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BACHELOR PROGRAM
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BACHELOR ACADEMIC HANDBOOK
Education Code – Articles L.675-1 and L.755-1;

Decree n° 2015-1176 dated 24 September 2015 relating to the organization and the administrative and financial status of École Polytechnique;

The resolution of the École Polytechnique Board of Directors dated 22 October 2015 delegating the authority to establish the fees for services provided by École Polytechnique to the Chairman;

The recommendation of the École Polytechnique Board of Directors dated 23 June 2016 relating to the creation of the Bachelor and Graduate Degree diplomas;

Decision n° 2016-162 EP/SG dated 13 July setting the Bachelor’s Programs tuition fees;

Decision n° 2016-164 EP/SG dated July 19, 2016 setting the Bachelor’s Programs application fees;

Decision n° 2017-83 EP/SG dated February 22, 2017 setting the Bachelor’s Programs terms of attribution of tuition-fee waivers based on students’ financial needs;
General Terms

This Academic Handbook defines the general principles governing the selection of applicants and their admission to the École Polytechnique’s Bachelor Program. Furthermore, it outlines the structure and conditions of the Program’s three years of study.

This document applies to students enrolled in the Program as of the 2019-2020 academic year. Terms outlined in this Handbook may be revised as needed.

Two additional documents supplement this Academic Handbook, setting out the framework for students’ training:

➤ École Polytechnique Rules and Procedures (Règlement Intérieur)
➤ Code of Student Conduct

In the event of any inconsistency between these documents, the École Polytechnique Rules and Procedures shall prevail.

1. École Polytechnique’s Bachelor Program

École Polytechnique’s Bachelor Program is a multidisciplinary degree taught primarily in English and primarily based on the natural sciences, mathematics foremost, coupled with exposure to social sciences and humanities. Consistent with the diverse backgrounds of its students, the Program trains them to take charge of their adult lives through personal development. As such, the Bachelor Program strives to allow each student to develop their multi-faceted personality through its unique academic curriculum. Therefore, École Polytechnique seeks to serve the greater good by preparing internationally-oriented students who hold dear the values of excellence, audacity, and integrity, to use these skills and values to improve our world.

The Program’s coursework is outlined in the syllabi published annually, which may be revised as required. For each course, students will receive a course outline which lists the course objectives, the skills they are expected to acquire upon course completion, and the ways in which their performance will be assessed.

The Bachelor Program’s first year is a foundational year in which students will develop the skills required to successfully complete their academic training. This initial year of study also allows students to discover various scientific fields to support them in selecting a major. By their second year at the latest, students must specialize. By the second semester, students thus typically select between the following double majors, which are subsequently pursued in the Program’s second and third years:

➤ Mathematics and Physics
➤ Mathematics and Computer Science
➤ Mathematics and Economics

Throughout their Program, students participate in activities and courses, particularly through sports, to foster their personal development.
Depending on their academic performance, students may be eligible to complete their fifth semester abroad (see section 3 below for additional details). Students must also complete a Bachelor thesis which is an 8-week lab-based research project in their sixth semester (second semester of Year 3). During their study breaks and holidays, students may pursue professional internships on a voluntary basis in accordance with relevant École Polytechnique policies.

2. Program Structure
The Bachelor Program consists of six (6) semesters over the course of which at least 180 ECTS credits must be obtained. These six (6) semesters are divided over three (3) years; thus, two (2) semesters per academic year. Each semester allows students to obtain at least 30 credits and a maximum of 36 credits. Students can opt to take electives or to complete projects complementary to their area of study, both of which reinforce the key skills acquired through their academic training, and for which they may receive ECTS credits.

Students are eligible to take (a) supplementary course(s) which would cause them to surpass the semestrial 36-credit limit. Only certain courses can be designated “supplementary courses” for the students. Supplementary courses are optional and are awarded ECTS credits; however, the credits obtained through the completion of such courses do not count towards the credits required for graduation or progression from one year to another. Furthermore, the grades obtained in supplementary courses do not count towards calculating the student’s GPA.

Students who wish to pursue a specific individualized project requiring a specific learning agreement, which would prove to be incompatible with the general structure of the Program as it is, may file a request to do so with the Bachelor Program Office. Those requests will be studied on a case-by-case basis by the Academic Council. Students who see their request approved may also pursue a diploma with a single major instead of a double major.

Students who commit to taking a supplementary course must complete the entire course and the course will normally appear on their transcripts. However, once their grade is known, students may file a request with the Bachelor Program Office to ask that the supplementary course be omitted from their transcript. To be considered, their request must be filed within two weeks of the first business day following the publication of results. Furthermore, requesting such a change on the transcript is irreversible.

The degree is awarded only if a student attains at least 180 ECTS credits over the course of six (6) semesters.
Each of the Program’s subject pillars (i.e. mathematics, physics, computer science and economics) is represented by at least one Academic Advisor, selected by these respective departments.

3. Semester Abroad

Subject to the specific conditions outlined below, Bachelor Program students may undertake a semester abroad in their fifth semester (first semester of Year 3) either at a partner institution via the Official Student Exchange Program, or at another institution via an Independent Student Exchange Program. The application process for the semester abroad begins at the end of semester 3. Official and Independent Exchange Program committees are held during the second year. In either case, students’ academic plans must be approved by both committees composed of the following:

➤ the Vice Provost for Education
➤ the Dean of the Bachelor Program
➤ the Bachelor Program Head of Personal Development
➤ Bachelor Program Student Exchange Academic Advisers
➤ The Associate Director of the Bachelor Program
➤ Bachelor Program Second- and Third-Year Officers
➤ Student Mobility Managers from the Vice-Presidency, Marketing and International Relations.

In order to apply for a semester abroad, students must have obtained at least 90 ECTS credits by the end of semester 3 and a cumulative GPA of at least 3.0 (overall B average, see Articles 7.1 and 23 for information regarding grades and GPAs, respectively). Students who do not have the minimum GPA required to study abroad, but who nevertheless would like to do so, can have their wish examined by the Academic Council which may provide an exception to the minimum GPA in some circumstances.

Even if initially accepted into the study abroad program, students are only eligible to leave if they have 90 ECTS credits completed by the end of semester 3 and 120 ECTS credits completed by the end of semester 4 without remedial exams for Year 2, as well as a cumulative GPA of 3.0 or higher at the end of semester 4.

4. Bachelor Thesis

Students are required to complete a Bachelor thesis linked to their double major in their sixth semester (second semester of Year 3). The thesis is composed of a lab-based research internship (see 5-Internships), written report, and oral defense.

The internship is worth 14 ECTS credits, typically takes place over at least an eight-week period, and is undertaken in a lab at École Polytechnique or at a partner institution, when possible. The Academic Council may exceptionally authorize students to pursue a thesis related to their minor (if applicable); in such instances, the thesis project must be undertaken at a lab at École Polytechnique.
Students must undertake a literature review in their area of interest, identifying gaps or inconsistencies to develop their own argument or hypothesis which they will test.

Students will receive a numeric grade (from 0 to 20) and a letter grade (from A+ to F) for their Bachelor thesis, taking into consideration both the written report and oral defense, in accordance with Section 3, Article 7 of this handbook.

5. Internships

Internships are an optional component of the Bachelor Program’s academic curriculum. Students are responsible for finding their own internship(s), which typically take(s) place over the summer months after courses end (i.e. approximately July 1 to September 1). Internships can take place in France, within Europe, or overseas, in accordance with the student’s wishes. They may or may not be remunerated, in accordance with the labor code/standards of the country in which the internship takes place. If a student requires work authorization to undertake the internship in a foreign country, s/he is responsible for obtaining such authorization. Language requirements may apply to certain destinations.

Although the Bachelor Program Office does not actively seek out internship opportunities on behalf of students, it is closely involved in supporting them through their work experience.

5.1-Definitions

Each student completing an internship is assigned the following:

- **Internship Supervisor** (référent): this individual is assigned to the student by the Bachelor Program Office to mentor and support them throughout their internship. Internship supervisors are also responsible for reviewing and approving the conditions under which a student will be expected to work. An internship supervisor must have a link to École Polytechnique and can be anyone deemed competent by the Bachelor Program Office, including but not limited to: an instructor, an École Polytechnique alumnus/alumna, a Personal Development Officer, etc.

- **Site Supervisor** (tuteur): this individual is appointed to a student by the hiring company/organization. The student will have daily interaction with this person as s/he will be reporting directly to him/her in their internship. The site supervisor must be able to properly communicate in English or in French.

*Note: The names and signatures of these individuals must appear in each student’s internship contract.*

5.2. Preparing for an internship

When a student receives an internship offer, s/he must inform the Bachelor Program Office who will then assign him/her an internship supervisor. At that point, the student must complete the internship agreement form provi-
ded. To this end, students must provide their site supervisor’s name and contact details, the length of the internship, the number of hours to be worked, the amount of the stipend (if applicable), etc.

Subsequently, the internship agreement must be signed by the student, the internship supervisor, site supervisor, and École Polytechnique’s representative responsible for signing internship agreements.

In the event where a hiring company/organization refuses to agree to an internship agreement drafted by École Polytechnique, the student should contact and inform the Bachelor Program Office immediately.

5.3. Internship assessment

A student may request that their internship appear on his/her transcript. This must be submitted in writing to the First, Second, or Third Year Officer, depending on which year the internship takes place (e.g. an internship which takes place during the summer between year 1 and year 2 can appear on the 1st year transcript). The minimum requirement for an internship to appear on a transcript is that the work experience takes place on a full-time basis (at least 35 hours per week) over at least 4 weeks.

Regardless of whether an internship appears on a student’s transcript, the student must submit an internship report to the Bachelor Program Office, unless otherwise exempted. The student should also share his/her internship report with his/her internship and site supervisors.

Should a student wish to have this experience appear on his/her transcript, s/he must subsequently also present an overview of their experience to the Internship Review Committee composed of two individuals, usually one representative from the Personal Development Team and another from the Bachelor Program Office. The Committee may also invite a guest from the Career Center.

Students who will study abroad during their fifth semester and who wish to have their experience appear on their transcript, but who cannot do an oral presentation on campus due to their studying abroad, must then give an oral presentation via a digital video platform.

While no grade or ECTS credits are assigned to the internship experience, the Internship Review Committee is charged with approving the student’s request to have the internship experience appear on his/her transcript, and also provides feedback to the student on his/her report and presentation.

Guidelines related to the internship report and the internship presentation will be communicated to students by the Bachelor Program Office.
Section 1
Recruitment and Selection of Applicants

Article 1. Application

Procedure Applications are open to the following:

➤ those preparing for a diploma awarded for the completion of secondary education (French baccalauréate, baccalauréate with an international option, International Baccalaureate, Swiss Gymnasium Matura, European certificate attesting the completion of secondary education, high school diploma, etc.),

➤ those preparing for an entrance certificate to enter higher education, scientific universities in particular,

➤ those who have already obtained a diploma or entrance certification enabling them to enter higher education.

Applications are to be made online and supporting documents to be submitted include transcripts, a personal statement, a CV and two reference letters. Following a review of their application, preselected applicants are invited to take part in a video conference interview. Applicants selected following the interview are admitted to the École Polytechnique Bachelor Program, provided they obtain a diploma awarded for the completion of secondary studies or an entrance certificate to enter higher education.

A decision of the President of École Polytechnique sets the amount of the application fee. This €95 application fee is due when the application is submitted and is non-refundable, regardless of the admission decision. Payment of the fee is a prerequisite for the application to be considered by the Admissions Committee; therefore, non-payment of the fee results in the automatic rejection of the associated application.

Article 2. Selection

Applications are reviewed by a Preselection Committee and an Admissions Committee, both of which are chaired by the Provost or the Vice Provost.

The membership of the Preselection Committee is the same as that of the Admissions Committee. The mandatory members are:

➤ the Provost or the Vice Provost
➤ the Dean of the Bachelor Program or his/her representative
➤ the Director of Military Training and Personal Development, or their representative
➤ a representative from either the Department of Pure Mathematics or from the Department of Applied Mathematics
➤ a representative from either the Department of Physics or the Department of Mechanics
➤ a representative from the Department of Economics
➤ a representative from the Department of Computer Science.
Non-mandatory members acting in an advisory capacity are:

➤ a representative from the Department of Marketing and International Relations
➤ a representative from the École Polytechnique Alumni Association
➤ a representative from the École Polytechnique Foundation
➤ the Associate Director of the Bachelor Program
➤ Bachelor Program first-, second- and third-year officers
➤ the Bachelor Program Admissions Officer.

Selection criteria are primarily based on outstanding academic results already achieved in previous education. However, they also take into account personal motivation, applicants’ academic projects, their proficiency in English, as well as their commitment to studying and living in an international and multicultural environment.

Once the Admissions Committee has reviewed applications, the Bachelor Program Office notifies applicants of their (in)admissibility by email. An official certificate of admission is sent to all admitted candidates. However, students are advised that registration for the Bachelor Program is conditional on their obtaining a diploma awarded for the completion of secondary education or any other diploma or certificate mentioned in this Handbook (see Article 1 – Application Procedure).

Section 2
Registration Procedure, Tuition, and Fees

Registration is mandatory and enables students to attend courses and take exams. It consists in annual administrative registration and academic registration each semester.

Article 3. Annual Administrative Registration

Students complete their annual administrative registration online. In Year 1, administrative registration is conditional on the payment of a first non-refundable €1,400 tuition deposit and a second non-refundable €1,400 tuition deposit when applicable: the first is due upon acceptance of the offer of admission, while the second must be submitted by July 14. While all students have to pay the first €1,400 tuition deposit, the amount of the second tuition deposit may vary for students benefiting from tuition waivers.

Students’ administrative registration is confirmed once these deposits have been received and their online registration has been completed. These deposits are applied towards students’ first year tuition.

The deposits are eligible for reimbursement only in the following two cases:
1. Withdrawal due to medical issues for which a medical certificate must be provided.
2. Administrative registration cancelation by École Polytechnique due to non-compliance with the criteria listed in the conditional offer of admission.

In very specific circumstances, students may request a reduced tuition deposit of €400. To be eligible for this, the student must have been awarded an interest-free loan in the amount of €12,000 per year in collaboration with the École Polytechnique Foundation, and they must also have received at least one other form of financial aid from École Polytechnique or the Foundation (i.e. tuition waiver, Excellence Scholarship, Living Costs Scholarship, Women in Science Scholarship).

