of integration; limits; maximum and minimum problems. 5 hrs. wk.; 3 cr. Prereq.: trigonometry, advanced algebra and placement by the Mathematics Department. With departmental permission, partial credit may be given for Math. 7 after completion of Math. 61. (Core-A)

8. Analytic Geometry and Calculus B. Differentials; parametric representation of curves; center of gravity; improper integrals; polar coordinates; solid analytic geometry; partial derivatives; multiple integrals with applications; infinite series; Taylor's theorem. 5 hrs. wk.; 5 cr. Prereq.: Math. 7. (Core-A)

43. College Algebra. Systems of linear and quadratic equations, permutations and combinations, probability, binomial theorem, complex numbers, theory of equations, determinants, Cramer's Rule. 3 hrs. wk.; 3 cr. Prereq.: Math. 55 or placement by the Mathematics Department. No credit will be given if Math. 1 or 61 was taken. (Core-A)

61. Elements of Calculus I. Functions and graphs; rate of change; the limit concept; calculus of algebraic, logarithmic, exponential and trigonometric functions; techniques of integration; elementary applications to curve plotting, areas and volumes of solids of revolution. 4 hrs. wk.; 4 cr. Prereq.: Either intermediate algebra, trigonometry and placement by the Mathematics Department, or Math. 56. Credit will not be given for both Math. 1 and 61. With departmental permission, partial credit may be given for Math. 7 after completion of Math. 61. (Core-A)

61.9. Elements of Calculus I. This course is the same as Math. 61 but with two additional hours a week devoted to reviewing topics from algebra, geometry, and trigonometry directly related to calculus. 6 hrs. wk.; 4 cr. Prereq.: Placement by the Mathematics Department. (Core-A)

62. Elements of Calculus II. Infinite series, including Taylor expansion; differential equations, functions of several variables; partial derivatives, evaluation of double integrals; determinants with application to linear simultaneous equations. 3 hrs. wk.; 3 cr. Prereq.: Math. 61 (taken after Sept. 1969) or 61.9. (Core-A)

63. Introduction to Probability and Statistics. Descriptive statistics and frequency histograms; measures of location and dispersion; elementary probability; permutations and combinations; multiplication rule and conditional probability; Bayes' Theorem; independent events; random variables; expected values; applications to binomial, hypergeometric, uniform and normal distributions; the Central Limit Theorem; testing statistical hypotheses; correlation; linear regression and least squares. 4 hrs. wk.; 4 cr. Prereq.: Either intermediate algebra and placement by the Mathematics Department, or Math. 55. Credit given for only one of the following courses: Eco. 95, Math. 63, Psych. 19, Soc. 31. (Core-A)

64. Basic Ideas in Mathematics I. Sets, operations with sets, relations, functions, construction of number system, numerical systems with different bases, topics in number theory. 4 hrs. wk.; 3 cr. Prereq.: Either elementary algebra and plane geometry and placement by the Mathematics Department, or Math. 54 with the grade of "C" or higher. Credit will not be given for both Math. 64 and 65, nor will credit be given to students who have had intermediate algebra, 11th year mathematics or more advanced mathematics courses, except with departmental permission. Recommended for prospective elementary school teachers. (Core-A)

65. Introduction to Mathematics. Set theory, elementary probability and theory of games, elementary number theory, elements of graph theory and combinatorics, functions and derivatives. 3 hrs. wk.; 3 cr. Prereq.: Either intermediate algebra and placement by the Mathematics Department, or Math. 55. Credit will not be given for both Math. 64 and 65. Recommended for prospective elementary School teachers. (Core-A)

216. Basic Ideas in Mathematics II. Systems of numeration; axiomatic development of integers, rational numbers, real numbers; intuitive and axiomatic geometry; mensuration. 3 hrs. wk.; 3 cr. in the School of Education; no credit in the College of Liberal Arts and Science. Prereq.: Math. 64.

ADVANCED UNDERGRADUATE COURSES

9. Elementary Operations Research. Mathematical modeling, decision theory, linear and dynamic programming, game theory, stochastic models in queueing, inventory, and reliability theory, network analysis including PERT and CPM. 3 hrs. wk.; 3 cr. Prereq.: Math. 26 or 27 and 21 or 93. Credit will not be given to a student who has taken Math. 10. Specialization credit is given for only one of Math. 9 and C.S. 246.

