

DOWNLOAD PDF REPORTS ON THE COURSE OF INSTRUCTION IN YALE COLLEGE

Chapter 1 : Yale Report of - Wikipedia

The Yale Report of 1828: Part I Liberal Education and Collegiate Life Robert J. O'Hara (rjohara@blog.quintoapp.com) One of the most influential documents in the history of American higher education was "The Yale Report of 1828".

Part II begins here; running head throughout: Report on a Course of Liberal Education. Containing extracts from that part of the report of the faculty in which the resolution of the corporation is more particularly considered. A liberal, is obviously distinct from a professional, education. The former is conversant with those topics, an acquaintance with which is necessary or convenient, in any situation of life, the latter, with those which qualify the individual for a particular station, business or employment. The former is antecedent in time, the latter rests upon the former as its most appropriate foundation. A liberal education is fitted to occupy the mind, while its powers are opening and enlarging; a professional education requires an understanding already cultivated by study, and prepared by exercise for methodical and persevering efforts. It has been believed, that there are certain common subjects of knowledge, about which all men ought to be informed, who are best educated, who are prepared to mingle to the best advantage with persons of different tastes, ages and pursuits, and to enter with the best prospects of success, on the details of professional study and practice. As this education, which is called liberal, was originally founded on existing objects of literary interest and pursuit, it has always had reference to such objects, and has varied with the varying state of knowledge. What, therefore, at one time, has been held in little estimation, and has hardly found a place in a course of liberal instruction, has, under other circumstances, risen into repute, and received a proportional share of attention. It is not now the inquiry, whether the changes in the collegiate course have been sufficiently great and frequent; it is enough for the present purpose, to state the fact of such changes, and to admit their propriety. An education, then, to be liberal, should have reference to the principal branches of knowledge, and as knowledge varies, education should vary with it. The subject of inquiry now presented, is, whether the plan of instruction pursued in Yale College, is sufficiently accommodated to the present state of literature and science; and, especially, whether such a change is demanded as would leave out of this plan the study of the Greek and Roman classics, and make an acquaintance with ancient literature no longer necessary for a degree in the liberal arts. Before considering this topic directly, it may be useful to premise a few remarks on another branch of liberal education, in order more clearly to exhibit the kind of objections which are often thrown out, some against one part, and some against another, of the whole course of collegiate study; and to make more apparent the limited and inadequate views of those who urge them. The usefulness of mathematical learning is generally admitted, and few persons, perhaps none, would consider that course of education liberal, from which the mathematics are wholly excluded. If it is asked, on what grounds the pretensions of mathematical learning rest? The study of the mathematics, by the consent of the ablest men who have been conversant with the business of instruction, is especially adapted to sharpen the intellect, to strengthen the faculty of reason, and to induce a general habit of mind favorable to the discovery of truth and the detection of error. Mathematical science, furthermore, lies at the foundation of most of the practical sciences, or affords valuable aid in illustrating their principles, and in applying them to the purposes of life. It forms the best preparation for pursuing the study of physics in all its branches, and is not without its use, at least in its indirect influence, in most of our reasoning on other subjects. But here it is sometimes objected, that though much of this may be true, still mathematical knowledge, to most students is of little practical use. The plain rules of arithmetic, it is said, are all which most men ever find occasion to apply, and if to these rules is added a knowledge of bookkeeping, few, indeed, feel the want of more extensive information in this department of knowledge. Why, it is asked, should a student be compelled to devote years to the acquisition of a species of knowledge, which is useful only, as it enables him to advance the study of navigation, surveying, astronomy, and other sciences, into which mathematical principles largely enter, when he has no wish or expectation to engage practically in either of these sciences, and will probably from his distaste for the whole subject, forget in a few years,

