EXPLORING COLUMBIA ENGINEERING MAJORS

LETTER FROM THE DEAN

Making a decision about your engineering or applied science major can seem like a daunting dilemma, but, with the right approach and information, it won't be. You already may have an idea of what you want your major to be, so this publication may reinforce your initial thinking. Or, it may provide you with additional options to consider.

Although engineering is a global, interdisciplinary field, once you choose your major, it will set you on a path that leads in a specific direction. This booklet is intended to help you learn more about the majors that the School offers and assist you in focusing on the field of interest that best suits you, discovering those disciplines, or that single discipline, to which you are naturally drawn.

Beneath the description of each major you will find a list of useful links that will help you learn more about the opportunities available within each major. In addition, there are references to professional societies and other resources that will provide you with a more complete picture of each major.

I hope you will use this booklet to spark discussions with your academic adviser about possible career trajectories and that it will be a valuable tool for you as you begin to find your own area of special interest within Columbia Engineering.

Donald Goldfarb
Interim Dean

P.S. You also can find a copy of this booklet online at
http://engineering.columbia.edu/files/engineering/ExploringMajors.pdf.

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DEPARTMENT | APPLIED PHYSICS & APPLIED MATHEMATICS

MAJOR | APPLIED MATHEMATICS

WWW.APAM.COLUMBIA.EDU

POSSIBLE CAREERS

Graduate and professional schools, risk management, consulting, government agencies, technical, manufacturing, and financial industries.

DESCRIPTION OF DISCIPLINE

Applied Mathematics deals with the use of mathematical concepts and techniques in various fields of science, technology, and engineering. The applied mathematician is interested in problems coming from other fields, in the formulation and solutions of these problems, and in the interpretation of the results. Their work frequently overlaps with that of other scientists and engineers.

http://bulletin.engineering.columbia.edu/applied-physics-and-applied-mathematics

RESEARCH

http://engineering.columbia.edu/undergraduate-research-involvement-program

RESOURCES

http://www.siam.org
http://www.ams.org
http://www.careereducation.columbia.edu/resources/industry/engg/appm

DEPARTMENT | APPLIED PHYSICS & APPLIED MATHEMATICS

MAJOR | APPLIED PHYSICS

WWW.APAM.COLUMBIA.EDU

POSSIBLE CAREERS

Graduate and professional schools, risk management, consulting, government agencies, technical, manufacturing, and financial industries.

DESCRIPTION OF DISCIPLINE

The Applied Physics Program stresses the basic physics that underlies most developments in technology and engineering and the mathematical tools that are important to both physicists and engineers. Since the advances in most branches of technology lead to rapid changes in state-of-the-art techniques, the applied physics program provides the student with a broad base of fundamental science and mathematics while retaining the opportunity for specialization through technical electives.

Research areas include fusion and space plasma physics, optical and laser physics, condensed matter physics, and nanophysics.

http://bulletin.engineering.columbia.edu/undergraduate-programs-applied-physics

RESEARCH

http://www.seas.columbia.edu/matsci/pages/research/index.html
http://engineering.columbia.edu/undergraduate-research-involvement-program

RESOURCES

http://www.aps.org
http://www.aip.org
http://apl.aip.org/
http://www.careereducation.columbia.edu/resources/industry/engg/appp

DEPARTMENT	APPLIED PHYSICS & APPLIED MATHEMATICS

MAJOR	MATERIALS SCIENCE & ENGINEERING

WWW.APAM.COLUMBIA.EDU

POSSIBLE CAREERS

Graduate and professional schools, risk management, consulting, government agencies, technical, manufacturing, and financial industries.

DESCRIPTION OF DISCIPLINE

The Materials Science and Engineering Program provides the basis for developing, improving, and understanding materials and processes for electronic, structural, and other applications. The emphasis is on fundamentals relating atomic- to microscopic-scale phenomena to materials properties and processing, including design and control of industrially important materials processes. Focus areas include electronic materials, polymers, ceramics, biomaterials, nanomaterials, structural materials, and metals and mineral processing.

http://www.seas.columbia.edu/matsci/

RESEARCH

http://engineering.columbia.edu/undergraduate-research-involvement-program

RESOURCES

http://www.mrs.org
http://www.asminternational.org
http://tryengineering.org/become.php?major=Materials+Engineering
http://www.careereducation.columbia.edu/resources/industry/engg/materials

DEPARTMENT	BIOMEDICAL ENGINEERING

MAJOR	BIOMEDICAL ENGINEERING

WWW.BME.COLUMBIA.EDU

POSSIBLE CAREERS

Biomedical engineers develop devices and procedures that solve medical and health-related problems; do research to develop and evaluate systems and products such as artificial organs, prostheses (artificial devices that replace missing body parts), instrumentation, medical information systems, and health management and care delivery systems; design devices used in various medical procedures, imaging systems such as magnetic resonance imaging (MRI), and devices for automating insulin injections or controlling body functions.

