“Chemical engineering prepares you for solving big picture problems while still being aware of what’s happening on the molecular scale.”

Paula Hammond
David H. Koch Professor in Engineering
Why ChemE?

The world today faces many challenges. Even when it comes to our most basic needs – from the foods we eat to the medicines we take, the clothes we wear and the energy we use – the world is ready and waiting for new ideas.

And chemical engineers are uniquely prepared not only to come up with new ideas, but also to turn them into real solutions.

Chemical engineers solve problems at the most fundamental levels. By combining mastery in traditional engineering, including physics, mathematics and modeling, with expertise in chemistry, the ability to put molecules to work, chemical engineers have a view of the world like no other. When they see a waterproof jacket, they don’t see the color or fit, they see the coating, the mesh of materials – the magical molecular mix – that makes that jacket repel water.

There has never been a more exciting time to be a chemical engineer. With the advent of biotechnology and the power of modern computer technology, chemical engineers play a role in almost every industry and they collaborate with all types of engineers and scientists. They make new materials that make computers smaller, clothes warmer and medicines more effective. They design new processes to make food healthier and drug production more efficient. They even put viruses to work not just to produce energy, but also to help assemble new materials that make solar cells more powerful.

Want to learn more?

Turn the pages and explore our world of chemical engineering. MIT Chemical Engineering. We put molecules to work.
What is ChemE?

How many chemical engineers does it take to coat an M&M? Answer: 5

In 1991, a team of 4 MIT chemical engineering undergrads worked with professor Jeffrey Feerer to understand the coatings and suggest improvements.

Because we can. In 1921, a lab in MIT chemical engineering alumnus Arthur D. Little’s company reduced 100 pounds of sows’ ears into ten pounds of glue, added chrome, alum and acetone to make gelatin, and spun that into silk. “Not very good silk,” said the company report. But they had made a silk purse of a sow’s ear.

In 1991, a team of 4 MIT chemical engineering undergrads worked with professor Jeffrey Feerer to understand the coatings and suggest improvements.

Live Wire.
Professor Paula Hammond is layering nanotubes with viruses and proteins to create new kinds of materials that make solar cells more efficient.

Wound, heal thyself.
Assistant professor Bradley Olsen is developing smart bandages that stop bleeding instantly and use bio-inspired materials that help the body heal itself.
The future is bright for chemical engineers. Think about the world today. We need to feed and clothe billions of people, we have to find new energy sources, and we want to help people live longer and healthier. These are all things chemical engineers are involved in. Molecular interactions are the root of everything. In chemical engineering, we teach our students to translate these molecular interactions into everyday – and not so everyday – products and processes. As a result, they go off in many directions, creating and improving pharmaceuticals, fuels, polymers, plastics, cosmetics, cereals and more.”

Klavs Jensen, Department Head and Warren K. Lewis Professor of Chemical Engineering
On Being a Chemical Engineer

Nature’s chemical factory. Associate professor Kristala Prather is turning single-celled organisms into miniature chemical plants by embedding multiple enzymatic pathways inside the bacteria cell walls.

Plastics.
Chemical engineers are finding ways to harvest biodegradable plastics from bacterial strains that store excess energy in the form of polymers instead of fats.

Wear your Metabolism on Your Sleeve.
MIT chemical engineering professors are developing tattoos made of fluorescent, glucose-detecting nanoparticles that may soon help diabetics monitor blood-sugar levels.

Plastics. Chemical engineers are finding ways to harvest biodegradable plastics from bacterial strains that store excess energy in the form of polymers instead of fats.

Wrap it Up.
Novel plastic bags, envisioned by professor Paula Hammond, may help preserve the casava harvest in Africa by blocking out oxygen, a food spoiler, and consuming the oxygen already inside the bag.

Cancer-seeking Missiles.
Institute professor Robert Langer’s lab helped create drug-carrying nanoparticles designed to specifically seek out prostate tumor cells and destroy them.

