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.
MAJOR | APPLIED PHYSICS & 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.


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

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://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/app
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://www.careereducation.columbia.edu/resources/industry/engg/materials

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
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.

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

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.

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.careereducation.columbia.edu/resources/industry/engg/civil
## Computer Science

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

## Computer Engineering

**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.

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

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

DEPARTMENT | EARTH & ENVIRONMENTAL ENGINEERING
MAJOR | EARTH & ENVIRONMENTAL ENGINEERING

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

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

DEPARTMENT | ELECTRICAL ENGINEERING
MAJOR | ELECTRICAL ENGINEERING

WWW.EE.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.careereducation.columbia.edu/resources/industry/engg/ior
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.careereducation.columbia.edu/resources/industry/engg/ior
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

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 Cornerstone Center (http://www.careercornerstone.org)
  and TryEngineering.org (http://www.tryengineering.org)