what he has learned with so great labor? If a man occupied in divinity, law or physic, wishes to know any principle in navigation, let him inquire, says the objector, of some one whose business it is to understand this science. If he wishes a substance analyzed, let him apply to the professional chemist, if he wishes to know the name of some mineral, its properties, or its use, let him ask the mineralogist, who from his love of this science, has made himself familiar with the numerous facts and details which it embraces, and who, by his far superior knowledge in his profession, finds actual employment within its precincts. Let those study the sciences, and those only, who have a taste for them, and who expect to pursue at least some one science for a livelihood. If the knowledge of any science is of use, the demand for this knowledge will insure not only its existence, but its prevalence to the exact extent needed; and every thing beyond this is not only superfluous but injurious. Those act in opposition to the plainest principles of political economy, who manufacture for the market an unsaleable article. If wares are not wanted, who does not see, that there will be a glut? But notwithstanding all these difficulties and objections, the knowledge in question is still practical, not in the narrow view of it which the objector takes, but in a sense higher and wider, and which it may be useful briefly to explain. The student, who has laid up a fund of mathematical knowledge, and has extended his inquiries to those sciences which depend upon mathematical principles, though he is employed in the practical application of no science, yet is brought into an important relation to those who are so employed, and experiences from this relation the most important benefits. He is able to judge of the pursuits of others, to estimate the value of those pursuits, to understand the progress of science, and to feel an interest in the occupations of a large portion of mankind. Whether his own station in life is public or private, whether he engages in a professional career, or is called upon to discharge the duties of a magistrate, the occasions for employing his knowledge are innumerable. Granting, that he loses from his memory, many or most of the details of the sciences, he still knows where to apply for information, and how to direct his inquiries, and is able to judge correctly the talents and pretensions of those who are prominent in any one department, and whom he may wish to employ in the accomplishment of actual business. He is acquainted with the region where he is, acts more understandingly in what he undertakes, and is found, in consequence of his knowledge, to be, in all his transactions, a more practical man. Educated in this way, besides the advantages of mental discipline which have been already mentioned, he enlarges the circle of his thoughts, finds in his superior information, new means of benefiting or influencing others, and his mind is thus far liberalized by liberal knowledge. It is on the same general grounds, that the use and necessity of classical literature in a liberal education may be defended. That this study occupies, at the present time, an important place among literary pursuits, both in Europe and America, will not be denied. In the British Islands, in France, Germany, Italy, and, indeed, in every country of Europe in which literature has acquired distinction and importance, the Greek and Roman classics constitute an essential part of a liberal education. In some countries, classical studies are reviving from a temporary depression, in others, where no such depression has been experienced, they are pursued with increased ardor, and in none, are they known to be declining in public estimation. There may be more variety of opinion than formerly, as to the use of classical learning in certain departments of life; but the conviction of its necessity in the highest education, that which has any claim or pretence to be denominated liberal, is not known to have sustained any considerable change. The literature of every country of Europe is founded more or less on classical literature, and derives from this source its most important illustrations. This is evident not only from such works as have long since appeared, and which form the standard literature of modern times, but from those most recently published, and even from the periodical works of the day. Classical learning is interwoven with every literary discussion. The fact only is here insisted on, and this is undeniable. Whoever, then, without a preparation in classical literature, engages in any literary investigation, or undertakes to discuss any literary topic, or associates with those who in any country of Europe, or in this country, are acknowledged to be men of liberal acquirements, immediately feels a deficiency in his education, and is convinced that he is destitute of an important part of practical learning. If scholars, then, are to be prepared to act in the literary world as it in fact exists, classical literature, from considerations purely practical, should form an important part of their early