DESCRIPTION OF DISCIPLINE

Biomedical Engineering is a discipline that advances knowledge in engineering, biology, and medicine — and improves human health through cross-disciplinary activities that integrate the engineering sciences with the biomedical sciences and clinical practice. Bioengineering/Biomedical Engineering combines engineering expertise with medical needs for the enhancement of health care. It is a branch of engineering in which knowledge and skills are developed and applied to define and solve problems in biology and medicine.

http://www.careercornerstone.org
http://www.tryengineering.org

RESEARCH

http://engineering.columbia.edu/undergraduate-research-involvement-program

RESOURCES

http://www.embs.org
http://www.bme.columbia.edu/pages/research/index.html
http://www.careereducation.columbia.edu/resources/industry/engg/biomed

DEPARTMENT	CHEMICAL ENGINEERING

MAJOR	CHEMICAL ENGINEERING

WWW.CHEME.COLUMBIA.EDU

POSSIBLE CAREERS

The chemical engineering degree is a passport to exciting careers in directly related industries as diverse as biochemical engineering, environmental management, and pharmaceuticals. Graduates launch careers in medicine, law, management, banking and finance, and politics. Chemical engineers can be found in fields as diverse as fuels, electronics, food and consumer products, pharmaceuticals, environmental engineering, and pulp and paper.

DESCRIPTION OF DISCIPLINE

Chemical Engineering enables the production of useful and essential chemicals and materials by processes that require controlled physical, chemical, or biological transformations. Chemical engineers guide the passage of the product from the laboratory to the marketplace, from ideas and prototypes to functioning articles and processes, from theory to reality. This expertise is essential to production, marketing and application in areas such as pharmaceuticals, high performance materials in the automotive and aerospace industries, semiconductors in the electronics industry, paints and plastics, consumer products, petroleum refining, industrial chemicals, synthetic fibers, and bioengineering and biotechnology areas from artificial organs to biosensors.

http://www.cheme.columbia.edu/pdf-files/ugrad_HandBook2006.pdf

RESEARCH

http://www.cheme.columbia.edu/pages/research/index.html
http://engineering.columbia.edu/undergraduate-research-involvement-program

RESOURCES

http://www.aiche.org/
http://www.careereducation.columbia.edu/resources/industry/engg/chem

DEPARTMENT	CIVIL ENGINEERING & ENGINEERING MECHANICS

MAJOR	CIVIL ENGINEERING

MAJOR	ENGINEERING MECHANICS

WWW.CIVIL.COLUMBIA.EDU

POSSIBLE CAREERS

Civil engineers design and build buildings, bridges, dams, airports, railroads, aqueducts, offshore structures, as well as airplanes, ships, automobiles, etc. They manage construction projects that can range from a single building or bridge to entire cities. Civil engineers are also prominent in protecting the environment. Their work helps improve the quality of life.

DESCRIPTION OF DISCIPLINE

Civil engineers are in the forefront of technology. They build buildings and bridges using the latest technologies and materials. Today we can talk about smart bridges and buildings, capable to adapt themselves to the demand conditions. Civil engineers are the leading users of sophisticated high-tech products, applying the very latest concepts in computer-aided design (CAD) during design, construction, project scheduling, and cost control.

Civil engineering is about community service, development, and improvement. It involves the conception, planning, design, construction, and operation of facilities essential to modern life, ranging from transit systems to offshore structures to space satellites.

http://www.careercornerstone.org
http://www.tryengineering.org

RESEARCH

http://www.civil.columbia.edu/pages/research/index.html
http://engineering.columbia.edu/undergraduate-research-involvement-program

RESOURCES

http://www.asce.org
http://www.civil.columbia.edu/pages/research/index.html
http://www.careereducation.columbia.edu/resources/industry/engg/civil

DEPARTMENT	COMPUTER SCIENCE

MAJOR	COMPUTER SCIENCE

WWW.CS.COLUMBIA.EDU

POSSIBLE CAREERS

Software engineering and development, technical analysis, programming.