Students must be covered by a public health insurance plan (sécurité sociale) when they register at the start of each academic year. Students from countries outside the European Union must adhere to the French public health insurance plan, while students from countries within the European Union have the option to keep their home country’s health insurance.

All students in France have to pay a €91 Student and Campus Life Contribution (CVEC- Contribution vie étudiante et de campus). It is intended to finance social, cultural, and sports endeavors in higher education in France. This €91 fee must be paid prior to beginning courses and students must submit an attestation – proof of payment – to École Polytechnique.

Students are required to produce a civil liability insurance certificate, covering them against any damage caused during the Program. Although not compulsory, purchasing a private top-up health insurance policy (mutuelle) is highly recommended.

Once the administrative registration is complete, each student will be provided with a badge, which doubles as a student card, at the start of the academic year. Badges must be returned to École Polytechnique at the end of the Program.

**Article 4. Academic Registration**

Academic registration each semester is mandatory. Academic registration serves as registration for exams for the relevant semester. Students must communicate their chosen courses to the Bachelor Program Office in the manner and timeframe indicated to them. If they fail to do so, their courses will be allocated to them automatically by the Bachelor Program Office.

Registering for electives or supplementary courses requires the prior approval of the Bachelor Program's academic advising team.

By the end of Year 1, students choose their double major for Years 2 and 3 from among those offered by the Bachelor Program. The chosen major is approved by the Bachelor Program Academic Council, as defined in section 4, depending on the student’s academic level, in the manner and timeframe indicated beforehand. Any request to change majors from Year 2 must be duly justified and sub-
mitted to the Academic Council for its consideration.

Article 5. Tuition and Fees
Tuition and fees are determined by the President of École Polytechnique annually. Tuition and fees may be refunded only for medical reasons in which a student is unable to continue in the Program for which a medical certificate must be provided. Tuition and fees are not refunded in cases of expulsion from École Polytechnique.

Students are committed to paying the entirety of their annual tuition by October 15. Unpaid tuition may result in the student’s deregistration from the Program; this entails loss of access to his/her École Polytechnique email account, inability to access the institution’s online platforms, to request transcripts/official documents, and ineligibility to take final exams. In addition, students with unpaid tuition are unable to progress from one year to the next; all tuition and fees must be paid in full before graduation.

Article 6. Financial Aid
Students admitted with honors and who demonstrate financial need are eligible to apply for tuition waivers. Funds attributed to tuition waivers may not exceed 20% of the sum of all tuition paid in a given year. Eligible students may apply for tuition fee waivers in the manner outlined by the Bachelor Program Office. Tuition fee waiver applications are evaluated by the Financial Aid Committee composed of the following individuals:
➤ Secretary General (Committee Chair)
➤ Director of the Budget, Finances and Procurement, or his/her representative
➤ Director of International Relations, or his/her representative
➤ Director of the Accounting Department
➤ Head of the Student Diversity Department, or his/her representative
➤ Head of the Administration and Finance, Provost’s Office, or his/her representative
➤ Vice-Provost for Education
➤ Dean of the Bachelor Program

Invited, non-voting members, include:
➤ Admissions Officer of the Bachelor Program
➤ Associate Director of the Bachelor Program
➤ Bachelor Program Head of Personal Development
➤ Head of Legal Services, or his/her representative

The Financial Aid Committee ensures that it awards comparable tuition-fee waivers to students admitted with honors during the various waves of admissions. The decision to award tuition-fee waivers shall be taken by the Director General on the advice of the Committee. Unless otherwise specified, need-based tuition-fee waivers are granted to each beneficiary student for a period of three (3) years, except if the student repeats a year. A student who repeats a year loses the benefit of the tuition waiver for the repeated
year and must then pay tuition fees in full for that year.

Section 3
Knowledge Assessment

Article 7. Grading system
1. Grading
For each course, students will receive a letter grade (from A+ to F). At the beginning of the course, the instructor must outline the manner in which students will be evaluated and must enumerate the course’s academic objectives each student must acquire upon course completion.

Letter grades are as follows: A+, A, A-, B+, B, B-, C, D, E, F. These grades indicate the level to which the student has achieved a given course’s academic objectives.

Letter grades mean the following:

➤ A+: The course’s academic objectives were surpassed and the student has gone above and beyond the expectations
➤ A: The course’s academic objectives were attained and the student has demonstrated particular efforts during the course
➤ A-: The course’s academic objectives were attained and the student has demonstrated some efforts during the course
➤ B+: The course’s academic objectives were attained
➤ B, B-: The course’s academic objectives were generally attained
➤ C: The course’s academic objectives were generally attained with some persistent weaknesses
➤ D: The course’s academic objectives were minimally attained with persistent weaknesses
➤ E: The course’s academic objectives were not attained
➤ F: The course’s academic objectives were not attained as the student demonstrated no or little effort (e.g. numerous unexcused absences, failed to attend exams) and/or committed/attempted to commit an academic offense (e.g. cheating, plagiarism)

Grades ranging from A+ to D are passing grades which allow students to receive ECTS credits. Grades of E and F allow students to take remedial exams (see Article 12 for additional details).

During the first semester, students can request to have a Pass/Fail grade instead of a letter grade in one or two of the courses:
➤ ECO101 Introduction to Economics;
➤ MAA103 Discrete Mathematics;
➤ PHY101 Mechanics and Heat;
➤ PHY103 Beginner’s Physics Lab;
➤ CHE101 General Chemistry.

Students who receive a Pass grade still benefit from the ECTS credits associated to the course(s) but their grade does not count towards calculating their GPA (see Article 23 for additional details). Once their grade is known, students may file a request with the Bachelor Program Office to ask that their grade be transformed in a Pass/fail. To be considered, their request
must be filed within two weeks of the first business day following the publication of results. Furthermore, requesting such a change on the transcript is irreversible.

2. Language Requirements
Learning French is obligatory for non-Francophone students. Unless otherwise deemed by the Department of Languages and Cultures, students are considered non-Francophone if they have not completed at least three years of their high school education in French. A “B2” French level on the Common European Framework of Reference for Languages (CERFL) is required of non-Francophone students to obtain their degree.

Francophone students must learn another foreign language. If their knowledge level permits, they may also take culture and civilization courses in a foreign language. Regardless of the initial foreign language class taken (including French), a “C1” CERFL level is required for a student to begin learning another foreign language that replaces the language initially selected. This requirement may be waived by the Academic Council, and all changes to foreign language classes must be approved by the Department of Languages and Cultures.

3. Specific Terms Relating to Personal Development and Sports
Unless exempt by the Director of Military Training and Personal Development, playing sports is required, as it is a fundamental element of the program’s personal development component, which allows students to develop all facets of their personalities.

École Polytechnique believes it is necessary for students to become involved in the collective and individual duty of applying the terms of this program handbook and of the student handbook. Collective living and academic life are governed by the same guiding principle: responsibility shared between staff and students. The objective is for everyone to achieve a sense of responsibility and autonomy. The optional Personal Development course, contributing to enhancing commitment to the concept of personal development, is intended in that spirit.

For Personal Development courses, students receive a Pass/Fail grade instead of a letter grade, and the course appears on the transcripts only for students with a passing grade. Students with passing grades still benefit from the ECTS credits associated to the Personal Development courses but their grades do not count towards calculating their GPA (see Article 23 for additional details).

4. Humanities and Social Sciences Requirements
Over the course of the three years of the Program, the students have to follow at least two courses in Humanities and Social Sciences in order to graduate. In the two last semesters in which students may access courses in Humanities and Social Sciences, they will be automatically enrolled in those courses if they have not fulfilled this requirement earlier throughout the Program.
Article 8. Coursework and Exams
Knowledge acquisition is assessed in either of the following two ways, as determined by the instructor of each course:

➤ Coursework throughout the semester (e.g. take-home/in-class assignments, group work, quizzes, etc.).
➤ Coursework as described in the bullet above AND a final exam.

Coursework allows for students’ progress and knowledge acquisition to be regularly monitored; as such, it must consist of at least 50% of the final grade.

The final exam schedule is communicated to students by the Bachelor Program Office. Once final exams are corrected, and final grades are approved by the Academic Council, corrected final exam copies are then made available to students upon request.

In order to request a copy of their corrected final exams, students must submit their request in writing via email to the Academic Support, copying the Dean and Associate Director of the Bachelor Program, within the deadlines communicated by the Bachelor Program Office. Exam copies are provided electronically. All final exam copies are archived until the students who took the exams graduate. After this date, 1% of the total exam copies per course, or at least 3 copies, will continue to be archived while the other copies are destroyed.

Article 9. Attendance
Attendance of all classes and exams is mandatory.

Absence and tardiness disrupt class for others and may adversely affect coursework’s grade. More than three unexcused absences in courses with small groups such as tutorials, labs, seminars, sports, and language classes will result in a maximum coursework grade of C. Absences and tardiness during lectures can be penalized by the lecturer and may impact the coursework grade.

Absences and tardiness may also be further penalized by the Academic Council.

All absences should be notified and justified. The Bachelor Personal Development team is charged with validating the documentation provided to justify absences from class and/or exams, and is responsible for excusing absences. Acceptable reasons for absences, which must all rely on a written documentation, are the following:

➤ Medical reasons;
➤ Family emergency (e.g. death of a relative);
➤ Obligation set up by École Polytechnique itself (e.g. a student representative asked to miss a class to attend a Committee);
➤ Administrative obligation (e.g. a student who has to attend to a mandatory civic duty).

Absences for other reasons should still be notified, but will not be excused.
It is the responsibility of each student to make up for missed classes and to inform the professor(s) concerned in advance.

**Article 10. Plagiarism and Cheating**

Evaluation of knowledge acquired throughout the course seeks to assess students’ individual and group work skills. All coursework produced by students must be his/her own personal work, or the work of his/her group for instances involving groupwork.

Plagiarism means the representation of another’s work, published or unpublished, as his or her own in any academic writing (*e.g.* essay, thesis, research report, project or assignment) submitted in a course, whether the material so represented constitutes a part or the entirety of the work submitted. École Polytechnique reserves the right to employ the means necessary to identify plagiarism and cheating, and to prosecute such offences in accordance with the institution’s rules and regulations.

All infractions during exams may lead to a disciplinary procedure brought forth against the student concerned. In the event of a flagrant case of cheating or attempted cheating, the exam invigilator shall take all appropriate measures to stop the cheating, or attempted cheating, while allowing the suspected student(s) to complete their exam. Materials used to support cheating shall be immediately confiscated by the invigilator and shall be submitted to the Bachelor Program Office which will transmit it to the Disciplinary Committee which will use the evidence to establish the facts of the situation. The invigilator shall immediately draft a report, which must be signed by the other invigilators present as well as by the perpetrator who cheated/attempted to cheat. When the perpetrator refuses to sign, this shall be reflected in the report.

Plagiarism, cheating or attempted cheating automatically may result in prosecution before the Disciplinary Committee. In cases in which plagiarism, cheating or attempted cheating is proven, consequences may range from receiving a 0 or F on the coursework concerned, to permanent expulsion from École Polytechnique.

**Article 11. Make-up Exams**

Make-up exams are scheduled for each semester and take place during the timeframe outlined in the academic calendar provided to students. When a student has an excused absence from an exam, and this absence would cause him/her to fail the course, then s/he automatically has the right to a make-up exam.

Unexcused absences from exams may result in a grade of zero or F for the relevant exam(s) and do not provide access to make up exams.

Make-up exams are assessed with a numerical grade (from 0 to 20). This grade, in addition to the results related to other coursework allows the instructor to attribute a letter grade (A+ to F) in accordance
with the terms outlined in Article 7 (Grading). Students who fail the make-up exam are, like other students, eligible to participate in remedial exams.

**Article 12. Remedial Exams**

When a student does not receive ECTS credits for a course given his/her poor academic performance, s/he may take a remedial course. Remedial exams take place during the timeframe outlined in the Academic Calendar. Content of remedial exams is guided by the courses a student failed (*i.e.* the courses in which they received a grade of E or F).

When a student passes a remedial course, s/he can only receive a maximum number grade of 10 and a letter grade of D, with the following transcript notation: Remedial course completion. This grade replaces the failing grade initially obtained.

Absence from a remedial course exam, whether excused or unexcused, results in an automatic failure of the exam.

**Article 13. Promotion**

Degree conferral requires at least 180 ECTS credits obtained through the course of at least six semesters. All students are required to obtain these credits and to graduate with no more than 4 years; the Academic Council may provide an exception to this rule in exceptional circumstances (*e.g.* medical issue).

Promotion from one year to the following requires to have followed courses for at least 60 ECTS credits per year. Promotion from one year to the next is not automatic and only occurs once approval is granted by the Academic Council and Student Progression Committee.

Promotion and repeating a year for the Bachelor Program’s three years occurs as follows:

➤ **Year 1**
- Upon completion of at least 60 ECTS credits: promotion to Year 2, specialization selections pending review by the Academic Council/Student Progression Committee;
- Upon completion of 59 ECTS credits or fewer: readmission to Year 1 reviewed by the Academic Council/Student Progression Committee.

➤ **Year 2**
- Upon completion of at least 120 ECTS credits: promotion to Year 3;
- Upon completion of 119 ECTS credits or fewer: readmission to Year 2 reviewed by the Academic Council/Student Progression Committee.

➤ **Year 3**
- Upon completion of at least 180 ECTS credits: degree conferred;
- Upon completion of 179 ECTS credits or fewer: readmission to Year 3 reviewed by the Academic Council/Student Progression Committee.

The Student Progression and Graduation Committee may provide exceptions to the rules stated above.
Students who have not completed 90 ECTS credits after the end of semester 3, or have not completed 120 ECTS credits at the end of semester 4, are unable to undertake a semester abroad in Semester 5. The Academic Council/Student Progression and Graduation Committee has the authority to provide an exception to this rule.

**Article 14. Appeal Procedures**

1. **Grade Appeal**
   In the event of a grade appeal, a written, duly justified and signed request for must be sent to the instructor in charge of the relevant course and copied to the Dean of the Bachelor Program within two weeks of the first business day following the publication of results.
   The decision to modify the challenged grade belongs to the instructor in charge of the course.

   The instructor may provide for a review of the paper in a manner devised by him/her and communicated to the student concerned.

2. **Appeal of a Decision of the Student Progression Committee**
   In the event of an appeal against the decision of the Student Progression and Graduation Committee, a written, duly justified and signed request must be sent to the Chairman of the Committee within two weeks of the first working day following the publication of the decision.
   The right to modify the challenged decision belongs to the Chairman of the Committee.