discipline. It may be defended not only as a necessary branch of education, in the present state of the world, but on the ground of its distinct and independent merits. Familiarity with the Greek and Roman writers is especially adapted to form the taste, and to discipline the mind, both in thought and diction, to the relish of what is elevated, chaste, and simple. The compositions which these writers have left us, both in prose and verse, whether considered in reference to structure, style, modes of illustration, or general execution, approach nearer than any others to what the human mind, when thoroughly informed and disciplined, of course approves, and constitute, what is most desirable to possess, a standard for determining literary merit. This excellence of the ancient classic writers is, indeed, doubted or denied; and it becomes, therefore, necessary to adduce such proof of it as the subject admits. The case here to be considered is not unaccompanied by analogues. In the range of human improvement, there are other facts nearly allied, both in their character and circumstances, to this now asserted, which afford it very powerful support. Architecture and sculpture, in their most approved forms, not only had their origin, but received their perfection in Greece. These arts may have been, in certain respects, modified in the progress of time, changes may have been introduced to accommodate their productions to the necessities and manners of a later age; yet the original works of Grecian genius are the models by which artists, even at the present time, direct their labors, the standard by which, in a great measure, their merits are determined. It is in vain to pretend that this is the effect of prejudice, the bias of early impressions, and the undue veneration of antiquity. The statuary, in modelling a head or an arm, has nature always in view, yet he refers notwithstanding to the remains of Grecian art as his best guides, the surest interpreters of nature itself. His work is not imitation, it is a nearer approach to perfection through the skill derived from the contemplation and study of superior excellence. In architecture, the eye of one least conversant with antiquity is struck with the simplicity and just proportions of Grecian models; and these first impressions are strengthened by observation and reflection. If, then, sculpture and architecture, after the revolution of so many centuries, still derive aid from the remains of ancient skill, it ought not to excite surprise, that in other departments of taste, antiquity should exhibit the same excellence; we need not wonder, that in poetry and eloquence, it should have likewise left specimens, worthy to become patterns for succeeding ages. That this superiority belongs to ancient literature, is proved by the only proper evidence, the voice of men of letters in every country where the classics have been studied, and where a correct taste has prevailed. It is unnecessary here to cite authorities. The literature of Europe attests the fact. Hardly a question can be named where the practical decision of mankind has been more absolute. But the study of the classics is useful, not only as it lays the foundations of a correct taste, and furnishes the student with those elementary ideas which are found in the literature of modern times, and which he no where so well acquires as in their original sources, but also as the study itself forms the most effectual discipline of the mental faculties. This is a topic so often insisted on, that little need be said of it here. It must be obvious to the most cursory observer, that the classics afford materials to exercise talent of every degree, from the first opening of the youthful intellect to the period of its highest maturity. The range of classical study extends from the elements of language, to the most difficult questions arising from literary research and criticism. Every faculty of the mind is employed; not only the memory, judgment, and reasoning powers, but the taste and fancy are occupied and improved. Classical discipline, likewise, forms the best preparation for professional study. The interpretation of language, and its correct use, are no where more important, than in the professions of divinity and law. But in a course of classical education, every step familiarizes the mind with the structure of language, and the meaning of words and phrases. In researches of a historical nature, and many such occur in the professions, a knowledge, especially of the Latin language, is often indispensable. The use of a thorough knowledge of Greek to a theologian, no one will deny. In settling a plan of education, the inquiry should be, not what some men of uncommon endowments have done, but what most men find necessary. Even in cases of extraordinary success, such as have been now alluded to, the want of classical knowledge has often been felt and lamented. In the profession of medicine, the knowledge of the Greek and Latin languages is less necessary now than formerly, but even at the present time it may be doubted, whether the facilities which classical learning affords