DESCRIPTION OF DISCIPLINE

Computer Science is an integrated curriculum, partially in areas with an immediate relationship to the computer, such as programming languages, operating systems, and computer architecture, and partially in theoretical computer science and mathematics. Topics include artificial intelligence, natural language processing, computational complexity and the analysis of algorithms, computer communications, combinatorial methods, computer architecture, computer graphics, databases, mathematical models for computation, optimization, programming environments, computational biology, and spoken language processing.

http://www.cs.columbia.edu

RESEARCH

http://www.cs.columbia.edu/research/areas
http://engineering.columbia.edu/undergraduate-research-involvement-program

RESOURCES

http://www.acm.org
http://xrds.acm.org/
http://www.cs.columbia.edu/studentlife/lifeaftercscu
http://computingcareers.acm.org/
http://www.careereducation.columbia.edu/resources/industry/engg/comps

DEPARTMENT	COMPUTER SCIENCE & ELECTRICAL ENGINEERING

MAJOR	COMPUTER ENGINEERING

WWW.COMPENG.COLUMBIA.EDU
WWW.CS.COLUMBIA.EDU
WWW.EE.COLUMBIA.EDU

POSSIBLE CAREERS

Computer engineers work in fields of digital and computer design, CAD, software, embedded systems (i.e. consumer electronics), computer networks, aerospace, and hardware and software system design.

DESCRIPTION OF DISCIPLINE

Computer engineering is currently the largest inter-departmental major within Columbia Engineering. It is co-run by the Computer Science and Electrical Engineering Departments, as a separate major, and covers topics at the boundary between the two disciplines. Computer engineers analyze and develop computer systems, including both hardware and software. Some of the key areas are: computer design (i.e. computer architecture); embedded systems (i.e. dedicated hardware/software for cell phones, automobiles, robots, games, and aerospace); digital and VLSI circuit design; computer networks; design automation (i.e. CAD); low-power design; and parallel and distributed systems including architectures, programming, and compilers).

The Computer Engineering Program combines some of the most exciting topics in both electrical engineering and computer science. Majors develop strong skills in both programming and circuit design.

www.compeng.columbia.edu

RESEARCH

http://www.compeng.columbia.edu/pages/research/index.html
http://engineering.columbia.edu/undergraduate-research-involvement-program

RESOURCES

http://www.acm.org
http://www.ieee.org
http://www.careercornerstone.org/pdf/tryengineering/compengieee.pdf
http://computingcareers.acm.org/

DEPARTMENT	EARTH & ENVIRONMENTAL ENGINEERING

MAJOR	EARTH & ENVIRONMENTAL ENGINEERING

WWW.EEE.COLUMBIA.EDU

POSSIBLE CAREERS

Work includes research and design, operation of pollution control facilities, government regulatory agencies, program management. Employers are in private consulting engineering firms, universities, private research firms, testing laboratories, government agencies, corporations, and private businesses.

DESCRIPTION OF DISCIPLINE

Earth and environmental engineers strive to develop effective solutions to problems such as the rapid consumption of natural resources, extensive waste production, environmental degradation, threats to human health, and climate change. Columbia's program focuses on three broad themes:

- Water resources and climate risks
- Sustainable energy and materials
- Environmental health engineering

http://www.eee.columbia.edu

RESEARCH

http://www.eee.columbia.edu/pages/research/index.html
http://engineering.columbia.edu/undergraduate-research-involvement-program

RESOURCES

http://www.aaee.net
http://www.careereducation.columbia.edu/resources/industry/engg/earthenv

DEPARTMENT	ELECTRICAL ENGINEERING

MAJOR	ELECTRICAL ENGINEERING

WWW.EE.COLUMBIA.EDU

POSSIBLE CAREERS

Some key industries that employ electrical engineers:

- Aerospace
- Bioengineering
- Computers
- Education and Research
- Energy and Electric Power
- Manufacturing
- Semiconductors
- Services and Other Professions
- Telecommunications
- Transportation and Automotive

DESCRIPTION OF DISCIPLINE

Electrical engineers have made remarkable contributions to the world. Electrical engineers helped invent the computer, DSL, cellular phones, microchips, and solar panels - to name just a few! Electrical engineers also make important contributions to the development of DVD players, radio, television, airplanes, space vehicles, cars, motorcycles, home appliances, life-saving medical equipment, and computer games.

http://www.careercornerstone.org
http://www.tryengineering.org

RESEARCH

http://www.ee.columbia.edu/pages/research/index.html
http://engineering.columbia.edu/undergraduate-research-involvement-program