10. 1610. Theory of Games and Mathematical Methods of Operations Research. Theory of games; linear programming, network analysis and PERT, dynamic programming; non-linear programming. 3 hrs. wk.; 3 cr. Prereq.: Math. 13 or 23, Math. 26 or 27. Credit will not be given for both Math. 10 and C.S. 246.

11. 1611. Theory of Numbers. Divisibility, primes, fundamental theorem of arithmetic; congruences; number theory from an algebraic viewpoint; quadratic reciprocity; number theoretic functions; diophantine equations. 3 hrs. wk.; 3 cr. Prereq.: Math. 23 or 13 or departmental permission.

12. History of Mathematics. Greek mathematics; non-Euclidean geometries; Hilbert's Grundlagen; algebraic structure; the modern method; axiomatics for the reals; symbolic logic and foundations. 3 hrs. wk.; 3 cr. Prereq.: Math. 3 or 8.

13. 1613. Introduction to Higher Analysis I. Sets, relations, functions, operations; construction of number systems; properties of the real numbers; point sets in higher dimensions; compactness, connectedness, completeness; metric spaces, topological spaces; limits and continuity; topological properties of continuous functions; uniform convergence; Taylor's theorem; theorems of partial differentiation; implicit function theorems. 5 hrs. wk.; 5 cr. Prereq.: Math. 3 or 8, or departmental permission. Credit is not given for Math. 13, 14 and 23, 24, 25. These sequences are similar. The principal differences are that Math. 13, 14 cover the material in greater depth and at a faster rate. No graduate credit given except with prior departmental approval.

14. 1614. Introduction to Higher Analysis II. Mappings; Jacobians; vector fields; surface theory, line and surface integrals; theorems of Green and Stokes; divergence theorem; theory of integration; Riemann integral; Stieltjes integral; infinite series and uniform convergence; improper integrals. 5 hrs. wk.; 5 cr. Prereq.: Math. 13. No graduate credit given except with prior departmental approval.

15. 1615. Ordinary Differential Equations. Special methods for first order equations; existence and uniqueness theorems; linear equations; plane autonomous systems. 3 hrs. wk.; 3 cr. Prereq.: Math. 23 or 13. A student may receive credit for only one of Math. 15, 91, and 113.

16. Elementary Combinatorial Mathematics. Classification of finite functions, partitions, sets, relations, principle of induction, permutations and combinations, binomial and multinomial coefficients, stochastic processes, basic definitions of abstract algebra. 3 hrs. wk.; 3 cr. Prereq.: Math. 3 or 8, or permission of the instructor. This course is required of all operations research majors. Specialization credit will be given to other majors only with departmental permission. Credit will not be given for both Math. 16 and C.S. 105.

17. 1617. Differential Geometry. Local geometry of plane and space curves and surfaces in 3-space. Some global results. 3 hrs. wk.; 4 cr. Prereq.: Math. 25 or 14.

18. 1618. Calculus of Variations. Extremal problems for one or several functions; the necessary conditions of Euler, Legendre, Weierstrass, Jacobi; sets of sufficient conditions; problems in parametric form; Hamilton-Jacobi theory; isoperimetric problems. 3 hrs. wk.; 4 cr. Prereq.: Math. 25 or 14.

20. 1620. Mathematical Logic. The propositional calculus, the sentential calculus, normal forms, first-order theories, consistency, categoricity, decidability, Gödel's completeness theorem, the Löwenheim-Skolem theorem. 3 hrs. wk.; 4 cr. Prereq.: Math. 23 or 13, or permission of the instructor. Credit is given for only one of the following courses: Math. 20, Philo. 30, Philo. 37.

21. Probability Theory I. Probability set functions, random variables; moment generating functions and moments; Chebyshev's Theorem; marginal distributions; correlation; special distributions in one and several variables; transformations of variables. 3 hrs. wk.; 3 cr. Prereq.: Math. 3 or 8. Credit will not be allowed for both Math. 21 and 93. Though Math. 21 and 93 cover similar material, Math. 21 is a more theoretical course.