for understanding and rendering familiar the terms of science, do not more than counterbalance the time and labor requisite for obtaining this learning. Besides, a physician, who would thoroughly investigate the history of his profession, will find a knowledge of the ancient languages, essential to his object. In all the professions, likewise, a knowledge of general literature is of high importance as a qualification for extensive intercourse with mankind. The formality of the professional character, where the course of reading and thinking is confined to one channel, has often been remarked. The mere divine, the mere lawyer, or the mere physician, however well informed he may be in his particular profession, has less chance of success, than if his early education had been of a more liberal character. For these very obvious advantages, which now attend the study of classical literature in the college, the course of study which, it is understood, would be proposed as a substitute, promises but few and partial equivalents. Instead of the poems of Homer, which have had so extensive and important an influence on the heroic poetry of all succeeding times, and which, it cannot be denied, are constantly appealed to as establishing many of the most important canons of criticism, we are presented in several new courses, with the *Henriade* of Voltaire, and the *History of Charles XII*. This is a specimen of the improvements in education which are the occasion of so much boasting, an example of a change to render knowledge more practical and popular. How is the former to qualify its possessor to act in the literary world in a manner more advantageous than the latter? Do we find that by critics of eminence, Voltaire as a poet has a higher place assigned him than Homer, or that they consider him as a model to be more carefully studied and imitated? Or to make the inquiry more general, in order to understand the true spirit and genius of English literature, which is of the greatest practical use, the literature of France, or the literature of Greece and Rome? The most superficial acquaintance with the principal authors in our language, is sufficient to excite wonder, that such questions should be seriously asked. If the new course proposed, considered as an introduction to a knowledge of general literature, is altogether inferior to the old, and far less practical in its character, it will be found not less deficient for the purposes of mental discipline. To acquire the knowledge of any of the modern languages of Europe, is chiefly an effort of memory. The general structure of these languages is much the same as that of our own. The few idiomatical differences, are made familiar with little labor, nor is there the same necessity of accurate comparison and discrimination, as in studying the classic writers of Greece and Rome. To establish this truth, let a page of Voltaire be compared with a page of Tacitus. Nor is this course of education which excludes ancient literature, less objectionable as the foundation of professional study. The student who has limited himself to French, Italian and Spanish, is very imperfectly prepared to commence a course of either divinity or law. He knows less of the literature of his own country, than if he had been educated in the old method, the faculties of his mind have been brought into less vigorous exercise, and the sources of the knowledge which he is now to acquire, are less accessible. If it is said, that the course of exclusive modern literature is intended for those who are not designed for professional life, the reply is, that the number of those who obtain a liberal education, without at first deciding whether they shall be professional men or not, is far from inconsiderable. Many, who originally suppose their minds determined on this subject, alter their determinations from circumstances, which they could not foresee. But here it will be asked, Is the literature of the modern nations of Europe to form no part of a course of liberal education? Is not modern literature a subject of discussion as well as ancient?

Chapter 2 : Reports on the Course of Instruction in Yale College

That His Excellency Governor Tomlinson, Rev. President Day, Rev. Dr. Chapin, Hon. Noyes Darling, and Rev. Abel McEwen, be u committee to inquire into the expediency of so altering the regular course of instruction in this college, as to leave out of said course the study of the dead languages.