DIY Energy.
Think like a chemical engineer and imagine a world with self-powered iPads, spray-on virus-based batteries, and self-healing solar cells.
Alissa Borshchenko ‘16

The Community of Course X

Biology and chemistry were Alissa Borshchenko’s favorite classes in high school, but she says, “the idea of engineering was new to me.” She had heard that engineering was fast-paced and hands-on, but the prospect of learning about large scale processes and how they worked excited her. “Course X has opened up a wide variety of opportunities – most recently my summer internship at Biogen Idec. In working under the manufacturing branch of the company, I have seen a lot of the topics I have learned in my classes come to life,” Alissa states. “My experience in the department has prepared me well for my experience in terms of content, problem solving methods, and leadership skills.”

It’s more than just the curriculum that has helped Alissa develop her skills. “The thing that has stood out the most for me in the department is the faculty. From professors to the advisors to the administrators in Course X, everyone has been so open, welcoming and willing to help. I truly feel like I am cared for as a student and that I am in good hands in the department.”

Joel Schneider ‘15

A Wealth of Opportunities

When he arrived at MIT, Joel Schneider was interested in both chemistry and mathematics, and found chemical engineering to fit his goals since “it takes principles from chemistry and applies them to real world problems while using applied math to model how everything works.” He says that chemical engineering stands out because of the wide range of careers and fields in which the major is applicable. “I’ve met people with chemical engineering degrees working in oil, nanotechnology, materials, computational modeling, biotechnology, and manufacturing, just to name a few. Majoring in chemical engineering really leaves your options wide open upon graduation!”

Soon after joining Course X, he found another opportunity to broaden his experience, through the student chapter of the American Institute of Chemical Engineers. “By being on the leadership board, I’ve been able to help shape the relationship between the department and the students,” says Joel. “It’s been a lot of fun getting to know my peers as well as the ChemE faculty and staff, and I’ve learned a lot through helping organize and plan all of our fun times.”

“The coursework is often challenging, but between the faculty, staff, classmates, and TAs, there will always be people alongside you to encourage you and help make what you’re learning rewarding,” says Joel Schneider ’15. “With the events put on by AIChE and the department, widely attended office hours, and smaller classes and lab groups, Course X is very close-knit.”
Current Research

Kristala Jones Prather
Associate Professor of Chemical Engineering

Unnatural, Made by Nature

About 6,000 years ago, brewers in Sumeria used fermentation – a natural chemical process carried out by enzymes inside of bacteria – to turn grain into ethanol. In contrast, says Kristala Prather, “we’re trying to make compounds biology doesn’t make naturally.” For instance, the compound called 3-hydroxybutyrolactone, an intermediate molecule used in pharmaceutical manufacturing to make cholesterol-lowering statins, is not produced by any known microbe. So Prather is using genetic engineering tools and chemical engineering know-how to build one herself.

Undergraduates in Prather’s lab learn the techniques of science – from genetic cloning to protein gels – and what it means to be an engineer who can scale a process up and evaluate its productivity levels. “It’s exciting,” says Prather, who has companies looking to her to find biological alternatives to chemicals that, for example, traditionally come from petroleum. “It’s a great opportunity for my students to tap into the downstream applications and to see their research turn into a product.”

William Tisdale
Assistant Professor of Chemical Engineering

Energy Efficiency

In the search for renewable energy sources, solar technologies have shown great promise in helping to meet the growing needs of our planet. In fact, the energy from the sun is so powerful that today’s silicon solar cell is only able to capture about a third of it: the highest solar energy, called “hot electrons,” is too great to be converted into usable electricity and is lost as heat. Will Tisdale’s lab is using quantum dots to develop a technology to capture those hot electrons and quickly cool them down, allowing them to be captured and used. The next step is to make this technology viable on the global scale, which means the processing method for these nanomaterials must be low-cost and scalable.

Tisdale, winner of MIT’s only teaching award that is nominated and selected entirely by students, understands the importance of hands-on and immersive education for undergraduates. He uses the same collaborative approach of his laboratory in the classroom, where Course X undergraduates learn the principles of transport processes. Stated one of his students, “Professor Tisdale brings out the best in individuals and inspires them to want to learn and gain understanding.”

“UROP opportunities at MIT and Course X are invaluable,” says Amanda Lanza ’08. “There are significant mentorship benefits from working with motivated graduate students as well as faculty outside of the classroom.”