**Article 15. Leave of Absence**

A leave of absence may be granted for students in compelling circumstances. Leaves of absence are considered for students who plan to undertake an activity that is consistent with their academic and professional goals. Leaves of absence are only granted one time to current students in any year, except in year 1. Such leave must be requested in writing and must be addressed to the Director General. The letter which must state the exact dates of the leave, should outline the reason(s) for the leave of absence, how this leave advances the student’s academic/professional goals, and how it is consistent with his/her academic path at École Polytechnique. Any relevant supporting documentation should also be submitted.

Typically, a leave of absence takes place for one academic year from September to August; therefore, leave requests must be submitted to the Bachelor Program Office by June 30 immediately preceding the leave.

The ability to make decisions concerning leave requests is vested in the Leave of Absence Committee, which is composed of the following members:
- Director General
- Provost (or his/her delegate)
- Dean of the Bachelor Program
- Bachelor Program Head of Personal Development
- At least two Bachelor Program Academic Advisors
- At least one student representative
If approved, the student concerned is required to maintain regular contact with the Bachelor Program Office and must keep the Office up-to-date on his/her situation during the leave; the nature of this contact is determined upon approval of the leave of absence by the Leave of Absence Committee. Students who receive financial aid are ineligible to receive such funding during their leave.

In the event the Leave of Absence Committee refuses to grant leave to a student, he/she may contest this decision in the French judicial system within two months after the date the requestor receives the Leave of Absence Committee’s decision.

Article 16. Expulsion
A student may be expelled for disciplinary reasons and/or for poor academic performance. A decision to expel a student permanently is taken by the Director-General, according to the recommendation of the Disciplinary Committee, which may meet on the recommendation of the Bachelor Program Academic Council or the Bachelor Program Office.

Section 4 Bachelor Program Academic Council

Article 17. Organization and Membership
Members of the Bachelor Program Academic Council are:
➤ the Vice Provost for Education,
➤ the Dean of the Bachelor Program,
➤ the Bachelor Program Head of Personal Development,
➤ Bachelor Program Academic Advisers,
➤ Bachelor Program first-, second- and third-year officiers,
➤ the Manager of Academic Records,
➤ student representatives.

It is chaired by the Vice Provost for Education or by the Dean of the Bachelor Program in his/her absence. The Council may also invite guests, such as instructors and departmental representatives as needed.

Article 18. Role of the Bachelor Program Academic Council
The Bachelor Program Academic Council is tasked with checking and validating the grades awarded to students.

Taking into account any particular circumstances which may affect the personal and academic progress of each student, the Academic Council formulates recommendations to the Student Progression Committee. More specifically, it advises on students’ double majors or specializations, the electives and supplementary courses they can pursue, and their choice of university for the semester abroad.

The Academic Council reviews program components and makes recommendations as to areas for improvement. It analyses the course evaluation forms completed by students and acts as an advisor for continuous improvement.
The minutes of the Academic Council are prepared under the supervision of the chairperson who signs them.

The Bachelor Program Office undertakes the secretarial duties of the Academic Council.

Section 5 Student Progression and Graduation Committee

Article 19. Organization and Membership
The Student Progression and Graduation Committee’s voting members are:
- the Provost,
- the Vice Provost for Education,
- the Dean of the Bachelor Program,
- Bachelor Program Academic Advisers,
- the Director of Military Training and Personal Development.

It is chaired by the Provost or the Vice Provost for Education in his/her absence.

A preliminary Committee meets prior to the Student Progression and Graduation Committee. Its membership is extended to the following members, acting in advisory capacity:
- the Bachelor Program Head of Personal Development,
- Bachelor Program first, second- and third-year officers, student representatives.

The Manager of Academic Records is also present during the whole duration of the Committee, acting in advisory capacity.

Article 20. Role of the Student Progression and Graduation Committee
Promotion from Year 1 to Year 2 and from Year 2 to Year 3, as well as graduation approval occurs after deliberation of the Student Progression and Graduation Committee. The Committee also approves major, elective, and supplementary course choices. It bases its decisions on all the results achieved by students, taking into account the recommendations from the Academic Council.

The decisions of the Student Progression and Graduation Committee are final. The Committee may, after deliberation, modify or compensate each grade and/or decide to award one or more additional ECTS credits to students.

The Student Progression and Graduation Committee may impose sanctions on the grounds of poor academic performance, which can extend to permanent expulsion of the student concerned.

The minutes of the Student Progression and Graduation Committee are prepared under the supervision of the chairperson who signs them. The Bachelor Program Office undertakes the secretarial duties of the Student Progression and Graduation Committee.
Section 6
Disciplinary Committee and disciplinary sanctions

Article 21. Disciplinary sanctions
As stated in article 53.6 of École Polytechnique Rules and Procedures, any misconduct and/or failure to comply with the rules stated in École Polytechnique Rules and Procedures, in this Academic Handbook or in the Code of Student Conduct, may lead to the following disciplinary sanctions for the student concerned:
➤ A warning;
➤ An official blame;
➤ Temporary exclusion of up to one month;
➤ Permanent expulsion from École Polytechnique.

The warning is issued by the Director General after the student concerned has been put in a position to assert his/her rights. The other sanctions are issued by the Director General, upon advice of the Disciplinary Committee.

Article 22. Disciplinary Committee
The Disciplinary Committee meets at the request of the Director General, upon recommendation of the Bachelor Program Academic Council, the Bachelor Program Academic Team and/or the Bachelor Program Personal Development Team. As stated in École Polytechnique Rules and Procedures, the Disciplinary Committee may impose sanctions on disciplinary grounds, which can extend to permanent expulsion of the student concerned. The Disciplinary Committee includes representatives from École Polytechnique Faculty as well as student representatives, and is chaired by a Professor from École Polytechnique.

Section 7
Grade Transcript and Degree

Article 23. Transcript and Degree Award Procedures
Diplomas and transcripts are personal documents which may only be given to the individuals concerned or their legal representatives.

At the end of each semester, students receive a transcript summarizing the grades and ECTS credits achieved. Transcripts also include a GPA for each semester and a cumulative GPA. GPAs are based on a scale of 4.0 and are weighted and calculated as follows:

<table>
<thead>
<tr>
<th>Grade</th>
<th>GPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+</td>
<td>4.3</td>
</tr>
<tr>
<td>A</td>
<td>4.0</td>
</tr>
<tr>
<td>A-</td>
<td>3.7</td>
</tr>
<tr>
<td>B+</td>
<td>3.3</td>
</tr>
<tr>
<td>B</td>
<td>3.0</td>
</tr>
<tr>
<td>B-</td>
<td>2.7</td>
</tr>
<tr>
<td>C</td>
<td>2.0</td>
</tr>
<tr>
<td>D</td>
<td>1.0</td>
</tr>
<tr>
<td>E/F</td>
<td>0</td>
</tr>
</tbody>
</table>
There is no indication of ranking on the transcript. However, it provides an indication of the student’s rank relative to his/her fellow students.

For the first year, students are placed into quartiles compared to all students in their cohort. In the second and third year, students are placed in quartiles compared to students in the same major.

For playing a leading role in projects in line with École Polytechnique values, doing outstanding work for the benefit of their campus community or for the common good of society, certain students have “Outstanding student who has distinguished himself/herself through his/her dedication to the École Polytechnique community and/or to the welfare of society” listed on their transcript. The number of such students does not exceed 30% of the class.

At the end of the Program, the student is awarded École Polytechnique Bachelor of Science and the French grade de licence, provided s/he has met all administrative and academic requirements.

There is no indication of ranking on the diploma. However, distinctions awarded to certain students are inscribed on the diploma, as follows:

- Summa cum laude: this distinction is awarded to students who graduate with a cumulative GPA of 4.0 or more;
- Magna cum laude: this distinction is awarded to students who graduate with a cumulative GPA of 3.9 or more, up to 4.0;
- Cum laude: this distinction is awarded to students who graduate with a cumulative GPA of 3.7 or more, up to 3.9.

These distinctions are awarded by the Student Progression and Graduation Committee to recognize those students who have distinguished themselves by their academic excellence, their sustained efforts and their involvement in their class year and in École Polytechnique.

Revised: July 2019
BACHELOR PROGRAM CODE OF STUDENT CONDUCT
This is the latest version of the Code of Student Conduct. It will be updated as needed.

Students will be formally notified should changes be made in this document.

General principles

The Bachelor Program Code of Student Conduct is aligned with current French laws. Therefore, all the provisions of the French Civil Code and Penal Code are in force within it. The Bachelor Program Code of Student Conduct supplements École Polytechnique’s Rules and Regulations (Règlement intérieur). It aims to structure community life by formally describing the behavior expected of students. Students in the Bachelor Program are voluntarily pursuing studies at a scientific institution overseen by the Ministry of the Armed Forces, and they abide by its rules.

École Polytechnique offers an environment that fosters the pursuit of knowledge through academic work and research and is conducive to personal development grounded in the military tradition. Upholding respect for diverse backgrounds and behaviors, École Polytechnique seeks to help students grow into responsible adults while guiding them through the academics of the Bachelor Program. Students are therefore expected to abide by the following:

➤ Integrity in academic and personal life
➤ The pursuit of excellence
➤ Open-mindedness
➤ Community spirit and mutual care
➤ The commitment to serve the public good.

École Polytechnique strives to give all students the chance to realize their full potential and to cultivate the different aspects of their personality within the setting of the Bachelor Program. This Code of Student Conduct, which is based on the fundamental principles of respect for persons and property, represents the guarantee that every individual will be able to enjoy a peaceful coexistence on campus.

École Polytechnique is composed of students, faculty and staff from very diverse backgrounds, who are engaged in learning, teaching, research, sports and other activities. All members of this community are devoted to creating a positive environment in which respect, civility, diversity and inclusiveness are paramount. This Code of Student Conduct...
Conduct reflects École Polytechnique’s commitment to these values and attempts to ensure that all community members can be fully active and engaged in all of the institution’s undertakings.

I. Responsibility

École Polytechnique believes that students need to play an active role in the collective and individual responsibility to enforce this Code of Student Conduct. Academic life and student life are governed by a shared philosophy: individual and collective responsibility and understanding of rights and obligations.

At the beginning of the program, students commit formally to assuming these responsibilities by signing a charter of good conduct, an example of which appears at the end of this Code of Student Conduct.

The administration of École Polytechnique reserves the right to react decisively in case any rules are breached, particularly with regard to respect for persons and communal property.

II. Daily Life

1. Respect for others

Politeness and courtesy demonstrate the mutual respect that should be shown to members of the community at large and particularly to those of École Polytechnique, whether they are students, instructors or administrators.

Each member of the École Polytechnique community must respect the dignity of other community members and must treat them fairly and equitably. In addition, all members have a responsibility to promote and maintain an environment free of any form of harassment and discrimination. As such, no member of the community is permitted to create a condition that unnecessarily endangers, threatens or undermines the health, well-being or dignity of others.

Respect for diversity, particularly differences in gender, religion, beliefs, nationality, culture, social origin, geographic origin and physical ability should guide all daily actions and the relations among students and between students and the rest of the community.

Self-respect and respect for others are demonstrated through perseverance in academic, social, extracurricular, on- and
off-campus commitments, and in personal moral commitments.

Students must be considerate of their peers’ need to study, concentrate and rest by limiting noise disturbances and by not disrupting their sleep. No noise of any form will be accepted in the housing accommodation after 10p.m. in accordance with French law.

Groups of students may not make noise near study areas and lounges. Disruptive use of a device (e.g. telephone, laptop computer, stereo, radio, etc.) is prohibited between 10p.m. and 7a.m. Unless students are granted special permission to be absent, their attendance in class and at scheduled activities is mandatory. Students are expected to comply with posted schedules. École Polytechnique is especially strict about beginning class on time.

The use of cell phones in class is prohibited.

Dress code: Respect for others is demonstrated through proper clothing as well as through proper behavior, during academic activities as well as in daily life. Modest, appropriate clothing correlates closely to the concentration needed to work seriously and efficiently. In lab premises and during sports activities, clothing must be in accordance with safety regulations.

Athletic attire is reserved exclusively for physical education classes.

When Bachelor Program students participate in major events at École Polytechnique (e.g. ceremonies, lectures, visits by figures of authority, etc.) or in certain examinations (e.g. a defense with a jury), they must wear business attire (e.g. full suit with dress shirt and tie; skirt/pants/dress and blazer).

Hygiene: Individual bathroom facilities and École Polytechnique laundry rooms are available so students can maintain personal bodily hygiene and wash their clothing. These personal hygiene rules must be observed for self-respect as well as respect for others. It is strictly prohibited to bring animals onto the École Polytechnique campus, including in the student residences.

Students should be considerate toward École Polytechnique staff by trying to facilitate their work.

Students must respect everyone’s privacy. In particular, they must limit the number of people not affiliated with the institution whom they bring into the student residences. When receiving visitors, students must stay with the visitor and ensure that the visitor behaves appropriately.

2. Respect for the living environment
Community life is grounded in respect for property and people. Students are expected to make sure not to damage the equipment and facilities made available to them and to safeguard their living environment from any defacement.
Students are prohibited from using École Polytechnique’s facilities, resources, equipment or services for reasons unrelated to the institution’s activities. Furthermore, students are forbidden from stealing, destroying, defacing or damaging École Polytechnique’s property, and students are not to harbor stolen or illicit materials on campus.

**Housing** on campus: Students are tenants of a room in a communal building on campus. They may not sublet this room.

Subletting one’s room may lead to an exclusion from the students residence.

They may not house a third party for free over a prolonged period. Should a student wish to host for a short period an overnight guest who does not hold a housing agreement on campus, the guest should be registered at the housing office for the purpose of the invitation. They receive a lease, sign a move-in inspection form and pay a security deposit that will be returned to them when they leave, based on the move-out inspection.

They pay rent on a monthly basis. They are responsible for the upkeep of their accommodation. The special terms and conditions of maintenance and use of their accommodation are subject to separate regulations published by the housing office. Smoking is prohibited in common areas and individual rooms.

Students have access to **common areas** (e.g. shared kitchen, lounge). The daily upkeep and compliance with hygiene measures in these common areas are everyone’s responsibility. Should the common areas be found in a state that prevents them to be maintained by the cleaning staff, they can be closed temporarily by decision of the housing office and/or the DFHM.