22. Mathematical Statistics. The gamma, chi-square, T and F distributions; the bivariate normal distribution; the Central Limit Theorem; Confidence intervals and tests of hypotheses; the Neyman-Pearson Theorem; likelihood ratio tests; estimation: sufficiency, unbiasedness, completeness; the Rao-Blackwell Theorem; the Rao-Cramer inequality; the method of maximum likelihood; chi-square tests; introduction to the analysis of variance and regression. 4 hrs. wk.; 4 cr. Prereq.: Math. 21 or 93.

23. 1623. Introduction to Higher Mathematics (Advanced Calculus I). Sets, relations, functions, operations; construction of number systems; point-sets in higher dimensions, metric spaces; limits and continuity, uniform convergence. 4 hrs. wk.; 4 cr. Prereq.: Math. 3 or 8, or departmental permission. Credit is not given for both Math. 13, 14 and 23, 24, 25. These sequences are similar. The principal differences are that Math. 13, 14 cover the material in greater depth and at a faster rate. No graduate credit.

24. 1624. Advanced Calculus II. Taylor's theorem; theorems of partial differentiation; implicit-function theorems; mappings; vector fields; surface theory, line and surface integrals. 3 hrs. wk.; 3 cr. Prereq.: Math. 23. Specialization credit is given for only one of Math. 24 and 92. No graduate credit given except with prior departmental approval.

25. 1625. Advanced Calculus III. Theory of integration; infinite series and uniform convergence; improper integrals. 3 hrs. wk.; 3 cr. Prereq.: Math. 24. No graduate credit given except with prior departmental approval.

26. Elements of Linear Algebra. Vector spaces, basis and dimension, matrices, linear transformations, determinants, solution of systems of linear equations, eigenvalues and eigenvectors. 3 hrs. wk.; 3 cr. Prereq.: Math. 3 or 8 or Coreq.: Math. 3 or 8 and departmental permission. With departmental permission, partial credit may be given for Math. 27 after completion of Math. 26.

27. 1627. Linear Algebra. Vector spaces; linear transformations; matrices; the dual space; inner product spaces; bilinear and quadratic forms; eigenvalues and eigenvectors; triangulation and diagonalization; Hamilton-Cayley Theorem; spectral theorem; rational decompositions; Jordan normal form. 4 hrs. wk.; 4 cr.; 2 grad. cr. Prereq.: Math. 23 (or 13), or Math. 3 (or 8) and departmental permission. With departmental permission, partial credit may be given for Math. 27 after completion of Math. 26. No graduate credit given except with prior departmental approval.

28. Methods of Numerical Analysis. Solutions of equations by iteration techniques, interpolation and approximation, numerical differentiation and integration, difference methods and difference equations. 3 hrs. wk.; 3 cr. Prereq.: Math 91 or 15 or 113 and knowledge of FORTRAN.

29. 1629. Theory of Numerical Analysis. Numerical solutions of linear system and matrix inversions, computations of eigenvectors and eigenvalues, numerical solutions of ordinary differential equations. 3 hrs. wk.; 3 cr. Prereq.: Math. 26 or 27, 23 or 13, 91 or 15 or 113.

30. Elements of Modern Algebra. Sets; mappings; rings; isomorphisms; integral domains; properties of integers; fields; rational numbers; complex numbers; polynomials; groups. 4 hrs. wk.; 4 cr. Prereq.: Math. 3 or 8. With departmental permission, partial credit may be given for Math. 33 after completion of Math. 30. Recommended for prospective school teachers and others who want a basic course in abstract algebra.

31. 1631. Introduction to Modern Geometry. Logical deficiencies in Euclidean geometry; Euclid's parallel postulate; introduction to non-Euclidean geometry; the logical consistency of the non-Euclidean geometries; the theory of incidence; the theory of order on the line. 3 hrs. wk.; 3 cr. Prereq.: Math. 3 or 8.

32. 1632. Theory of Functions of a Complex Variable. Cauchy-Riemann equations; conformal mapping; elementary, entire, meromorphic, multiple-valued functions; Cauchy integral theorems; series expansion. 3 hrs. wk.; 4 cr. Prereq.: Math. 25 or 14.

33. 1633. Introduction to Modern Algebra. Groups, rings, fields. 3 hrs. wk.; 4 cr. Prereq.: Math. 23 (or 13). With departmental permission, partial credit may be given for Math. 33 after completion of Math. 30.