Containing a summary view of the plan of education in the college. The committee of the corporation, to whom was referred the motion, to inquire into the expediency of dispensing with the study of the ancient languages, as a part of the regular course of instruction in this college, having requested the views of the faculty on the subject, we would respectfully submit the following considerations. We are decidedly of the opinion, that our present plan of education admits of improvement. We are aware that the system is imperfect: We believe that changes may, from time to time be made with advantage, to meet the varying demands of the community, to accommodate the course of instruction to the rapid advance of the country, in population, refinement, and opulence. We have no doubt that important improvements may be suggested, by attentive observation of the literary institutions in Europe; and by the earnest spirit of inquiry which is now so prevalent, on the subject of education. The guardians of the college appear to have ever acted upon the principle, that it ought not to be stationary, but continually advancing. Some alteration has accordingly been proposed, almost every year, from its first establishment. Nothing is more common, than to hear those who revisit the college, after a few years absence, express their surprise at the changes which have been made since they were graduated. Report on a Course of Liberal Education. By raising the qualifications for admission, the standard of attainment has been elevated. Alterations so extensive and frequent, satisfactorily prove, that if those who are intrusted with the superintendence of the institution, still firmly adhere to some of its original features, it is from a higher principle, than a blind opposition to salutary reform. Improvements, we trust, will continue to be made, as rapidly as they can be, without hazarding the loss of what has been already attained. But perhaps the time has come, when we ought to pause, and inquire, whether it will be sufficient to make gradual changes, as heretofore; and whether the whole system is not rather to be broken up, and a better one substituted in its stead. From different quarters, we have heard the suggestion, that our colleges must be new-modelled; that they are not adapted to the spirit and wants of the age; that they will soon be deserted, unless they are better accommodated to the business character of the nation. As this point may have an important bearing upon the question immediately before the committee, we would ask their indulgence, while we attempt to explain, at some length, the nature and object of the present plan of education at the college. We shall in vain attempt to decide on the expediency of retaining our present course of instruction, unless we have a distinct apprehension of the object of a collegiate education. A plan of study may well be well adapted to a particular purpose, though it may be very unsuitable for a different one. Universities, colleges, academical, and professional seminaries, ought not to be all constituted upon the same model; but should be so varied as to attain the ends which they have severally in view. What then is the appropriate object of a college? It is not necessary here to determine what it is which, in every case, entitles an institution to the name of a college. But if we have not greatly misapprehended the design of the patrons and guardians of this college, its object is to lay the foundation of a superior education: The ground work of a thorough education, must be broad, and deep, and solid. For a partial or superficial education, the support may be of looser materials, and more hastily laid. The former of these is, perhaps, the more important of the two. A commanding object, therefore, in a collegiate course, should be, to call into daily and vigorous exercise the faculties of the student. Those branches of study should be prescribed, and those modes of instruction adopted, which are best calculated to teach the art of fixing the attention, directing the train of thought, analyzing a subject proposed for investigation; following, with accurate discrimination, the course of argument; balancing nicely the evidence presented to the judgment; awakening, elevating, and controlling the imagination; arranging, with skill, the treasures which memory gathers; rousing and guiding the powers of genius. All this is not to be effected by a

light and hasty course of study; by reading a few books, hearing a few lectures, and spending some months at a literary institution. The habits of thinking are to be formed, by long continued and close application. The mines of science must be penetrated far below the surface, before they will disclose their treasures. If a dexterous performance of the manual operations, in many of the mechanical arts, requires an apprenticeship, with diligent attention for years; much more does the training of the powers of the mind demand vigorous, and steady, and systematic effort. In laying the foundation of a thorough education, it is necessary that all the important mental faculties be brought into exercise. It is not sufficient that one or two be cultivated, while others are neglected. A costly edifice ought not to be left to rest upon a single pillar. When certain mental endowments receive a much higher culture than others, there is a distortion in the intellectual character. The mind never attains its full perfection, unless its various powers are so trained as to give them the fair proportions which nature designed. If the student exercises his reasoning powers only, he will be deficient in imagination and taste, in fervid and impressive eloquence. If he confines his attention to demonstrative evidence, he will be unfitted to decide correctly, in cases of probability. If he relies principally on his memory, his powers of invention will be impaired by disuse. From the pure mathematics, he learns the art of demonstrative reasoning. In attending to the physical sciences, he becomes familiar with facts, with the process of induction, and the varieties of probable evidence. In ancient literature, he finds some of the most finished models of taste. By English reading, he learns the powers of the language in which he is to speak and write. By logic and mental philosophy, he is taught the art of thinking; by rhetoric and oratory, the art of speaking. By frequent exercise on written composition, he acquires copiousness and accuracy of expression. By extemporaneous discussion, he becomes prompt, and fluent, and animated. It is a point of high importance, that eloquence and solid learning should go together; that he who has accumulated the richest treasures of thought, should possess the highest powers of oratory. To what purpose has a man become deeply learned, if he has no faculty of communicating his knowledge? And of what use is a display of rhetorical elegance, from one who knows little or nothing which is worth communicating? *Est enim scientia comprehendenda rerum plurimarum, sine qua verborum volubilitas inanis atque irridenda est.* No one feature in a system of intellectual education, is of greater moment than such an arrangement of duties and motives, as will most effectually throw the student upon the resources of his own mind. Without this, the whole apparatus of libraries, and instruments, and specimens, and lectures, and teachers, will be insufficient to secure distinguished excellence. The scholar must form himself, by his own exertions. The advantages furnished by a residence at a college, can do little more than stimulate and aid his personal efforts. The inventive powers are especially to be called into vigorous exercise. However abundant may be the acquisitions of the student, if he has no talent at forming new combinations of thought, he will be dull and inefficient. The sublimest efforts of genius consist in the creations of the imagination, the discoveries of the intellect, the conquests by which the dominions of science are extended. But the culture of the inventive faculties is not the only object of a liberal education. The most gifted understanding cannot greatly enlarge the amount of science to which the wisdom of ages has contributed. To the discipline of the mind, therefore, is to be added instruction. The analytic method must be combined with the synthetic. Analysis is most efficacious in directing the powers of invention; but is far too slow in its progress to teach, within a moderate space of time, the circle of the sciences. In our arrangements for the communication of knowledge, as well as in intellectual discipline, such branches are to be taught as will produce a proper symmetry and balance of character. We doubt whether the powers of the mind can be developed, in their fairest proportions, by studying languages alone, or mathematics alone, or natural or political science alone. As the bodily frame is brought to its highest perfection, not by one simple and uniform motion, but by a variety of exercises; so the mental faculties are expanded, and invigorated, and adapted to each other, by familiarity with different departments of science. A most important feature in the colleges of this country is, that the students are generally of an age which requires, that a substitute be provided for parental superintendence. When removed from under the roof of their parents, and exposed to the untried scenes of temptation, it is necessary that some faithful and affectionate guardian take them by the hand, and