Students agree to facilitate the inspection and maintenance of the rooms and other housing facilities that are done regularly by the Personal Development Officers and housing staff. The rooms are usually inspected in December and May.

3. Freedom of expression

Philosophical, religious or political opinions or beliefs are free and may be expressed in public or private during activities that are authorized and approved by the administration of École Polytechnique. This is particularly the case for lectures, discussions or forums organized by students. This does not mean that individuals may say whatever they wish, wherever they wish: expression may be restricted when it violates the French law. Different opinions should be stated in a way that guarantees mutual respect and civility. In addition to Article 24 of the Code of Conduct with regard to the principles of the separation of church and state (laïcité), due to its special status under the oversight of the Ministry of the Armed Forces, École Polytechnique has military and civil defense chaplaincies within the Department of Personal Development and Military Training (DFHM). They advise the administration and provide religious and moral support to students.
and staff of École Polytechnique. The chaplaincies are organized by faith (i.e. Catholic, Jewish, Muslim, Protestant). Freedom of expression shall not, by action, threat or otherwise, intentionally obstruct the institution’s activities. Such activities include teaching, research, studying, administration, sports and events.

Students may express themselves freely through poster campaigns, newspapers or computing channels set aside for that purpose. Messages may not include insults, personal attacks, harm to human dignity, discriminatory, racist or sexist statements, or opinions that are likely to harm École Polytechnique or the Ministry under which it falls. The individuals who publish the messages, which may never be anonymous, are responsible for them.

When students have reason to communicate with an audience outside École Polytechnique (e.g. news reports, journalism, promotion), they must first consult with the Offices in charge of Marketing, International Relations or Communications. Students should observe caution when using social networks so as to avoid endangering their own or others’ reputation by what they post on these networks.

Students who wish to report a specific problem to the administration or who would like to react to an event or procedure have the following options:

- Meet with a member of the DFHM to discuss the issue
- Refer the matter to the elected student representative bodies
- Contact the relevant person or the Bachelor Program Office
- If they feel they have not been heard, they may send an e-mail to the relevant administrator, up to the level of Director-General.

4. Right of publicity

Unless specified explicitly in writing, all students grant École Polytechnique the right of publicity (i.e., the right to use an individual’s personal portrayal) during their time at the institution and beyond, for communication purposes and to promote the institution.

The form pertaining to the right of publicity is included in the online enrolment form.

In addition to complying with the provisions of Article 26 of École Polytechnique’s Code of Conduct regarding respect for privacy and the right of publicity, images are stored and circulated in strict compliance with the rules on the protection of human rights and of an individual’s image. In particular, the French Law on Information Technology, Data Files and Civil Liberty regarding the automated processing of personal data is enforced.

New-generation telephones and drones make it possible to capture, store and circulate images. They should be used in compliance with all legal provisions and not harm others or the operation or reputation of École Polytechnique. Breach of personal privacy or harm to reputation are subject to criminal penalties.
5. Authorizations
The Director of Military Training and Personal Development is responsible for tracking the administrative status of students in the Bachelor Program (i.e. attendance, absence) and the issuance of authorizations for absences.

In accordance with Article 9 of the Bachelor Program Handbook.
Attendance of all classes and exams is mandatory.

Absence and tardiness disrupt class for others and may adversely affect coursework’s grade. More than three unexcused absences in courses with small groups such as tutorials, labs, seminars, sports, and language classes will result in a maximum coursework grade of C. Absences and tardiness during lectures can be penalized by the lecturer and may impact the coursework grade. Absences and tardiness may also be further penalized by the Academic Council.

All absences should be notified and justified. The Bachelor Personal Development team is charged with validating the documentation provided to justify absences from class and/or exams, and is responsible for excusing absences. Acceptable reasons for absences, which must all rely on a written documentation, are the following:
➤ Medical reasons;
➤ Family emergency (e.g. death of a relative);
➤ Obligation set up by École Polytechnique itself (e.g. a student representative asked to miss a class to attend a Committee);
➤ Administrative obligation (e.g. a student who has to attend to a mandatory civic duty).

Absences for other reasons should still be notified, but will not be excused.

It is the responsibility of each student to make up for all missed classes and to inform the professor(s) concerned when absent.

Personal Development Officers and the staff of the Bachelor Program Office contact each other promptly when they learn that a student is going to be absent.

For health-related issues, students should talk to their Personal Development Officer.

Permission to depart early or return late from school vacation is granted in exceptional cases. Early departures or late returns that are not excused by an occurrence of force majeure are automatically penalized. The penalty may be as severe as suspension.

III. Vacation
School vacation dates are listed in the annual calendar set by the Bachelor Program Office.
For safety reasons, when students leave the institution, they inform their Personal Development Officer where they are going and provide an emergency contact in the event of an accident.

IV. Student Extracurricular Activities

1. Ethos
Students are encouraged to create extracurricular activities in a variety of areas (e.g. cultural, athletic, social, scientific, etc.) in order to promote personal growth, foster community spirit and raise the profile of École Polytechnique. These activities are organized with the support of École Polytechnique within a regulated structure that is compatible with the values and principles set out in this Code of Conduct.

There is an elected student council called the L’Ore that plans these extracurricular activities.

2. Parties
Students who wish to organize a party or an event on campus should request prior authorization at least 10 working days before the selected date using the dedicated form. Depending on the size of the party, two at least of the organizers must be over 18. They must attend a training session organized by the counselling services and sign the charter of Student Associations and Activities (Appendix B).

V. Discipline and safety
Students are required to abide by the rules and regulations of École Polytechnique. École Polytechnique reserves the right to lodge a complaint against a student who commits wrongful acts. The penalties for educational and academic infractions are outlined in École Polytechnique Rules and Regulations.

At École Polytechnique, discipline is inseparable from the trust placed in students and may not be an end in and of itself or a way to eliminate a problem. Rather, discipline is part and parcel of a single educational approach.

1. Penalties
As stated in article 53.6 of École Polytechnique Rules and Procedures, any misconduct and/or failure to comply with the rules stated in École Polytechnique Rules and Procedures, in this Academic Handbook or in the Code of Student Conduct, may lead to disciplinary sanctions for the student concerned. A student committing fraud or complicit in committing fraud, or a student who attempted fraud upon registration, during a course exam or a final exam, or a student committing an act that harms the organization or operation of École Polytechnique, may be subject to disciplinary action.

Acts that harm the organization or operation of the institution include but are not limited to the following:
Violation of the regulations of École Polytechnique;
Violation of the law;
Physical aggression;
Theft;
Threats;
Hazing;
Harassment;
Acts of hostility;
Sharing hurtful, personal, or disparaging information or images of/about others via social media platforms;
Behavioral consequences of alcohol use;
Consumption of drugs and behavioral consequences of drug use;
Intentional or unintentional damage;
Document forgery;
Computer crime;
Conscious or unconscious endangerment of other people.

Penalties are determined on an individual basis and are proportional to the infractions committed. To the extent possible, they fit the infractions:
- Warning;
- Official blame;
- Suspension from École Polytechnique and/or temporary banning from the student residence for a maximum of one month;
- Expulsion from École Polytechnique and/or from the student residence.

Damage inflicted by a group of students may be repaired through an act of community service.

The Director-General makes the decision after receiving the recommendation of the Disciplinary Committee.

The Director of Military Training and Personal Development is authorized by the Director-General to decide on penalties involving community service and a warning.

The decision made by the Director-General after the Disciplinary Committee meets is conveyed orally to the student as well as the student’s parent/legal guardian after the Disciplinary Committee’s meeting in case the student is minor. It is confirmed through a letter sent to the student as well as the student’s parent/legal guardian in case the student is minor.

2. Personal safety

Students are required to enroll in a public health insurance plan and to take out third-party liability insurance that covers damage they may cause. They submit their documents to the Bachelor Program Office.

École Polytechnique is obligated to guarantee the safety of students who are on the premises.

For that purpose, several measures and systems are in place to prevent accidents and deal with emergency situations that may arise.
When s/he is on duty at École Polytechnique, the Personal Development Officer is the first person who should be contacted in case of an accident that does not present immediate danger.

All community members should always be aware of fire hazard. Safety standards for institutions that are opened to the public are legally mandated and must be observed. Fire detection systems are installed in numerous locations and there are regular fire drills.

It is prohibited to activate fire alarms, play with fire extinguishers and use wedges to prop doors open and block them from traffic. Because it is vital to abide by safety measures, all infractions will be severely punished.

**Injury or emergency situation**

Students who get injured or find themselves in an emergency health situation should contact the SPIS (Fire and Safety Department) directly. The SPIS may be reached at +33 1 69 33 34 33 from a mobile phone or at 34 33 or 18 from an École Polytechnique internal land line.

After responding and assessing the situation, the SPIS transfers the alert to the relevant services (Personal Development Officer, on-call DFHM officer, Medical Service, paramedics, firefighters, etc.).

In case of a less serious emergency during normal business hours, students should visit École Polytechnique’s Medical Service. The office staff will check them in and direct them to an on-duty doctor or nurse.

In all cases, students must immediately notify or have someone else notify their Personal Development Officer or, if the Personal Development Officer is not available, the DFHM officer on duty, who can be reached 24/7 at +33 6 82 42 32 55.

**3. Security of property**

**Building access**

Students have access to most buildings at École Polytechnique in accordance with the policies established.

In order to guarantee safety inside buildings and to prevent unauthorized access, all community members should keep the entrances to buildings closed. They are opened with an individual electronic badge issued to each building occupant.

The doors to the studios are equipped with a cylinder that corresponds to a master key system set up by the locksmiths in the Facilities Department. Tenants are strictly prohibited from replacing this cylinder with their own cylinder.

If students wish to hold a group activity in a location used for academic purposes (e.g. classroom, lecture hall), they must submit a request to use the site through École Polytechnique’s intranet and wait for permission to be granted. They are then responsible for the site and the resources that are found in it permanently (e.g. tables, chairs, video projector, etc.), and they must leave the site clean and orderly. Any damage found will
be attributed to the student who requested the use of the premises.

Students are responsible for their belongings. It is up to them to protect themselves from theft by locking their doors and putting valuable items away. Possession of dangerous objects is regulated by law. It is strictly prohibited for Bachelor students to transport and bear dangerous objects (e.g. weapons, guns, smoke grenades, etc.) on campus.

**Personal vehicles**

Personal vehicles may be driven on campus in authorized areas as long as they are insured and the driver holds the proper license. Normal traffic regulations apply to campus.

It is prohibited to drive and park on grassy areas. Drivers must park in authorized areas (student, laboratory or visitor parking) under penalty of stopping by École Polytechnique’s Security Services or towing by an outside service.

4. Alcohol and drugs policy

➤ Students are expected to comply with the French law regarding alcohol and drugs.

➤ Minor students may not purchase or accept alcoholic beverages. This prohibition also applies to carry-out purchases of alcohol.

➤ Students may not possess or consume alcohol in an alcohol-free location. In particular, alcohol is prohibited in the shared kitchens and lounges of the Bachelor’s students’ residences. In general, the possession and consumption of alcohol are regulated within strictly designated locations which are authorized by the administration of École Polytechnique.

➤ All students must abide by the Charter of Community life (appendix A)

➤ The possession or consumption of drugs is prohibited on École polytechnique campus.

➤ École Polytechnique acknowledges that there may be alcohol or drug medical emergencies in which the potential for disciplinary action could act as a barrier to students who want to seek medical assistance for themselves or others. When a student seeks aid for a peer experiencing an alcohol or other drug-related emergency, neither of the two will be subject to disciplinary action for the violation of the code of conduct title V.4. However, all information related to the incident will be documented in a report.

VI. Provisions Regarding Minors

In France, the legal age to be considered an adult is 18. Minors are under 18.

If the Bachelor student is a minor, this Code of Student Conduct is signed at the beginning of the program by the student and his/her parent or legal guardian. In addition, at the beginning of the program, the parent or legal guardian of a minor signs all authorizations regarding
BACHELOR PROGRAM

medical treatment and the processing of personal data.

If a minor student violates the policies set out in École Polytechnique Rules and Procedures, in the Bachelor Program Academic Handbook or in this Code of Student Conduct, the parent/legal guardian is notified.

Arrivals to and departures from campus remain the responsibility of the parent/legal guardian of a minor student.

Causing a minor to get drunk is subject to criminal penalties in France.

In terms of sexual relations, French law draws a distinction for minors depending on if the person is younger or older than 15. Persons under 15 receive extra protection, particularly if the partner is a legal adult. The law also addresses sexual relations between an adult and a minor between 15 and 18 years old; the adult may be prosecuted if a notion of authority is ascertained.

Furthermore, French law punishes adults (18 or older) who organize gatherings that include sexual exhibitions or sexual relations that a minor may witness or participate in.

Dialogue between parents of minor students and the administration
Parent/legal guardians are notified promptly of their child’s situation: repeated absences or tardies, academic difficulties, disciplinary problems, etc.

Parents may request a meeting with the administration. This meeting may take place on-site or by telephone or videoconference.

VII. Daily Life: Who does What?

Communicating directly and on an ongoing basis with the Dean of the Bachelor Program, the Director of Military Training and Personal Development is responsible for overseeing the enforcement of this Code of Student Conduct by the students in the Bachelor Program. He is represented on a day-to-day level by the Head of Personal Development of the Bachelor Program.

The Bachelor students non-academic activities and structure is managed by the Department of Personal Development and Military Training, better known as the DFHM; the Head of Personal Development is a representative of this Department.

The students are organized into 4 groups, each led by a Personal Development Officer (also called “coach”) who is also a representative of the DFHM and who reports to the Head of Personal Development of the Bachelor Program.
APPENDICES
Charter of Community Life
Charter of Student Associations and Activities
APPENDIX A
Charter of Community Life
_Drafted jointly by the Prevention of Risks of Alcohol Misuse Student Task Force and the École Polytechnique Psychology Service_

In order to help students thrive on campus and to promote cohesion within each cohort, it is important to ensure that community life and festive events are pleasant for everyone.

It is vital that everyday life on campus take place in an environment that fosters respect for the people who work there (i.e., students and staff), for the groups involved in organizing events and for the premises.

Individuals and groups should always behave respectfully, while complying with the laws and regulations that apply to community life.

Responsible behavior is demonstrated by:

➤ Individual respect
  – Respect each student’s freedom when it comes to individual participation in activities: special attention must be paid to direct or indirect incitement to consume alcohol.
  – Excessive consumption of alcohol does not excuse degrading behavior or statements targeting oneself or others (violence, sexism, xenophobia, homophobia, etc.).
  – Living in close vicinity to others does not give anyone the right to disturb others with excessive noise or to deface anything in any way.