RESOURCES

http://www.ieee.org
http://www.careereducation.columbia.edu/resources/industry/engg/ee

DEPARTMENT	INDUSTRIAL ENGINEERING & OPERATIONS RESEARCH

MAJOR	INDUSTRIAL ENGINEERING

WWW.IEOR.COLUMBIA.EDU

POSSIBLE CAREERS

Our graduates pursue a variety of positions in various sections including financial services, professional/consulting services, information/technology services, manufacturing, business analytics, social networking, not-for-profit, government, and academia.They are viewed as entrepreneurs, leaders, and problem solvers in various organizations, taking on roles such as analysts, associates, consultants, and strategists.

DESCRIPTION OF DISCIPLINE

Industrial engineering is the branch of the engineering profession that is concerned with the design, analysis, and control of production and service operations and systems. Industrial engineers are broadly concerned with productivity and all of the technical problems of production management and control. They may be found working in every kind of organization: manufacturing, distribution, transportation, mercantile, and service. Their responsibilities range from the design of unit operations to that of controlling complete production and service systems. Their jobs involve the integration of the physical, financial, economic, and human components of such systems to attain specified goals.

http://ieor.columbia.edu/pages/dptoverview

RESEARCH

http://ieor.columbia.edu/pages/research/index.html
http://engineering.columbia.edu/undergraduate-research-involvement-program

RESOURCES

http://www.iienet.org
http://www.informs.org
http://www.scienceofbetter.org
http://www.iafe.org
http://www.careercornerstone.org/pdf/tryengineering/indengieee.pdf
http://www.careereducation.columbia.edu/resources/industry/engg/ior

DEPARTMENT	INDUSTRIAL ENGINEERING & OPERATIONS RESEARCH

MAJOR	OPERATIONS RESEARCH

WWW.IEOR.COLUMBIA.EDU

POSSIBLE CAREERS

Our graduates pursue a variety of positions in various sections including financial services, professional/consulting services, information/technology services, manufacturing, business analytics, social networking, not-for-profit, government, and academia.They are viewed as entrepreneurs, leaders, and problem solvers in various organizations, taking on roles such as analysts, associates, consultants, and strategists.

DESCRIPTION OF DISCIPLINE

Operations research is an applied science, and is concerned with quantitative decision problems, generally involving the allocation and control of limited resources. Such problems arise, for example, in the operations of industrial firms, financial institutions, health care organizations, transportation systems, energy and resources, and government. The operations research analyst develops and uses mathematical and statistical models to help solve these decision problems.

http://ieor.columbia.edu/pages/dptoverview

RESEARCH

http://ieor.columbia.edu/pages/research/index.html
http://engineering.columbia.edu/undergraduate-research-involvement-program

RESOURCES

http://www.iienet.org
http://www.informs.org
http://www.scienceofbetter.org
http://www.iafe.org
http://www.careercornerstone.org/pdf/tryengineering/indengieee.pdf
http://www.careereducation.columbia.edu/resources/industry/engg/ior

DEPARTMENT	INDUSTRIAL ENGINEERING & OPERATIONS RESEARCH

MAJOR	OPERATIONS RESEARCH: ENGINEERING MANAGEMENT SYSTEMS

WWW.IEOR.COLUMBIA.EDU

POSSIBLE CAREERS

Our graduates pursue a variety of positions in various sections including financial services, professional/consulting services, information/technology services, manufacturing, business analytics, social networking, not-for-profit, government, and academia.They are viewed as entrepreneurs, leaders, and problem solvers in various organizations, taking on roles such as analysts, associates, consultants, and strategists.

DESCRIPTION OF DISCIPLINE

Management science is an interdisciplinary branch of applied mathematics, engineering, and sciences that uses various scientific research-based principles, strategies, and analytical methods including mathematical modeling, statistics, and algorithms to improve an organization's ability to enact rational and meaningful management decisions. It provides a rigorous exposure to deterministic optimization and stochastic modeling, a basic coverage of applications in the areas of operations engineering and management, and an in-depth coverage of applications in the areas of the selected concentration.

http://ieor.columbia.edu/pages/dptoverview

RESEARCH

http://ieor.columbia.edu/pages/research/index.html
http://engineering.columbia.edu/undergraduate-research-involvement-program

RESOURCES

http://www.iienet.org
http://www.informs.org
http://www.scienceofbetter.org
http://www.iafe.org
http://www.careercornerstone.org/pdf/tryengineering/indengieee.pdf
http://www.careereducation.columbia.edu/resources/industry/engg/ior