guide their steps. This consideration determines the kind of government which ought to be maintained in our colleges. As it is a substitute for the regulations of a family, it should approach as near to the character of parental control as the circumstances of the case will admit. It should be founded on mutual affection and confidence. It should aim to effect its purpose, principally by kind and persuasive influence; not wholly or chiefly by restraint and terror. Still, punishment may sometimes be necessary. There may be perverse members of a college, as well as of a family. There may be those whom nothing but the arm of law can reach. This renders it necessary that suitable buildings be provided, for the residence of the students: This may be the case also, in professional institutions, in which the students are more advanced in age, and, therefore, do not require a minute superintendence on the part of their instructors. Having now stated what we understand to be the proper object of an education at this college, viz. In giving the course of instruction, it is intended that a due proportion be observed between lectures, and the exercises which are familiarly termed recitations; that is, examinations in a text book. The great advantage of lectures is, that while they call forth the highest efforts of the lecturer, and accelerate his advance to professional eminence; they give that light and spirit to the subject, which awaken the interest and ardor of the student. They may place before him the principles of science, in the attractive dress of living eloquence. Where instruments are to be explained, experiments performed, or specimens exhibited; they are the appropriate mode of communication. But we are far from believing, that all the purposes of instruction can be best answered by lectures alone. They do not always bring upon the student a pressing and definite responsibility. He may repose upon his seat, and yield a passive hearing to the lecturer, without ever calling into exercise the active powers of his own mind. This defect we endeavor to remedy, in part, by frequent examinations on the subjects of the lectures. Still it is important, that the student should have opportunities of retiring by himself, and giving a more commanding direction to his thoughts, than when listening to oral instruction. To secure his steady and earnest efforts, is the great object of the daily examinations or recitations. In these exercises, a text-book is commonly the guide. A particular portion of this is assigned for each meeting. In this way only, can the responsibility be made sufficiently definite. If it be distributed among several books upon the same subject, the diversity of statement in these, will furnish the student with an apology for want of exactness in his answers. Besides, we know of no method which will more effectually bewilder and confound the learner, on his first entrance upon a new science, than to refer him to half a dozen different authors, to be read at the same time. He will be in danger of learning nothing effectually. Text-books are, therefore, not as necessary in this advanced stage of education, as in the course at college, where the time allotted to each branch is rarely more than sufficient for the learner to become familiar with its elementary principles. These, with a few exceptions, are not new and controverted points, but such as have been long settled; and they are exhibited to the best advantage, in the consistent and peculiar manner of some eminent writer. Opportunity is given, however, to our classes, for a full investigation and discussion of particular subjects, in the written and extemporaneous disputes, which constitute an important part of our course of exercises. So far as the student has time to extend his inquiries, beyond the limits of his text-book, first faithfully studied, his instructor may aid him greatly, by referring to the various authors who have treated of the more important points in the lessons; and by introducing corrections, illustrations, and comments of his own. In this way, no small portion of our daily exercises become informal and extemporaneous lectures. But the business of explaining and commenting is carried to an extreme, whenever it supersedes the necessity of effort on the part of the learner.