➤ Attentive behavior
  – Treat peers with kindness, particularly those in a state of vulnerability.
  – Pay attention to the risky behaviors that may affect one’s physical or mental health (occasional overconsumption of or dependence on alcohol or any other risky product or behavior, excessive desire to feel strong sensations, exposure to STDs, etc.).
  – It is stressed that the consumption, sale or purchase of certain psychotropic drugs (cannabis, cocaine, ecstasy, hallucinogens) is prohibited on campus.
➤ Awareness of people and mechanisms available to help students
  – Staff liaisons: Personal Development Officer, Medical Service, Psychology Service,
  Security Command Center (can be reached by dialing 18),
  – Task forces or study groups (Student Life Committee, Prevention of Risks of Alco-
  hol Misuse, etc.), prevention initiatives, etc.

➤ Compliance with the law, regulations, the institution’s Code of Conduct (or those of
  premises outside the institution, where applicable), hygiene and safety rules.

➤ Respect for École Polytechnique’s reputation and its values, both on and off campus.

With full knowledge of the facts, I, the undersigned ..................................................
confirm that I will behave responsibly, and I agree to do all that is required to abide by
this Charter.

I am aware that I put myself at risk of penalties in case of a serious breach of the afore-
mentioned policies. I am also aware that the École Polytechnique administration shares
these goals that enable a fulfilling community life and that it encourages dialogue
above all. To this end, it is always available to answer questions, respond to suggestions
or assist with problems.

Date: ...........................................

Signature
APPENDIX B
Charter of Student Associations and Activities

I, the undersigned ___________________________________________,
member of the following association of École Polytechnique: ______________________;
acting as: ___________________ (president, treasurer, head of the association, member...),
confirm that I will help prevent risky uses and behaviors related to festive or day-to-day
activities and to addictive behaviors that are likely to occur within my purview.

As a member of an association of École Polytechnique, I am aware of my civil and crimi-

nal liabilities. Consequently, I agree to implement the procedures needed to prevent
risks related to excessive alcohol consumption.

I have been informed that if needed, I may call on the available designated professionals
on the École Polytechnique campus: DFHM – Psychology Service (3916), Medical
Service (3906), Security (3433).

I am also aware of the personal development and counseling resources available to me
(intranet references: “Welcome > Campus life > Medical and social services”).

Date: __________________________________________

Signature
BACHELOR PROGRAM SYLLABUS
YEAR 1

COURSE OFFERING

Fall Semester
MATHEMATICS

Linear Algebra (MAA 101)

Linear algebra (MAA 101) is a fast-paced course which provides students with an overview of the most useful techniques of linear algebra. Upon completion of this course, students will fully understand the fundamental concepts of vector spaces, dimension, linear systems, and determinants, and how they apply to problems in other fields of the Bachelor program.

Professor(s): S. Bijakowski
ECTS Credits: 4
MANDATORY

Introduction to Analysis (MAA 102)

Introduction to analysis (MAA 102) is an introductory-level mathematical analysis course that provides a well-balanced approach between calculus and foundational notions; it is designed to equip students with the fundamental analytical tools required in all scientific fields. In particular, this course covers derivatives and function approximation in one real variable. It also introduces students to important mathematical concepts which will be expanded upon later in the program; namely, the basics of topology on the real line.

Professor(s): F. Pacard
ECTS Credits: 4
MANDATORY

Discrete Mathematics (MAA 103)

Discrete Mathematics (MAA 103) begins by introducing students to the central notions needed to pursue advanced mathematics, such as elementary logic (e.g. quantifiers, different methods of proof), sets, and functions. The second part of the course introduces students to combinatorics and probability (on finite sets). Course material is supplemented with examples and applications, such as graphical modeling and generating functions.

For this course, students can request to have a Pass/Fail grade instead of a letter grade. Students who receive a Pass grade still benefit from the ECTS credits associated to the course but their grade does not count towards calculating their GPA. Students can do such a request for a maximum of two courses during Semester 1.

Professor(s): I. Kortchemski
ECTS Credits: 4
MANDATORY
COMPUTER SCIENCE

Computer Programming (CSE 101)

Professor(s): B. Smith
ECTS Credits: 4

Computer programming (CSE 101) introduces students (with or without previous programming experience) to the fundamentals of computer programming in Python, with applications across the sciences. In this course, students will explore fundamental algorithms and data structures, up to and including binary trees, using a mixture of procedural, recursive, and object-oriented techniques. Upon completion of this course, students will have a solid foundation in the culture and practice of modern programming, and the basic skills to solve real-world problems using efficient, well-written programs and open-source tools. These foundations will be extended and completed in CSE 102 and CSE 103.

ECONOMICS

Introduction to Economics (ECO 101)

Professor(s): Y. Koriyama  J-B. Michaud
ECTS Credits: 4

Introduction to Economics (ECO 101) provides students with the foundational concepts of economics. The course begins with the investigation of the individual behavior of households and firms. Subsequently, students review and develop a thorough understanding of the concepts of supply and demand, before investigating how markets function. The course also covers imperfect competition and other market failures, as well as macroeconomic aggregates and the role of the central bank.

Required reading: Principle of Economics by N. Gregory Mankiw
For this course, students can request to have a Pass/Fail grade instead of a letter grade. Students who receive a Pass grade still benefit from the ECTS credits associated to the course but their grade does not count towards calculating their GPA. Students can do such a request for a maximum of two courses during Semester 1.
PHYSICS

Physics I: Mechanics And Heat (PHY 101)

Physics I (PHY 101) introduces students to basic concepts in mechanics and thermodynamics. It first covers point-like and simple solids in various coordinate systems; while providing an overview of the fundamental law of dynamics, kinetic and potential energy, linear and angular momentum; central and conservative forces and mechanical work. Harmonic oscillators, free and forced oscillations, resonance, eigenmodes, and one dimensional waves are studied in this context. Kinetic theory of ideal gas introduces the basic thermodynamic concepts: heat, temperature, entropy, efficiency, state variables, phase change for closed system. Upon completion of this course, students will master basic equations and principles in classical mechanics and thermodynamics and will be able to derive and solve simple models taken from their environment.

For this course, students can request to have a Pass/Fail grade instead of a letter grade. Students who receive a Pass grade still benefit from the ECTS credits associated to the course but their grade does not count towards calculating their GPA. Students can do such a request for a maximum of two courses during Semester 1.

Professor(s): D. Clouteau
ECTS Credits: 4
MANDATORY

Mathematical Methods for Physics I (PHY 102)

Introduction to analysis (MAA 102) is an introductory-level mathematical analysis course that provides a well-balanced approach between calculus and foundational notions; it is designed to equip students with the fundamental analytical tools required in all scientific fields. In particular, this course covers derivatives and function approximation in one real variable. It also introduces students to important mathematical concepts which will be expanded upon later in the program; namely, the basics of topology on the real line.

Professor(s): D. Clouteau
ECTS Credits: 2
MANDATORY
PHYSICS

Beginner’s Physics Lab I (PHY 103)

Course description: Computer programming (CSE 101) introduces students (with or without previous programming experience) to the fundamentals of computer programming in Python, with applications across the sciences. In this course, students will explore fundamental algorithms and data structures, up to and including binary trees, using a mixture of procedural, recursive, and object oriented techniques. Upon completion of this course, students will have a solid foundation in the culture and practice of modern programming, and the basic skills to solve real-world problems using efficient, well-written programs and open-source tools. These foundations will be extended and completed in CSE 102 and CSE 103.

CHEMISTRY

General Chemistry (CHE 101)

General Chemistry (CHE 101) covers fundamental concepts of atomic structure, and bonding within molecules. It also describes intermolecular interactions and their consequences regarding macroscopic properties. Students also explore the notion of orbital.

CHE 101 aims to develop students’ fundamental knowledge in chemistry for further study of reactivity aspects in higher-level courses.

This course will rely on concepts covered in physics related to the particle-wave duality of elementary particles in quantum mechanics.
PERSONAL DEVELOPMENT

Seizing my New Life at University (PDV 101)

Transitioning from high school to university is an important step that touches all aspects of one’s life: starting university, the student will discover a new approach to academics but also live a new life on campus with new type of relations with adults and peers.

This unit is designed to help the student get a good start in university life. It will take the form of group sessions with members of the academic team, a counsellor, coaches and/or the head of personal development. These sessions will focus on diverse questions the student might encounter on campus and especially on the question of choice. How can one make good choices for his/her life?

Students will share points of view, learn to discover each other and tackle methods to work, think and choose effectively.

Professor(s): M. Bresson
ECTS Credits: 1
Eligible as a supplementary course
YEAR 1
COURSE OFFERING
Spring Semester
MATHEMATICS

Reduction of Endomorphisms (MAA 104)

**Prerequisite:** MAA 101
Reduction of endomorphisms (MAA 104) introduces students to more conceptual algebraic subjects. More precisely, students explore the fundamental structures of algebra including groups, rings, and fields. Topics covered in this course are designed to prepare students for later questions related to symmetry (including those arising in physics) and number theory. This course also covers the study of polynomials, including their application, to further develop techniques acquired from linear algebra.

**Professor(s):** J. Fresán
**ECTS Credits:** 5
**MANDATORY**

Integral and Differential Calculus (MAA 105)

**Prerequisite:** MAA 102
Integral and differential calculus (MAA 105) develops students’ skills in two crucial analytical tools: Integration and Differential Equations. The approach to Integration employed in this course is Riemann’s integral, a foundational mathematics theory. This course also introduces students to two important and related topics covered in the Bachelor program: differential equations which is required to understand basic physical problems (trajectories, populations, etc.), and geometry through the study of parametrized curves.

**Professor(s):** J. Bettinelli
**ECTS Credits:** 5
**MANDATORY**

Introduction to Numerical Analysis (MAA 106)

**Prerequisites:** MAA 102, MAA 103
The aim of Introduction to Numerical Analysis (MAA 106) is to provide students with practical knowledge of basic mathematic algorithms and computer programming. Computational Mathematics covers several notions such as representation of numbers, complexity of algorithms, interpolation of functions, numerical integration, optimization, error analysis, etc. The course’s focus is on implementation using Python.

**Professor(s):** A. Lefebvre-Lepot
**ECTS Credits:** 3
**Recommended for all double majors, Mandatory for the double major Math/CS, Eligible as a supplementary course**
Mathematical Modeling (MAA 107)

**Prerequisites:** MAA 101, MAA 102

Mathematical Modeling (MAA 107) introduces the topic as it applies to physics, biology, and economics. The course covers mathematical formalization which can be used to describe some dynamics related to the following topics: mechanical and biological systems, evolution of populations, pricing, contract theory, etc. Students learn to evaluate models and motivating questions, to determine how mathematics can provide quantitative or qualitative answers. To this end, the course introduces students to and develops tools and technics from dynamical systems (e.g. recurrence relation and ordinary differential equations) and random evolution (e.g. Markov chain on a finite state space and discrete martingale). The concepts of optimization and stability are also covered.
COMPUTER SCIENCE

Computer Programming (CSE 102)

**Prerequisite:** CSE101
Computer Programming (CSE 102) is the continuation of the previous semester’s course (CSE 101). We will continue to lay the foundations of modern computer science, while developing more sophisticated programming techniques in Python. At the end of this course, students will have the fundamental analytical and programming skills to solve everyday problems in the sciences more efficiently and effectively. They will also be prepared to continue learning other programming languages and paradigms, and the theoretical foundations of computer science itself.

**Professor(s):** K. Chaudhuri
**ECTS Credits:** 5
MANDATORY

Introduction to Algorithms (CSE 103)

**Prerequisite:** CSE 101
An algorithm is a sequence of instructions that allows us to solve a problem using a finite number of steps; as such, algorithms formalize the notion of what it means to “compute”. We study algorithms to know what can actually be computed, in theory and in practice, and to find out how efficiently it can be done. Introduction to Algorithms (CSE 103) is an initiation into the art and science of algorithms. This course will train students in how to think about algorithms, how to rigorously compare different algorithms and predict their performance, and how to apply this knowledge to solve computational problems efficiently.

**Professor(s):** I. Mackie
**ECTS Credits:** 3
Mandatory for the double major Math/CS, Eligible as a supplementary course

Web Programming (CSE 104)

**Prerequisite:** CSE 101
Web Programming (CSE 104) introduces the languages, tools, and techniques specific to developing web-based applications. Students will develop a solid understanding of the intricacies of contemporary, dynamic website development, and an insight into the internal workings of the web itself. This is a hands-on practical course that provides students with valuable practice developing their own web-based applications.

**Professor(s):** D. Rohmer
**ECTS Credits:** 3
Recommended for the double major Math/CS, Eligible as a supplementary course
Topics in Economics (ECO 102) provides an overview of how the concepts in economic analysis are applied through the real-life examples of scientific research in economics. Students will learn how theoretical and empirical methods in economics are employed in the analysis of diverse subjects, such as economic growth, environmental regulation, public policy, networks, firms’ behaviors, etc. Topics are chosen from the themes in the frontier of economic research.

Professor(s):
G. Barrows
A. Pérez-Baranoha
B. Schmutz

ECTS Credits: 3

Mandatory for the double major Math/Economics, Eligible as a supplementary course, Not compatible with PHY107
PHYSICS

Physics II: Electromagnetism and Light (PHY 104)

Physics II (PHY 104) provides an overview of numerous physics concepts related to the description of light and of electromagnetic phenomena. This course introduces the concept of fields in physics, in particular with the electric and magnetic fields, and develops students’ understanding of electrostatics, magnetostatics, electrical circuits, geometrical and wave description of light. In addition, students explore concepts such as Coulomb’s law, Lorentz force, Gauss’ law, Ohm’s law, Kirchhoff’s circuit laws, Faraday’s law, and others. Upon completion of the course, the students will understand how the classical field theory of electromagnetism with the set of Maxwell equations can describe in a unified way many physical phenomena, from the propagation of light to electrostatics, magnetostatics and electrical circuits.

Professor(s): S. Corde
ECTS Credits: 5
Mandatory for the double major Math/Physics, Eligible as a supplementary course

Mathematical Methods for Physics II (PHY 105)

Mathematical Methods for Physics II (PHY 105) builds upon the previous semester’s course PHY 102. The necessary mathematical techniques for PHY 104 and PHY 107 will further develop students’ knowledge of statistics, probability, Fourier analysis Vector analysis, gradient, divergence, curl, line integrals, partial differential equations, and surface integrals, while introducing students to Gauss’ theorem and Stokes’ theorem.