DEPARTMENT	INDUSTRIAL ENGINEERING & OPERATIONS RESEARCH

MAJOR	OPERATIONS RESEARCH: FINANCIAL ENGINEERING

WWW.IEOR.COLUMBIA.EDU

POSSIBLE CAREERS

Our graduates pursue a variety of positions in various sections including financial services, professional/consulting services, information/technology services, manufacturing, business analytics, social networking, not-for-profit, government, and academia.They are viewed as entrepreneurs, leaders, and problem solvers in various organizations, taking on roles such as analysts, associates, consultants, and strategists.

DESCRIPTION OF DISCIPLINE

Financial engineering is a multidisciplinary field that requests familiarity with financial theory, the methods of engineering, the tools of mathematics and the practice of programming. Undergraduate and graduate studies in financial engineering provide students training in the application of engineering methodologies and quantitative methods to finance.

http://informs.org/About-INFORMS/About-Operations-Research

RESEARCH

http://ieor.columbia.edu/pages/research/index.html
http://engineering.columbia.edu/undergraduate-research-involvement-program

RESOURCES

http://www.iienet.org
http://www.informs.org
http://www.scienceofbetter.org
http://www.iafe.org
http://www.careercornerstone.org/pdf/tryengineering/indengieee.pdf
http://www.careereducation.columbia.edu/resources/industry/engg/ior

DEPARTMENT	MECHANICAL ENGINEERING

MAJOR	MECHANICAL ENGINEERING

WWW.COLUMBIA.EDU/CU/MECHANICAL

POSSIBLE CAREERS

Mechanical engineers pioneered and continue to make technological advances in a diverse array of fields including automobiles, airplanes, spacecraft, power generation systems, computer-aided engineering, heating, ventilation and air conditioning (HVAC), robotics, and bioengineering, among many others. In addition, mechanical engineers are currently pioneering cutting edge technologies that include sustainable power systems tailored to economic development, alternative-fuel vehicles, green energy for HVAC, micro- and nano-technology and mechanisms, sensors, advanced materials and composite materials, automation, control and robotics, medical robotics, nano-medicine, and novel delivery systems for pharmaceuticals, to name but a few.

DESCRIPTION OF DISCIPLINE

Mechanical engineering is grounded in the fundamental fields of study of mechanics, mathematics and physics, thermodynamics and heat transfer, mechanics of solids and fluids, control theory, manufacturing and design, among other topics. They apply these principles to develop processes, devices, and systems that address societal needs and enhance and extend quality of life and the environment. In addition to inventing new technologies, mechanical engineers optimize existing technologies to achieve greater efficiency and sustainability. Because mechanical engineering is the broadest engineering discipline, it is an ideal incubator for cross-disciplinary studies.

http://www.columbia.edu/cu/mechanical

RESEARCH

http://engineering.columbia.edu/undergraduate-research-involvement-program

RESOURCES

http://www.asme.org/
http://www.columbia.edu/cu/mechanical/pages/research/index.html
http://www.careereducation.columbia.edu/resources/industry/engg/meche

OTHER USEFUL RESOURCES FOR MAJOR EXPLORATION:

- Departmental Faculty and Administrators
  (see Bulletin and departmental websites for details)

- Leora Brovman, Assistant Dean for Undergraduate Student Affairs and Global Programs: 254 Mudd, lb2258@columbia.edu

- Center for Student Advising – SEAS Departmental Liaisons:
  http://www.studentaffairs.columbia.edu/csa/academic_depts

- Professional-level Courses:
  http://bulletin.engineering.columbia.edu/professional-level-courses-first-and-second-year-students

- The Art of Engineering (required of all first-year engineering students):
  http://bulletin.engineering.columbia.edu/technical-course-requirements

- Monell Engineering Library:
  http://library.columbia.edu/content/libraryweb/indiv/eng.html

- Center for Career Education:
  http://www.careereducation.columbia.edu/
  http://www.careereducation.columbia.edu/resources/industry/engg/alleng

- Some material for POSSIBLE CAREERS and DESCRIPTION OF DISCIPLINE was drawn from the following websites:
  Sloan Career Cornerstore Center (http://www.careercornerstone.org)
  and TryEngineering.org (http://www.tryengineering.org)

COLUMBIA | ENGINEERING

The Fu Foundation School of Engineering and Applied Science

ENGINEERING.COLUMBIA.EDU