- New energy technologies, including photovoltaics, fuel cells, biofuel refinement, and gas to liquid transformations.
- Biomedical devices and methods including cancer and AIDS research.
- Materials for electronic, optical, medical, and energy-conversion devices.
- Biotechnology for therapeutics and biofuels.
- New approaches to pharmaceutical manufacturing.
- Process design and control for chemical, energy-conversion and materials processes.
Our Faculty

One-third of our thirty-five faculty members are members of the National Academy of Engineering.

Several are members of the National Academy of Sciences and the American Academy of Arts and Sciences. Over the years, professors Martin Bazant, Michael Strano and J. Christopher Love have all been named one of Popular Science’s annual “Brilliant 10.” Institute Professor Robert Langer has won the National Medal of Science, the Charles Stark Draper Prize, the 2008 Millennium Prize, and the Priestly Medal, chemistry’s highest honor. The list goes on and on.

Our faculty also do cutting-edge research. They collaborate on projects within and outside the Department and also in MIT-wide efforts such as the Broad Institute, the DuPont-MIT Alliance, the Deshpande Center for Innovation, the Institute for Soldier Nanotechnology, the Koch Institute for Integrative Cancer Research, the MIT Energy Initiative and more.

But perhaps more important, our faculty work with our students. Our faculty will be your instructors in chemical engineering classes and supervisors in research projects. They will help you select your subjects and guide your professional growth as you prepare for your career beyond your years of undergraduate study at MIT.

“If you ever have an issue, the faculty and staff help you handle it,” says Mark Kalinich ’13. “Mid-term advising meetings help keep you on track. The advisors work hard to make sure students are happy in their academic and personal lives and have all the support they need.”
ChemE Degree Options

Course 10:
Bachelor of Science in Chemical Engineering

This degree is for students who seek a broad education in the application of chemical engineering to a variety of specific areas, including energy and the environment, nanotechnology, polymers and colloids, surface science, catalysis and reaction engineering, systems and process design, and biotechnology. Degree requirements include the core chemical engineering subjects with a chemistry emphasis.

Course 10B:
Bachelor of Science in Chemical-Biological Engineering

This degree is for students who are specifically interested in the application of chemical engineering in the areas of biochemical and biomedical technologies. Degree requirements include core chemical engineering subjects and additional subjects in biological sciences and applied biology. This degree is excellent preparation for students also considering the biomedical engineering minor or medical school.

Course 10-ENG:
Bachelor of Science with Concentration

This flexible degree incorporates many of the core components of the traditional chemical engineering degree, while providing concentrations for specific relevant areas in the field, which can be designed from a set of courses offered by departments across the Institute. Students can choose one of four established concentrations (energy, biomedical engineering, materials design and processing, or environmental studies) or work with advisors to develop individualized programs.

MIT Science and HASS GIRs

Capstone
Concentration Track (4 Subjects)
Foundation (3 Subjects)
Career Options

“It became clear to me in my job search that the breadth of knowledge I had from my undergraduate studies made me qualified for positions outside my graduate focus. The experiences I had at MIT made me confident to pursue those positions – I knew that I could learn, adapt and thrive if given the opportunity.”

Amanda Lanza ’08

“In high school, I didn’t understand what I could do as a chemical engineer. Then I read an article about a ChemE intern whose summer job was to make tomato-stain-proof tupperware. For me, that was a practical, hands-on example of what chemical engineers can do.”

Mariah Hoover ’08, MSCEP ’12
MIT ChemE - Real World Experiences

Mariah Hoover ’08, MSCEP ’12
Global, Applicable, Eclectic

Mariah Hoover set out to be a chemical engineer because she wanted her work to make a difference in people’s lives. In her short career, Mariah has done a lot. After her bachelor’s, she worked on air fresheners in England. The appeal? “Consumer products have a quick turnaround. You can work on something, and see it in the grocery store 6 months later,” she says. Next, she helped clean up a chemical weapons site in Washington, D.C., work that really drew upon her training as a chemical engineer. “We had to figure out how to find the weapons in the ground, and to calculate exposure risks dermally, from inhalation, and long-term,” she says. “It was really exciting.”

During her master’s degree, Mariah worked at Novartis in San Francisco, her first foray into pharmaceuticals despite her emphasis on biology as an undergrad, as well as at Cabot, a chemical company. Her next step? “I’m working for Shell Oil,” she says. “I’ll be working on introducing new technologies into refineries across North America. I can’t wait to get started.”