34.1634. Theory of Functions of Real Variables. Lebesgue measure and integration on the real line; differentiation of real functions and the relation with integration; classical L spaces. 3 hrs. wk.; 4 cr. Prereq.: Math. 25 or 14.

35.1635. Partial Differential Equations, Integral Equations, Boundary Value Problems. First order equations; classification and canonical forms of higher order equations; the Cauchy problem for hyperbolic equations; Riemann function; wave equation; potential theory and the Dirichlet problem; harmonic and subharmonic functions; elementary functional analysis and the Fredholm alternative. 3 hrs. wk.; 4 cr. Prereq.: Math. 14 or 25 and 15 or 91 or 113.

36.1636. Set Theory. Axioms of Zermelo-Fraenkel set theory; the axiom of choice and equivalent formulations; rank and regularity; ordinal and cardinal numbers; the generalized continuum hypothesis. 3 hrs. wk.; 4 cr. Prereq.: Math. 23 or 13, or departmental permission.

37.1637. Topology. A course in general topology. Sets of points on the real line and in general abstract spaces. Relations between sets of points, between a set and the space containing it. Operations with sets, open sets, countability, compactness, connectedness, mappings, continuity, metric spaces, general topological spaces. 3 hrs. wk.; 4 cr. Prereq.: Math. 23 or 13.

38.1638. Probability Theory II. Special topics in probability such as stochastic processes, Markov chains, etc. 3 hrs. wk.; 4 cr. Prereq.: Math. 21, 26 (or 27); Coreq.: Math. 14 or 25.

40.1640. Mathematical Statistics II. The multivariate normal distribution; multiple and partial correlation; regression and least squares; the analysis of variance. 3 hrs. wk.; 3 cr. Prereq.: Math. 26 or 27, and 22.

80.1780. Selected Topics in Pure Mathematics. Topics to be chosen from the areas of algebra, analysis, topology, geometry, and logic. 3 hrs. wk.; 4 cr. Prereq.: to be determined by the instructor.

81.1781. Selected Topics in Classical Analysis. Topics will vary but will be chosen from applied mathematics and related fields. Typical subjects are: asymptotic methods, wave propagation, mathematical biology. 3 hrs. wk.; 4 cr. Prereq.: Math. 14 or 25, 91 or 15, 26 or 27, and other requirements to be determined by the instructor.

82.1782. Selected Topics in Probability, Statistics, and Operations Research. Topics to be chosen from the areas of probability, statistics, game theory, combinatorial analysis, etc. 3 hrs. wk.; 4 cr. Prereq.: to be determined by the instructor.

91. Methods in Differential Equations. Ordinary differential equations; first order equations; linear; series solution; Laplace transform techniques; Fourier analysis. 3 hrs. wk.; 3 cr. Prereq.: Math. 3 or 8. Credit will be given for only one of Math. 91, 15, and 113.

92. Linear Algebra and Vector Analysis for Engineers. Linear algebra, vector spaces, vector field theory, theorems of Green and Stokes. 3 hrs. wk.; 3 cr. Prereq.: Math. 91 or Math. 3 (or 8) and departmental permission. Specialization credit is given for only one of Math. 24 and 92.

93. Elements of Probability Theory. Permutations and combinations, conditional probability, independent events, random variables, probability distributions and densities, expectation, moments, moment generating functions, functions of random variables, Central Limit Theorem, sampling, confidence intervals. 3 hrs. wk.; 3 cr. Prereq.: Math. 3 or 8. Credit will not be allowed for both Math. 21 and 93. Though Math. 21 and 93 cover similar material, Math. 21 is a more theoretical course.

113. Topics in Advanced Calculus for Students of Physics I. Ordinary differential equations; functions of several variables; vector analysis; integration; Green's, Stokes' and divergence theorems. 3 hrs. wk.; 3 cr. Prereq.: Math. 3 or 8. Credit will be given for only one of Math. 113, 91, and 15.

114. Topics in Advanced Calculus for Students of Physics II. Matrix algebra. Series solutions to ordinary differential equations. Special functions: Bessel and Legendre functions. Fourier series and integral. 3 hrs. wk.; 3 cr. Prereq.: Math. 113.