Professor(s): B. Goutéraux
ECTS Credits: 2
Mandatory for the double major Math/Physics, Eligible as a supplementary course

Beginner’s Physics Lab II (PHY 106)

In the Beginner’s Physics Lab sessions, students will have the opportunity to apply the physics knowledge they have acquired in PHY104 in five distinct lab sessions of 4-hour duration. Students will learn basic experimental techniques, data analysis and interpretation, and documentation of experimental work. Students will cover, in-depth, the measurement of the speed of light, fiber-optical communication, measurement of e/m of the electron, photoelectric effect, as well as measurement of the Planck constant, and the Franck-Hertz experiment.

Professor(s): Y. Laplace
ECTS Credits: 2
Mandatory for the double major Math/Physics, Eligible as a supplementary course
Applied Physics (PHY 107)

**Professor(s):**
S. Starikovskaia

**ECTS Credits:** 3

Recommended for the double major Math/Physics. Eligible as a supplementary course. Not compatible with ECO 102

Applied Physics (PHY 107) provides a combination of lectures and seminars with a clear aim to show the link between advanced engineering and high-level physical/mathematical education. The course will cover selected questions based on fluid mechanics, thermodynamics, optics, electricity and magnetism. Background obtained during courses of general physics and mathematics will be used to understand the principles of rocket propulsion, engines for hypersonic flights, peculiarities of mass-spectrometry in physics/chemistry and biology, the link between optical spectroscopy, molecular analysis and quantum mechanics etc. As a result of the course, students should be able to look at applied physics problems combining deep knowledge in mathematics and physics and to be able to formulate to resolve a set of estimates giving the idea about mechanisms involved in the considered phenomena.

Biology (BIO 101)

**Professor(s):**
C. Le Clainche

**ECTS Credits:** 3

Required for the Biology minor. Eligible as a supplementary course

Biology (BIO 101) is a molecular and cellular biology course, which provides all the concepts required for a scientific understanding of living systems. This course aims both at preparing students for the biology option, which is available in the Mathematics & Computer Science and Mathematics & Physics majors, and at raising awareness about socio-economic issues related to biology, such as health, ethics or bioengineering.
Major Issues in Today’s World and the Place of France (HSS 101)

HSS 101 is designed to give a broad and comprehensive view of the political, economic and cultural place of France in today’s globalized world. It introduces the basics of international economics and international relations, with a particular focus on France, both from an institutional and “balance of power” perspective. Through the study of modern history and current events, students compare the French political system and its society to the countries with which France interacts, especially within the European Union. The course’s goal is to enable students to confront today’s changing world and to become agents of change.

Professor(s): N. Rousselier
ECTS Credits: 2
Eligible as a supplementary course

Meeting Professionals (PDV102)

In this unit, the students will interview a professional of their choice and present what they have learnt to their peers who will assess their presentation. Discussion will follow. It will help all students better their communication skills and reflect upon academic and career choices. Depending on the number of students, unformal meetings/tea parties with additional professionals chosen by the DFHM will follow.

Professor(s): M. Bresson
ECTS Credits: 1
Eligible as a supplementary course
YEAR 2
COURSE OFFERING
Fall Semester
MATHEMATICS

Euclidean and Hermitian Spaces (MAA 201)

**Prerequisite:** MAA 104

MAA 201 continues the study of linear maps between vector spaces, started in MAA 101. The goal is to obtain simple and efficient models for these applications up to suitable changes of coordinates. The concept of duality is initially introduced in the general context of mere vector spaces. Then, the focus is put on vector spaces enjoying a richer structure, namely prehilbert spaces, which is available in most applications (e.g. in solid mechanics or in quantum mechanics). The geometry of these spaces, as well as their important transformations (e.g. normal or unitary maps) is also discussed.

**Professor(s):** E. Balzin

**ECTS Credits:** 5

MANDATORY

Topology and Multivariable Calculus (MAA 202)

**Prerequisite:** MAA 105

Topology and multivariable calculus (MAA 202) builds on the concepts and techniques introduced in Analysis 102. In particular, students cover notions in topology. The course’s goal is to introduce complex functions that include several real variables, which are a more realistic tool for modeling phenomena in physics. Both differential calculus and integration is also covered.

**Professor(s):** Y. Bonthonneau

**ECTS Credits:** 5

MANDATORY

Introduction to Probability (MAA 203)

**Prerequisites:** MAA 105

MAA 203 covers a wide-range of important notions in probability theory and focuses in particular on discrete and continuous random variables with examples in modelling. A particular emphasis is put on how to perform and use computer simulations.

**Professor(s):** G. Conforti

**ECTS Credits:** 3

Recommended for all double majors, Mandatory for the double major Math/Economics
Statistics of Finite Samples (MAA 204)

Prerequisite: MAA 203
MAA 204 is an introductory course in statistics, with complements in probability. Topics include displaying and describing data, writing a statistical model, introduction to statistical inference, confidence intervals, approximations with the Central Limit Theorem.

Algorithms for Discrete Mathematics (MAA 205)

Prerequisites: MAA 101, MAA 103
The purpose of MAA 205 is to use computer science and programming to solve problems in discrete mathematics, and vice versa. Topics include: graphs and their matrices, combinatorics and generating functions, elementary probability, sorting algorithms. The course consists of lectures and practical labs in python.
COMPUTER SCIENCE

Object-oriented Programming in C++ (CSE 201)

The goal of CSE 201 is to introduce students to the C++ programming language, and the object-based view of software design. C++ is one of the most widely-used programming languages in the world, especially for system-level programming. Much of its power derives from its use of objects, packets of data and functionality that model things and concepts in the real world.

Professor(s): S. Mover, S. Redon
ECTS Credits: 5
Mandatory for the double major Math/CS

Design and Analysis of Algorithms (CSE 202)

Prerequisite: CSE 103
Algorithms are at the heart of all computation. Building on the algorithms the introduced in CSE112, this course provides a solid foundation in modern algorithmics. Students develop a deeper knowledge of the fundamental algorithms, an understanding of how they work, and an appreciation of how to implement them efficiently. They also learn how to reduce other problems related to these fundamentals.

Professor(s): B. Salvy
ECTS Credits: 5
Mandatory for the double major Math/CS

Logic and Proofs (CSE 203)

Prerequisite: CSE 101
Logic and Proofs (CSE 203) is an introduction to logic, a science that deals with the principles of validity of demonstration. Its goal is to familiarize students with formal methods for representing arguments and reasoning about them.

This encompasses propositional calculus, first-order logic, and deduction systems, as well as the related technologies (e.g. automated provers, proof assistants) for building mechanized proofs. No prior knowledge in logic is required.

Professor(s): PY. Strub
ECTS Credits: 3
Recommended for the double major Math/CS
**Intermediate Microeconomics (ECO 201)**

Intermediate Microeconomics (ECO 201) focuses on the study of consumer and producer decisions and interactions. It also introduces the students to decision-making under uncertainty and basic portfolio theory, market equilibrium and general equilibrium of the economy, monopolistic and oligopolistic competition among firms and other forms of strategic interaction studied in Game Theory. Additional issues are reviewed, including conditions for market efficiency, public goods, the effect of strategically used private information, market failures and their remedies, etc.


**Professor(s):**
- C. Pawlowitsch
- M. Nunez

**ECTS Credits:** 3

Mandatory for the double major Math/Economics

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**Intermediate Macroeconomics (ECO 202)**

Intermediate Macroeconomics (ECO 202) focuses on both the business cycle and long-term growth. The goal is to understand the relationship between key macroeconomic variables; namely, consumption, investment, money supply, interest rate, inflation, unemployment, and GDP growth. Students investigate the role of monetary and fiscal policy, while reviewing international issues, such as the behavior of exchange rates and capital flows.

Textbook: *Macroeconomics* by Olivier Blanchard

*Macroeconomics* by N. Gregory Mankiw.
Classical Mechanics (PHY 201)

This course introduces students to mechanics of complex system. After a reminder of the classical concepts of point mechanics (covered in PHY 101), the course extends these concepts to more general systems. Using energy-based formalisms, it provides a comprehensive approach to the concepts of force balance and moments, leading to the equations of the movement. This permits students to approach the concepts of oscillators, stabilities and behavior law. The energy-based approach that is at the heart of this course is also found in many other fields of physics: relativity, quantum physics, electromagnetism, etc.

Upon completion of this course, students master equations and principles in analytical mechanics. They will be able to discuss the relevance of the chosen model, as well as derive and solve simple models taken from their environment.

**Main concepts covered:** Rigid solids. External force and moment; center of mass. Equilibria. Fundamental law of dynamics; balance of linear and angular momentum; kinetic and potential energy; constitutive laws for perfect of viscous hinges. Linearized equations of motion, oscillations, stability. Lagrangian and Hamiltonian mechanics.

**Professor(s):**

**ECTS Credits:** 5

**Mandatory for the double major Math/Physics**
PHYSICS

Wave Optics and Radiation (PHY 202)

PHY 202 introduces the students to the basics of wave phenomena and focuses, in particular, on optical waves. The major concepts are first presented by studying oscillations from simple systems before waves in general are introduced. Light waves are then described in detail, with a focus on polarization, reflection and refraction at interfaces and scattering. The concept of coherence is developed along with its spectacular experimental manifestations in interferences and diffraction. The course then focuses on the way light is emitted in various situations and covers black body radiation, as well as emission and absorption of light by atoms. The latter provides an opportunity to discuss the quantum behavior of matter and to introduce the electronic structure of atoms in a phenomenological manner. Concrete examples and illustration of these phenomena, such as the principle of the laser, the temperature of stars, and spectroscopy in astrophysics, are given during the lectures.

Upon course completion, students will acquire a deeper physical understanding of wave phenomena, including the basic concepts of wave optics and light emission. They will also master the analytical skills needed to solve basic problems in physical optics and wave physics more generally.

Advanced Lab I (PHY 203)

In Advanced Lab I, students have the opportunity to apply the physics knowledge they acquired in PHY201 and PHY 202. PHY 203 consists of 7 distinct lab sessions of 4 hours each. It provides an in-depth study of a wide range of physical phenomena such as electronics (passive and active electronics, Fourier synthesis, Arduino micro-controller), wave-optics (diffraction, interference and polarization of light), nuclear physics (Rutherford scattering experiment) and the mechanics of solid bodies. Upon course completion, students will have acquired advanced experimental skills allowing them to set up, carry out and analyze critically experiments in physics and mechanics.
**BIOLOGY**

**Cell Biology (BIO 201)**

**Prerequisite:** BIO 101  
Cell Biology (BIO 201) introduces students to the mechanisms that cells use to regulate the physical properties of their dynamic architecture, to produce force and move, to compartmentalize and transport proteins, to regulate growth and death, and to communicate with their environment. The course focuses on human cells, and emphasis is placed on human diseases where appropriate. Upon course completion, students have a comprehensive understanding of the function and architecture of cells.

Because experimentation is at the heart of progress in cell biology, 50% of classes contain practical work, completed over the course of the semester. The intention is to allow students to develop their knowledge in the subject area, to acquire sound scientific reasoning, and to become familiar with the main techniques of modern cell biology, like quantitative microscopy imaging and computer-assisted data analysis.

**Professor(s):**

ECTS Credits: 3  
Required for the Biology minor

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**CHEMISTRY**

**Introduction to Reactivity (CHE 201)**

**Prerequisite:** CHE 101  
CHE 201 is an intermediate-level chemistry course that allows students to develop the tools to analyze a chemical transformation. In particular, students explore why, how and at which rate substances react. This interactive course explores these topics through lectures, tutorials and labs.

**Professor(s):**

ECTS Credits: 3  
Required for the Chemistry minor
History of Science and Technology (HSS 201)

History of Science and Technology (HSS 201) seeks to enhance students’ understanding of science and its relationship to social concerns throughout history. The course will offer both thematic and chronological approaches to the evolution of science in various societies from the antiquity to modern times. Historical periods covered include: ancient civilizations (e.g. Greece, Egypt, India, Babylon, China, etc.), the Renaissance, 17th century scientific revolution, the Enlightenment, the 19th/20th/21st centuries.

Professor(s):
M. Lyautey
ECTS Credits: 2

Eligible as a supplementary course
PERSONAL DEVELOPMENT

Hands-on Programs: Health or Volunteering (PDV201)

In this unit, students will choose between two hands-on programs designed by their personal development officers. One focused on health (sports, dietetics, sleep...), the other involving group volunteering in a charity. The aim is to take action collectively and develop one’s personal skills, all outside of lecture halls.

Professor(s): M. Bresson
ECTS Credits: 1

Eligible as a supplementary course
YEAR 2
COURSE OFFERING
Spring Semester
MATHEMATICS

Quadratic Forms and Applications (MAA 206)

Prerequisite: MAA 201
Quadratic forms and applications (MAA 206) is a continuation of Euclidean and Hermitian spaces (MAA 201) and covers objects in bilinear algebra. These objects, mainly quadratic forms, have fundamental applications (e.g. in Number Theory and Mechanics), and also lead to the study of algebraic objects; for instance, some special groups of matrices, whose applications in mathematics and physics are fundamental, from Number Theory and geometry to the classification of particles.

Professor(s): T. Gauthier
ECTS Credits: 5
MANDATORY

Series of Functions, Differential Equations (MAA 207)

Prerequisite: MAA 202
Series of functions, differential equations (MAA 207) builds upon the topology notions studied in Topology and multivariable calculus (MAA 202) to allow for a more profound study of functions. Examining functions as limits of simpler ones (e.g. for approximation problems) is made possible in a rigorous manner thanks to topological ideas. This provides the possibility of using crucial tools in many scientific fields; the most striking one being Fourier series (first designed to solve the heat equation and now ubiquitous in science and, in a hidden manner, in daily life). The second part of the course deals with a wide array of differential equations, permitting students to better understand complex physical questions.

Professor(s): R. Tessera
ECTS Credits: 5
MANDATORY
Numerical Linear Algebra (MAA 208)

Professor(s): T. Pichard
ECTS Credits: 3

Recommended for all double majors. Mandatory for the double major Math/CS

Prerequisite: MAA 106, MAA 201

MAA 208 covers the very important topic of numerical linear algebra. Starting with recalling linear algebra’s basic concepts (i.e. vectors, matrices, addition and multiplication), we quickly concentrate on methods for solving linear systems. Students study typical direct and iterative methods together with their practical implementation. This permits them to compare the methods in terms of complexity depending on the size of the problem to solve. The emphasis is put on the practical resolution of the problems and the theory that is required to understand the behavior of the methods considered. Subtle notions such as condition number, order of convergence, etc. are covered and explained. The course finishes with a project which is defended in-class during the last week of the semester. Students are evaluated based on this their project presentation, a report, and coursework.