Chapter 3 : Mathematics < Yale University

Report of the Committee on Sexual Harassment and Assault Prevention Education in Yale College (May) Special Programs Report of the Ad Hoc Committee on Special Academic Programs in Yale College (April).

See also Applied Mathematics. Director of undergraduate studies: Mika Havlickova, DL , , mika. The course offerings and the major in Mathematics reflect these multiple facets. The Mathematics major provides a broad education in various areas of mathematics in a program flexible enough to accommodate many ranges of interest. Prerequisite The prerequisite for both the B. Students who have not taken calculus at Yale and who wish to enroll in calculus must take the mathematics online placement examination; a link to the online examination and additional information are available on the departmental website. Enrolling students are expected to know the basic definitions of the trigonometric functions, synthetic division, factorization, and elementary area and volume formulas of plane and solid geometry. Requirements of the Major B. These ten may include no more than five term courses from other institutions. Each student is expected to take vector calculus and linear algebra: To acquire both depth and breadth in the field, students are required to take at least two term courses in each of three of the following five categories: Such courses require the approval of the DUS; written approval is advised. Taking courses from all three core areas is strongly recommended. Distinction in the major To be eligible for Distinction in the Major, a student must have completed at least one course from each of the three core areas. The categories and core areas to which each course belongs are indicated in the course listings. The intensive major Candidates for a degree with an intensive major in Mathematics must take courses in all three of the core areas: Intensive majors are also expected to include at least two graduate term courses in the Mathematics department, or equivalent independent study, in their programs. Familiarity with the material of the following courses is prerequisite to graduate courses in each category: Students wishing to write a senior essay should consult the DUS early in the fall term. In some instances a limited number of such courses may be counted among the ten courses required for the major in Mathematics, with the approval of the DUS. Further information may be obtained from the directors of undergraduate studies whose permission, with that of the relevant director of graduate studies, is required for admission. Candidates must submit a proposal that foresees this level of achievement to the DUS no later than the last day of classes in their fifth term of enrollment in Yale College. Students take at least two graduate term courses in the junior year normally courses in algebra or analysis are the first graduate courses taken. The general oral examination covers a list of topics available from the director of graduate studies and is accepted in lieu of the usual senior oral presentation. It is the language and tool of the sciences, a key part of cultural development since ancient times, and a model of abstract reasoning. The Mathematics program provides a broad education in various areas of mathematics and is flexible enough to accommodate many interests. Mathematics majors have numerous options after graduation, including graduate study in mathematics or in various fields of application, government or corporate laboratory work, consulting, finance and banking, and teaching. Students considering a major in Mathematics are encouraged to consult with the director of undergraduate studies DUS during their first year. A variety of resources are available to students who want additional help in any mathematics course: Each course instructor holds office hours for students multiple times a week. Undergraduate peer tutors associated with each calculus course provide help through regular office hours and private appointments. The Mathematics department offers coaching sessions for students in calculus courses. The department offers several courses that satisfy the QR distributional requirement and do not assume knowledge of mathematics beyond the basic high-school level. No prior exposure is assumed; some knowledge of algebra and precalculus mathematics is helpful. It focuses primarily on differentiation and assumes no previous exposure to calculus. It combines differential equations with geometrical modeling and applications in biology. It covers basic ideas in linear algebra as well as differential calculus of several variables. The higher-level courses below assume at least a year of calculus and are available to unusually well