115. Topics in Advanced Calculus for Students of Physics III. Complex variables. Evaluation of integrals by residues. Separation of variable methods for partial differential equations. 3 hrs. wk.; 3 cr. Prereq.: Math. 114 or 92.

301-304. Honors. Honors I (301), Honors II (302), Honors III (303), Honors IV (304). Approval of Dean and department Honors Supervisor required. Apply in Room 110 Shepard Hall not later than December 10 in the fall term or May 1 in the spring term. Credit flexible but usually 3 credits per term.

REQUIREMENTS FOR THE MASTER'S DEGREE IN MATHEMATICS

To matriculate for the M.A. degree in mathematics, a student must present eighteen credits in advanced mathematics courses and at least nine more credits in additional advanced mathematics courses or in advanced science courses of a mathematical nature. Students who do not present higher analysis or advanced calculus courses deemed equivalent to Mathematics 1613, 1614, or 1623, 1624, 1625 will be required to complete one of these sequences immediately upon admission. Students who do not present a satisfactory course in linear algebra will be required to complete Mathematics 1627 or its equivalent during their first semester.

The requirements for the master's degree in mathematics are as follows:

Course distribution: Thirty graduate credits will be required for the M.A. degree.

- 1) Candidates for the master's degree must choose one of three options: Option A (Pure Mathematics), Option B (Classical Analysis), or Option C (Probability, Statistics and Operations Research). They must take at least three 1700 level courses listed either under their chosen option in Group I or among related courses listed in Group II. Candidates who choose Option B will be required to complete Mathematics 1632 and 1634 or their equivalents. Candidates who choose Option C will be expected to take two graduate courses in Computer Science with the prior approval of the Mathematics Department graduate advisor.
- 2) Up to 12 credits may be taken in graduate courses other than mathematics; approval for such courses must be secured in advance from the Graduate Mathematics Committee.

Thesis: None required.

Comprehensive examination: A written or oral examination is required on all or part of the work counting toward the degree unless waived by the Graduate Mathematics Committee.

Foreign language proficiency: The foreign language proficiency may be met in French, German, or Russian.

MASTER'S LEVEL COURSES

Group I. It is anticipated that at least three courses in each option will be available during the two year period 1975-77.

OPTION A. PURE MATHEMATICS

1732. Theory of Functions of a Complex Variable, II. A continuation of Mathematics 1632, including such topics as analytic continuation, conformal mapping, Dirichlet problem, meromorphic functions, entire functions, Picard's theorem, elliptic functions. 3 hrs. wk., plus conferences; 4 cr. Prereq.: Math 1632 or equivalent.

1733. Introduction to Modern Algebra, II. Field extensions, Galois theory, vector spaces and modules, category theory, special topics. 3 hrs. wk., plus conferences; 4 cr. Prereq.: Math. 1633 or equivalent.

1734. Theory of Functions of a Real Variable, II. Abstract measure and integration theory: abstract Lebesgue measure and integral, signed measures, Radon-Nikodym derivative, L spaces, product spaces, Daniell integral. Special topics such as Stieltjes integrals, Denjoy integral, Haar measure, measure rings, applications to probability. 3 hrs. wk., plus conferences; 4 cr. Prereq.: Math. 1634 or equivalent.

1737. Topology, II. An introduction to algebraic topology, following a review of general topology. Homeomorphism, compactness, connectedness, arcwise connectedness; new topological properties in terms of groups; homotopy, homotopy classes, fundamental group, homology groups; simplexes, boundaries, cycles, barycentric subdivision, excision theorem, exact sequence, complexes. 3 hrs. wk., plus conferences; 4 cr. Prereq.: Math. 1637 and 1633 or equivalents.

OPTION B. CLASSICAL ANALYSIS

1715. A Second Course in Differential Equations. This course will consist of a selection of topics taken from the following: existence and uniqueness of solutions, linear differential equations, linear systems with isolated singularities, stability theory, asymptotic behavior of solutions and eigenvalue problems. 3 hrs. wk.; plus conferences; 4 cr. Prereq.: Math 1615 or equivalent.

1735. Partial Differential Equations, II. First order quasi-linear and nonlinear equations; Cauchy-Kowalewsky theorem; well posed problems; Cauchy problem for hyperbolic systems; the wave equation in n -dimensions; boundary value problems for elliptic equations; Laplace's equation; parabolic