A First Step in Numerical Optimization (MAA 209)

Professor(s): B. Bogosel
ECTS Credits: 3

Recommended for the double major Math/CS. Mandatory for the minor Computational Mathematics in the double major Math/Economics

Prerequisites: MAA 202, MAA 208

Numerical optimization concerns the minimization or maximization of an objective function. It often relies on the computation of the gradient of this function. MAA 209 covers several aspects of the classical methods that are used in such problems. For instance, the gradient methods (or steepest descent), the non-linear conjugate gradient methods will be seen. A particularly important topic concerns the Newton-Raphson method, which extends the mono-dimensional Newton method to higher dimension. MAA 209 follows MAA 208, since linear algebra methods are heavily used. Applications to the computation of the Eigen elements of a matrix or to the resolution of non-linear systems of equations are also studied. As before, the course heavily uses practical sessions, which are taken under consideration for the grading.
COMPUTER SCIENCE

Machine Learning (CSE 204)

**Prerequisites:**
CSE 101, CSE 102 and CSE 201

Machine Learning (CSE 204) describes some of the methods and algorithms used in contemporary machine learning, with a variety of scientific applications. When brought up to scale, this becomes an important part of what is now referred to as Big Data.

**Professor(s):**

ECTS Credits: 5

Computer Architecture (CSE 205)

**Prerequisite:** CSE 201

This course investigates the design and organization of computers at their lowest level. This encompasses computer hardware, and also the operating systems that provide an interface between most programs we write and use with the underlying machine and its network.

**Professor(s):**

ECTS Credits: 5

Introduction to Formal Languages (CSE 206)

This course introduces different concepts in automata theory and formal languages, including formal proofs, deterministic and non-deterministic automata, regular expressions, regular languages, context-free grammars and languages, and Turing machines.

**Professor(s):**

ECTS Credits: 3

Introduction to Networks (CSE 207)

This course will introduce students to the architecture and skeleton required for implementing a protocol - and part of that will include creating multiple threads, and synchronized queues.

**Professor(s):**

T. Clausen

ECTS Credits: 3
**Introduction to Econometrics (ECO 203)**

*Professor(s):* A. Simoni<br> A. Uhlendorff  
*ECTS Credits: 5*  
*Mandatory for the double major Math/Economics*

Introduction to Econometrics (ECO203) introduces the most common ways to study and analyze economic data, with a focus on emphasizing data analysis for empirical causal inference. Topics include randomized trials, regression, instrumental variables, differences-in-differences, and regression discontinuity designs. Students also learn how to study datasets through practical examples.

*Textbook:*
*Introductory Econometrics: A Modern Approach* by Jeffrey M. Wooldridge  
*Basic Econometrics* by Damodar N. Gujarati and Dawn C. Porter

**Introduction to Finance (ECO 204)**

*Professor(s):* L. Schilling  
*ECTS Credits: 5*  
*Mandatory for the double major Math/Economics*

Introduction to Finance (ECO 204) introduces fundamental ideas of modern portfolio theory and corporate finance. Topics include present value and discounting, interest rates and yield to maturity, various financial instruments including financial futures, mutual funds, the efficient market theory, basic asset pricing theory, the capital asset pricing model, models for pricing options and other contingent claims, and the use of derivatives for hedging.

**Topics in History of Economic Thought Since 1945 (ECO 205)**

*Professor(s):* B. Cherrier  
*ECTS Credits: 3*  
*Mandatory for the double major Math/Economics*

The Economics Workshop (ECO 205) is based on teamwork in which students work in groups of four or five to further explore economics issues. In particular, students discuss current events, create and test economic models, while developing and analyzing computer simulations.
Classical Electrodynamics (PHY 204)

Classical electrodynamics is an important pillar of physics given that it led to numerous scientific and technological developments since the 19th century. PHY 204 aims to provide students with an introduction to the principles and behaviors of dynamical electric and magnetic systems, and a theoretical foundation in classical field theory. It builds upon the knowledge acquired in PHY104 and begins with reminders in electrostatics and magnetostatics, before moving on to a more formal presentation of Maxwell’s equations in magnetic and dielectric media. Applications of the electromagnetic theory such as free or guided propagation, optical phenomena or the emission of radiation by moving charges are presented as key concepts illustrating the development of modern technology. The course concludes with an introduction to relativistic electrodynamics and its covariant formulation.

Upon completion of this course, students will master the fundamental principles in classical electrodynamics. They will be able to understand the origin of Maxwell’s equations in magnetic and dielectric media and their essential consequences. Besides deriving and solving simple models illustrating the main concepts, they will also be able to understand the physical principles governing everyday life and modern technological systems, from wave propagation phenomena to optical fibers, to antennas and electrical engines.

Topics covered in this course include: electrostatics, potential problems in 3D, boundary value problems, Poisson’s equation, multipole expansion; conservation laws; dia-para-ferro-magnetism, induction laws; field energy; displacement current; solution to Maxwell’s equations in vacuum, superconductivity (London theory); plane electromagnetic waves; waveguides and resonators; radiating systems; special theory of relativity; relativistic kinematics; Lorentz transforms of Fields; 4 vectors, covariant formulation of electromagnetism; radiation by moving charges; synchrotron radiation; Cherenkov radiation.

Professor(s): A. Couairon
ECTS Credits: 5
Mandatory for the double major Math/Physics
Introduction to Quantum Physics (PHY 205)

Quantum physics is the theoretical framework for the description of nature at the atomic length scale and below. According to our present knowledge, it encompasses the most fundamental physical theory, and is the basis for everyday applications like semi-conductor electrons, lasers, medical imaging to name only a few. In PHY 205, students discover quantum physics through the formalism of Schrödinger’s wave mechanics, and learn to describe simple, non-relativistic quantum phenomena, mainly in one dimension, by applying mathematics of classical waves to which they have become familiar. Subsequently, they are introduced to the quantum-mechanical formalism of which the central notion is the quantum state. Students also become familiar with the underlying mathematical structures, Hilbert spaces and Hermitian operators, and discover the quantum description of known classical systems and concepts such as free motion, the harmonic oscillator and angular momentum. The course also allows students to explore purely quantum phenomena that have no classical counterpart, such as the electron spin, and a brief overview on quantum communication may be provided. Throughout the course, the abstract theory will be illustrated by historic experimental evidence and modern applications whenever appropriate.

Upon completion of this course, students will be able to explain the conceptual difference between classical and quantum behavior, and solve simple one- or two-dimensional problems of quantum mechanics in the framework of wave mechanics. Furthermore, they will be able to wield the abstract formalism of quantum states in Hilbert spaces, and to apply it on simple quantum systems.

Professor(s): A. Specka
ECTS Credits: 5
Mandatory for the double major Math/Physics
Waves and Heat Transfer in Geophysics (PHY 206)

The course describes waves and heat transfer in fluids, with a preference for illustrations coming from the Earth system, in particular the atmosphere. Waves or oscillations are one essential type of motion present in many fluids. One goal of the course is to demonstrate how one proceeds to obtain wave solutions starting from a physical description of a system and its equations of motion. Acoustic waves will be considered as a first example, surface water waves at different scales (from ripples in the pond to tsunamis) will be derived as further examples. Basics of fluid mechanics (Euler equations, kinematics) will be introduced in order to make these developments possible. Similarities in the behavior of fluid waves and optical waves seen in PHY 202 will be discussed.

The structure of the atmosphere and how we have progressively come to understand it will be reviewed. To describe this understanding and touch upon the subject of climate change, thermodynamics will be revisited and applied to the atmosphere (thermal structure, radiative balance).

At the end of the course, the students will understand how one characterizes a family of waves (dispersion relation, polarisation relations), and how to proceed to obtain, in a given system, wave solutions if they exist. The students will have reviewed thermodynamics and have seen applications to the atmosphere (thermal structure, atmospheric stability, clouds, radiative balance). Finally, some elements of the study of the Earth, and of the atmosphere in particular, will have been introduced.

Professor(s): R. Plougonven
ECTS Credits: 3
1 Mandatory course to choose between PHY 206 and PHY 208 for the double major Math/Physics
Advanced Lab I (PHY 207)

Professor(s): Y. Laplace
ECTS Credits: 3

Mandatory for the double major Math/Physics

In Advanced Lab II, students have the opportunity to apply their physics knowledge they have acquired over the course of 7 distinct lab sessions of 4 hours each. PHY 207 provides an in-depth study of a wide range of physical phenomena such as fundamental and applied optics (Fourier optics, optical fiber communication), atomic and nuclear physics (Balmer series, Nuclear magnetic resonance), thermodynamics (low temperature physics, SF6 critical point) and the mechanics of deformable bodies.

Upon completion of this course, students will have acquired advanced experimental skills allowing them to set up, carry out and to critically analyze experiments in physics and mechanics.
PHY 208 is an introduction to light-matter interactions through the intricate relationship between atoms and lasers. Importantly, this course will build on experimental situations, and introduce models with increasing complexity to explain the observed results. As the basic component of a laser is a source of light, the course will start with basic spectroscopy, and several atomic models will be considered (Bohr model, Einstein coefficients, Schrodinger model, etc.). The emission of continuous laser light by such atoms will be described from both a classical (effective medium) and semi-classical (population inversion) perspective. The mirror will then be turned back on the atoms, and several applications of laser light revealing the behavior of atoms will be discussed (Light, Stark and Zee-man shift, Rabi oscillations etc.). Finally, some practical perspectives on advanced laser technologies and applications will be given.

This course will not add many new physical concepts, but rather show how results obtained in previous courses (especially in optics, classical and quantum mechanics) can be used. Upon completion of this course, students will have acquired key understandings concerning the bilateral interactions between laser devices and atoms. They will have understood the circumstances under which the emission of useful coherent light can be produced, and also the information that such light can provide when analyzing atomic systems. They will also be able to identify the relevance, necessity, and limitations that classical and quantum models display when analyzing problems in this field. They will also gain familiarity with some laser device technologies.

Professor(s):
D. Suchet
E. Johnson
ECTS Credits: 3

1 Mandatory course to choose between PHY 206 and PHY 208 for the double major Math/Physics
BIOLOGY

Molecular Genetics (BIO 202)

Professor(s): A. Auffrant, A. Guell
ECTS Credits: 3
Required for the Biology minor

Prerequisite: BIO 201
Molecular Genetics (BIO 202) provides an in-depth understanding of the mechanisms by which living organisms store, express and transmit genetic information and the basis of human genetic diseases. Lectures will cover a range of topics, including the molecular aspects of DNA replication and transcription, translation of RNA into protein and gene regulations. This course will also cover the latest methodologies used in genomics analysis, like DNA sequencing.

Because experimentation is at the heart of progress in cell biology, 50% of classes contain practical work, completed over the course of the semester. The intention is to allow students to develop their knowledge in the subject area, to acquire sound scientific reasoning, and to combine the modern techniques in molecular genetics with computer-assisted data analysis.

CHEMISTRY

Environment and Energy (CHE 202)

Professor(s): A. Auffrant, A. Guell
ECTS Credits: 3
Required for the Chemistry minor

Prerequisite: CHE 201
Environment and Energy is an intermediate-level chemistry course that explores topics such as chemistry in water (i.e. acid/base, complexation equilibrium), electrochemistry, and selectivity in chemical transformations. This interactive course explores these topics through lectures, tutorials and labs.
HUMANITIES AND SOCIAL SCIENCES

Philosophy: Science and Technology (HSS 202)

This course introduces students to foundational concepts in the philosophy of science. It asks the question of the relationship of philosophy to science and technology throughout history, examines some examples of encounters between science and philosophy with an emphasis on their social and political context and encourages students to exercise their own judgement on contemporary issues in philosophy of science.

Professor(s): J. Chalier
ECTS Credits: 2
Eligible as a supplementary course

PERSONAL DEVELOPMENT

Speech Contest (PDV202)

In this unit, the students will be trained for and participate in a speech contest. The aim is to succeed in convincing, moving, persuading, expressing oneself fluently on a specific subject.

Professor(s): M. Bresson
ECTS Credits: 1
Eligible as a supplementary course
YEAR 3
COURSE OFFERING
Fall Semester
MATHEMATICS

Measure and Integration (MAA 301)

**Prerequisite:** MAA 202

MAA 301 is devoted to the modern theory of integration. After first constructing the Lebesgue integral, and explaining how it improves the Riemann integral, a major part of the course will be devoted to discovering the power and ease of use of this tool. Applications in probability theory will then be briefly described. The course will finally provide an introduction to Lebesgue spaces and the Fourier transform, in order to demonstrate the usefulness of the theory for applications in physics and economics.

Professor(s): Y. Martel

ECTS Credits: 5

MANDATORY

Topology and Differential Calculus (MAA 302)

**Prerequisite:** MAA 202

MAA 302 is devoted first to the theory of metric and topological spaces in an abstract setting, including numerous examples of function spaces. We will then shift our focus towards Banach spaces, motivated by applications in optimization. Following this, the course will examine differentiable functions, smooth functions, and their local properties. Restricting our attention to finite dimensional spaces, the course will conclude with an abstract theory of optimization, with applications in economics and physics: optimization without constraints and with constraints, and the well-known Lagrange multiplier theorem will all be studied in detail.

Professor(s): K. Carrapatoso

ECTS Credits: 5

MANDATORY
At least 1 Mandatory course to choose between MAA 303, MAA 304 and MAA 305 for the double major Math/CS. MAA 303 and MAA 304 Recommended for the double major Math/Economics.

Algebra and Arithmetics (MAA 303)

**Professor(s):** D. Izquierdo  
**ECTS Credits:** 3

**Prerequisite:** MAA 104  
MAA 303 focuses on general group theory, ring theory and field theory. The first course objective is to describe group actions and geometric applications, as well as the notion of Sylow subgroups. The second part of the course develops general commutative ring theory, looking specifically at applications for the arithmetic of integers. The last aim of the course is to introduce students to the theory of field extensions, and the Galois theory of algebraic equations.