prepared first-year students. It emphasizes conceptual and logical structure and pays considerable attention to proofs and challenging problems. Additional higher-level courses may be open to exceptionally well prepared first-year students. Interested students should seek advice from the director of undergraduate studies DUS or another knowledgeable faculty member. No knowledge of calculus required. Enrollment limited to students who have not previously taken a high school or college calculus course. Estimation, order of magnitude, approximation and error, counting, units, scaling, measurement, variation, simple modeling. Applications to demographics, geology, ecology, finance, and other fields. Emphasis on both the practical and the philosophical implications of the mathematics. Does not count toward the requirements of a major in Mathematics. Precalculus and calculus topics are integrated. Emphasis on conceptual understanding and problem solving. No prior acquaintance with calculus is assumed; some knowledge of algebra and precalculus mathematics is helpful. Comprehensive review of precalculus, limits, differentiation and evaluation of definite integrals, with applications. Definitions and some techniques of differentiation and the evaluation of definite integrals, with applications. Use of the software package Mathematica to illustrate concepts. No prior acquaintance with calculus or computing assumed. Applications of integration, with some formal techniques and numerical methods. Improper integrals, approximation of functions by polynomials, infinite series. Exercises involve the software package Mathematica. Calculus Techniques John Hall Introduction to topics in mathematical modeling that are applicable to biological systems. Discrete and continuous models of population, neural, and cardiac dynamics. Stability of fixed points and limit cycles of differential equations. Matrix representation of linear equations, Gauss elimination, vector spaces, independence, basis and dimension, projections, least squares approximation, and orthogonality. Three-dimensional geometry, functions of two and three variables, level curves and surfaces, partial derivatives, maxima and minima, and optimization. Intended for students in the social sciences, especially Economics. Real-valued functions of two and three variables, partial derivatives, gradient and directional derivatives, level curves and surfaces, maxima and minima. Parametrized curves in space, motion in space, line integrals; applications. Multiple integrals, with applications. The theorems of Green, Stokes, and Gauss. Study of social and biological networks as well as networks in the humanities. Mathematical graphs provide a simple common language to describe the variety of networks and their properties. Topics include the pigeon-hole principle, probabilities, congruences, generating functions, polynomials, and basic number theory. Open to students with beginning, intermediate, or advanced problem-solving skills. Linear independence, basis, and dimension. Orthogonality, projection, least squares approximation; orthogonalization and orthogonal bases. Extension to function spaces. Difference equations and matrix differential equations. Symmetric and Hermitian matrices. Orthogonal and unitary transformations; similarity transformations. Some relations to calculus and geometry are included. Application of linear algebra to differential calculus. Examples from reflection groups introduce elements of group theory, Lie algebras, and representation theory. Reflections in a real Euclidean space, groups generated by reflections, crystallographic groups, and Coxeter groups. Preference to sophomores majoring in mathematics or the sciences. Topics include probability spaces, random variables, expectations and probabilities, conditional probability, independence, discrete and continuous distributions, central limit theorem, Markov chains, and probabilistic modeling. Topics include maximum likelihood, sampling distributions, estimation, confidence intervals, tests of significance, regression, analysis of variance, and the method of least squares. Properties of finite set systems. Geometric and algebraic properties of differential equations. The derivative as a linear mapping. Inverse and implicit function theorems. Transformation of multiple integrals. Line and surface integrals of vector fields. Applications chosen from communications, networking, image reconstruction, Bayesian statistics, finance, probabilistic analysis of algorithms, and genetics and evolution. Cardinal numbers and cardinal arithmetic. Order types and ordinal numbers. The axiom of choice and the well-ordering theorem. Differentiability of complex functions. Some knowledge of real analysis assumed. Relations to other areas of mathematics such as analysis, probability, and number theory. Symmetric groups and linear groups including orthogonal and unitary groups; properties of Euclidean and Hermitian spaces.

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