Amanda Lanza ’08
Practical Knowledge from the Beginning

As part of Bristol-Myers Squibb’s Biologics Development team, Amanda Lanza presently focuses on upstream process development of early, mid and late stage biological molecules to aid immunology and oncology therapies. “The skills that I acquired through Course X touch upon all aspects on my job,” she says. “I can directly apply the content from my classes when I am operating bioreactors and purifying protein product.”

A larger portion of what Amanda learned can be applied indirectly in her job when she designs new experiments, prepares technical documents, or evaluates the scientific proposals of colleagues. “The programming experience I gained through my Intro to Chemical Engineering class, and reinforced throughout Course X’s core courses, has been extremely beneficial, enabling me to rapidly implement automated computational tools that save time and make my group’s workflow more efficient.”

Mark Kalinich ’13
Looking Inward

As a freshman in Course X, Mark Kalinich worked in the laboratory of Institute Professor Robert Langer, which helped him appreciate how chemical engineering principles can be leveraged to solve biomedical problems. “Besides learning me basic lab techniques, I practiced understanding, analyzing, and questioning the experiments I performed and the science I read. My two graduate student mentors were amazingly patient, helpful, and knowledgeable, and their guidance played a huge role in my decision to pursue an M.D./Ph.D.”

Now in the Harvard-MIT combined M.D./Ph.D. program, Mark uses basic chemical engineering principles every day. “Course X has provided an amazing framework for understanding the human body,” he says. “Fluid mechanics explains how our .6-pound heart pumps 1900 gallons of blood a day through a maze of blood vessels to the tissues that need it. Mass transport is everywhere: the lungs are ultra-efficient gas exchangers; our kidneys act as some of the most advanced filtration units on the planet. Fluid flows, mass and energy balances, and transport processes are present throughout human physiology.”
Ask our students, alumni and faculty and they will all tell you the same thing:

“Course X is hard, but it’s also fun and everyone is here to help.”

Our department isn’t just a collection of people who study the same thing. We are a community. That means we work together, we solve problems together, and we celebrate together.

As an example, we surveyed students and recent alumni and learned that they wanted a degree program that leaves room for interdisciplinary studies. So we created one. We also built in a support system to help students design their own paths through this new flexible curriculum.

Because chemical engineering provides so many career options, our faculty help all students stay on track during mid-term advising meetings. Upperclassmen also get involved by becoming Associate Advisors who help each sophomore navigate his or her way through the major.

And the student office is always available to provide students with a listening ear and helping hand. Staff members help students plan events, find funding to support projects, coordinate schedules and make connections. The office also manages the annual holiday baking contest and Holiday Party, two memorable highlights of each academic year.

“Everyone really knows each other and spends time with each other,” says Saloni Jain ’12 and Vice President of MIT’s AIChE chapter, which arranges study groups, seminars, company tours and student/faculty lunches. “It ends up being really close knit.”

“All the ChemE students take all of their core classes together at the same time, which creates a very strong sense of community among the students and it makes it easier to make friends,” says Joshua Cohen ’12. “And the professors are open and approachable, so you can ask questions during class and approach them after class.”

“I wouldn’t have made it through MIT without my chemical engineering class— all 60-something of us. Although it was a long, winding, and p-set laden road, I wouldn’t choose to spend those 4 years with anyone else,” says Mark Kalinich ’13.
You’ve probably heard that Chemical Engineering at MIT has been ranked #1 by US News and World Report for 23 years running. You’ve probably also heard that MIT chemical engineering is one of the largest chemical engineering departments the country, which means that, no matter what you want to do in ChemE, there is someone here at MIT who is teaching it or researching it or, at the very least, wants to start.

That’s the great thing about MIT. It’s filled with energy. A different kind of energy. MIT attracts bright people who have a passion for turning ideas into reality. MIT is a place where students and professors are also innovators and life-long learners. It is a place where people are more interested in moving forward together than being competitive separately. It’s a place where people love to learn and discover.

And MIT is a place where people have a lot of fun.

Maybe it’s chemistry. Maybe the place is engineered for innovation. In Course X, no doubt, it’s a little bit of both.

**MIT Chemical Engineering. We put molecules to work.**

For more information visit: http://mit.edu/cheme/