Asymptotic Statistics (MAA 304)

**Professor(s):** E. Moulines  
**ECTS Credits:** 3

**Prerequisite:** MAA 203, MAA 204  
MAA 304 will open with a recap of convergences of random variables and convergences of distributions. The class will then investigate asymptotic statistics (asymptotic properties of MLE, asymptotic confidence intervals, asymptotic test theory etc.) and information theory for statistics (efficiency, Cramer-Rao theory etc.). Finally, students will be given an introduction to Bayesian statistics.

Probability: Stochastic Processes (MAA 305)

**Professor(s):** T. Mastrolia  
**ECTS Credits:** 3

**Prerequisite(s):** MAA 203, MAA 204  
This class examines Markov chains, Poisson processes, renewal processes and pure Markov chains. Starting with the theoretical aspects of process analysis, our lectures will then cover further applications and discuss modeling for issues appearing across various fields.
COMPUTER SCIENCE

Functional Programming (CSE 301)

**Prerequisites:** CSE 201 and CSE 203
In this course, we will study functional Programming, and will learn how to take advantage of the features of modern functional programming languages. We will study in depth the notions of functions (higher-order functions, closures), module systems (signatures, functors), and iterators. The practice sessions will be done in OCaml (but concepts presented in the course can be applied in many other languages such as Haskell, SML or JavaScript).

**Professor(s):** X. Rival
**ECTS Credits:** 5

1 Mandatory course to choose between CSE 301 and CSE 302 for the double major Math/CS

Compilers (CSE 302)

**Prerequisite:** CSE 201, CSE 207
Compilation is the process of transforming high-level programs and abstractions into the binary machine code used in computer processors. This course introduces the principles and techniques of compilation, with parsers, interpreters, and translators, as well as topics in code optimization and semantic analysis. Students will build a compiler for a simple programming language.

**Professor(s):** K. Chaudhuri
**ECTS Credits:** 5

1 Mandatory course to choose between CSE 301 and CSE 302 for the double major Math/CS

Computer Science Project (CSE 303)

This course will give the students the opportunity to design and implement a significant CS project.

In that perspective, the students will have to work in an organized and professional manner from conception to delivery, giving them the opportunity to apply all the knowledge they got from the previous courses.

**Professor(s):**

**ECTS Credits:** 3

Mandatory for the double major Math/CS. 1 Mandatory course to choose between CSE 303 and MAA 303 for the minor Computational Mathematics in the double major Math/Economics
Advanced Microeconomics (ECO 301)

In Advanced Microeconomics (ECO 301), we build on the ECO 201 course to go beyond the competitive equilibrium setting and elicit new causes of market failures. We aim to study how the presence of incomplete and asymmetric information affects the standard analysis of microeconomic theory. The starting point is that the presence of asymmetric information leads to market failures and open the question of how to regulate and appropriately design markets to solve or reduce these failures. We will present the basics of two important theories and methods which have been the core of the modern microeconomic analysis since 1970: the signaling games and the mechanism design. The students will learn the tools to analyze markets and interactions in the presence of incomplete and asymmetric information. They will learn how to develop policy tools and how to design markets to mitigate the issues induced by the information structure.

More specifically, we will cover the following topics:

- Chapter 1: Game theory under incomplete information (1)
- Chapter 2: Asymmetric Information, Signaling and Application to the Insurance Market (2)
- Chapter 3: The Principal Agent Model (3)
- Chapter 4: Auctions and Mechanism Design (4)
- Chapter 5: Market Design and Matching

The mathematical treatments are rigorous but not as much as at the graduate level. This course will be thus most useful as a preparation for formal graduate studies in Economics.

Textbooks:

Advanced Macroeconomics (ECO 302)

This course builds on the Intermediate macroeconomics course (ECO 202) and will cover both the short run (business cycles, crises, and stabilization policies) and the long run (the determinants of long-run economic growth). To be more specific, the course will cover the following topics:

**Part I: Business cycles and stabilization policies (7 lectures)**
- The New Keynesian model of aggregate demand and supply
- The propagation of business cycle shocks
- Conventional monetary and fiscal policies
- The liquidity trap and unconventional policies

**Part II: Economic Growth (7 lectures)**
- Growth facts and Solow reminder
- Immediate causes of economic development: human capital, physical capital, and technology
- The deep causes of economic development: geography, institutions, and culture
- Innovation and economic growth
- Economic growth and the environment

Textbooks:

A complementary reading list of policy and accessible research papers will be provided in due time.

**Professor(s):**
E. Challe

**ECTS Credits:** 5

**Mandatory for the double major Math/Economics**
Advanced Quantum Physics (PHY 301)

As its name suggests, this course is a sequel to PHY 205 “Introduction to Quantum Physics”. It will expand our view on three-dimensional quantum mechanical problems, by applying the formalism to the description of atoms and particles in a magnetic field. This includes also a deeper analysis of angular momentum, and its relation to rotational symmetry. We will discover approximation techniques for time-independent and time-dependent phenomena, and apply them to the detailed description of the hydrogen atom. The quantum-mechanical description of scattering will be introduced. Furthermore, we will study the notion of entanglement which is fundamental to quantum cryptography and quantum computing. The description of identical particles in quantum mechanics will build the bridge to the Pauli exclusion principle and the spin-statistics connection.

The following subjects are expected to be treated:

- The addition of angular momenta
- The notion of spin and magnetic resonance
- The hydrogen atom
- Approximation methods and time independent perturbation theory
- Entangled states, the EPR paradox and quantum information
- Particles in a magnetic field, Landau levels
- Identical particles and the spin-statistics connection
- Time-evolution and time-dependent perturbation theory
- Scattering theory.

Professor(s): M. Ferrero
ECTS Credits: 5

Mandatory for the double major Math/Physics
Introduction to Condensed Matter Physics (PHY 302)

Condensed matter physics deals with the microscopic description of the macroscopic physical properties of matter when the interactions between its constituents are very strong. It has an overlap with materials science, chemistry, biophysics and nanotechnology, and relates closely to atomic and molecular physics. Progress in materials elaboration has always been a driving force for technological progress: semiconductors, magnetic memory devices (“hard disks”), composite materials, or nanostructures are only few examples of solid state systems that directly connect fundamental concepts to applied physics.

This course provides an elementary introduction to condensed matter physics. Starting from the laws of quantum mechanics governing the constituents of matter, the course explores how the electronic properties of materials at the macroscopic scale emerge from the microscopic organization on an atomic or molecular scale. It will cover theoretical, experimental and technological aspects. The necessary theoretical concepts of statistical physics will be introduced heuristically during the course, and will be put on a sound foundation in the 6th semester course “Thermodynamics and Statistical Physics”.

The following subjects are expected to be treated:

➤ Crystal structures and symmetries. Structural characterization of solids.
➤ Quantum mechanics of electrons in crystalline solids, band theory.
➤ Metals, insulators and semiconductors.
➤ Transport properties (electric, thermal and thermoelectric)
➤ Collective phenomena (electronic orders including superconductivity)
➤ Spectroscopies: x-ray and neutron diffraction, tunneling
➤ Microscopy, photoemission.

Professor(s):
K. Behnia
ECTS Credits: 5

1 Mandatory course to choose between PHY 302 and PHY 304 for the double major Math/Physics
Advanced Lab III (PHY 303)

**Professor(s):**
Y. Laplace

**ECTS Credits:** 3

Mandatory for the double major Math/Physics

In Advanced Lab III, students have the opportunity to apply the physics knowledge they have acquired over the course of 6 lab sessions of 4 hours each. In PHY 303, the students will discover a more autonomous style of experimentation. The lab sessions will be centered on modern physics and are expected to address several among the following subjects: quantum physics (e.g. Nuclear magnetic resonance), subatomic physics (e.g. Compton scattering, half-life of the muon), condensed matter physics (e.g. crystallography), modern optics (e.g. lasers) as well as solid mechanics (e.g. mechanics of deformable bodies). It is envisaged to encourage project work, and to provide the possibility to extend more elaborate experiments over two sessions.

Upon completion of this course, students will have acquired advanced experimental skills allowing them to set up, carry out and to critically analyze experiments in physics.
Solid Mechanics (PHY 304)

**Prerequisite:** PHY 101, PHY 102, PHY 105, PHY 201, PHY 206. Some knowledge of ordinary differential equations would be helpful.

We are surrounded by natural and man-made structures that deform when subjected to loadings. These structures span a wide spectrum of length scales, from suspension bridges and aircrafts all the way down to spider webs, human hair, micro-electro-mechanical systems, and cell membranes. In this course, we will focus on slender bodies, which by virtue of their elongated aspect can be modeled as curvilinear media. This simplified geometry permits the introduction of the fundamental concepts of the mechanics of deformable solids without recourse to the heavy mathematical formalism that is inherent to the description of their three-dimensional counterparts. It will thus allow us to solve problems and comprehend phenomena (such as the buckling of elastic beams) involving geometric or behavioral nonlinearities that, in three dimensions, do not lend themselves to analytical treatment.

We will cover the following topics:

- Geometry, deformation, and kinematics of curvilinear media
- External and internal forces and couples, equilibrium equations
- Constitutive relations, including rigid bars, extensible strings, and elastic rods
- Boundary value problems associated with various models: elastic strings, beams, and arcs
- Euler's elastica (and, time permitting, its boundary layer)
- Linearized elasticity of slender bodies and its applications
- Stability of conservative systems (first discrete systems, later, via the calculus of variations, continuous systems) and, time permitting,
- Dynamics: wave propagation in elastic beams, forced and free vibrations of elastic rods.

**Professor(s):** M. Jabbour

**ECTS Credits:** 5

1 Mandatory course to choose between PHY 302 and PHY 304 for the double major Math/Physics
BIOLOGY

Biology Practicals (BIO 301)

**Professor(s):**

**ECTS Credits:** 3

**Required for the Biology minor**

**Prerequisite:** BIO 202

The primary goal of the Biology practicals is to provide an overview of the most recent techniques used by researchers in biology to complement the practicals of BIO 201 and BIO 202. During this course, students will rotate in several research laboratories of École Polytechnique where they will learn some of the most advanced techniques in microscopy and genetic manipulations under the supervision of researchers.

CHEMISTRY

Technological Tools for Chemistry (CHE 301)

**Professor(s):**

**ECTS Credits:** 3

**Required for the Chemistry minor**

**Prerequisite:** CHE 202

Chemistry strongly benefits from technological advances that accelerate the progress in the design and development of new compounds and materials, understanding their composition, properties and behavior. In this course, students explore the scientific basis and the technological features of the techniques/instruments employed on a daily basis in any cutting edge chemistry laboratory. Among these techniques, students review a set of spectroscopic tools (e.g. IR and Raman spectroscopy, Mass spectroscopy, Nuclear Magnetic Resonance), nanocharacterization microscopes (e.g. Scanning Electron Microscopy, Scanning Probe Microscopy), separation techniques (e.g. HPLC), and analytical tools (e.g. X-Ray diffraction). The course includes a significant amount of experimental time in the laboratory where the techniques will be employed to resolve interesting and exciting chemical problems. A visit to the Synchrotron radiation facility Soleil may also be planned.
HUMANITIES AND SOCIAL SCIENCES

Masterpieces of Western Literature: Sea and Sailors (HSS 301)

HSS 301 offers students the opportunity to engage in study and discussion of some of the most significant texts of Western literature. Its purpose is to provide students an understanding of these works and their relation to the values of the time and the region in which they were produced. Some of the historical and critical issues commonly addressed in this course are the representation of reality in literature, changing views of human moral problems, and the building of Western culture including historical and national differences.

**Professor(s):**
I. de Vendeuvre

**ECTS Credits:** 2

Eligible as a supplementary course

Diversity Report (PDV301)

This course unit is designed to allow students to reflect upon their experience of diversity on campus. It includes reading and communicating on the students’ experiences and reflections through a written report.

**Professor(s):**
M. Bresson

**ECTS Credits:** 1

Eligible as a supplementary course

Active Volunteering (PDV302)

This course unit is designed to allow students to acquire personal skills they will use in their future professional life. Since responsibility is paramount in professional life, the unit fosters and rewards community spirit as well as the students’ commitment for the public good. Students will learn through experience how to contribute to society. Being third year students, they will be expected to make personal choices and to take actions autonomously. The unit includes reflection and communication on the students’ practices and experiences through a written report.

**Professor(s):**
M. Bresson

**ECTS Credits:** 1

Eligible as a supplementary course
YEAR 3
COURSE OFFERING
Spring Semester
MATHEMATICS

Algebra and Geometry (MAA 306)

**Prerequisite:** MAA 206

The course “Algebra and geometry” splits into two parts. In the first part, we propose a geometric point of view on the differential calculus studied in the first semester. This includes an introduction to manifolds and a qualitative study of differential equations on manifolds. In the second part, we focus on specific groups of linear transformations arising from geometry and theoretical physics. We give in particular a very detailed description of their structures and links between them.

**Professor(s):** D. Renard

**ECTS Credits:** 4

**Convex Optimization and Optimal Control (MAA 307)**

**Prerequisite:** MAA 202

Convex optimization and optimal control (MAA 307) covers: basic functional analysis tools, projection on Hilbert spaces, duality; convex sets and their topological properties, convex functions, Polarity, convex duality, Hahn-Banach and min-max theorems; convexity and differentiability; convex optimization (Kuhn-Tucker), linear programming; calculus of variations, Pontryagin maximum principle, mixed inequality constraints, state constraints; dynamic programming: from discrete to continuous time, linear quadratic regulator; discrete time stochastic control, introduction to differential games.

**Professor(s):** S. Amstutz

**ECTS Credits:** 4

**Image Analysis: Registration (MAA 308)**

**Prerequisite:** MAA 206, MAA 208

When several pictures (obtained from a camera, a CT scan, etc.) of an object are available, registration refers to mathematical methods to combine those images. Registration is then an important first step to extract information from those images. This lecture introduce variational methods, that play a central role in many scientific problems, and in image analysis in particular.

**Professor(s):** S. Allassonnierre

**ECTS Credits:** 2
Image Analysis: Segmentation (MAA 309)

**Professor(s):** S. Allassonnière
**ECTS Credits:** 2

**Prerequisite:** MAA 308

In this lecture, we will consider the problem of partitioning an image into different segments. These segments should be meaningful: an organ in a CT scan, an object in a picture, etc. The lecture will cover a range of mathematical models and methods, such as regularization or level set methods.

Mandatory for the double majors Math/Physics and Math/CS (except if replaced by MAA 311)
At least 6 Mandatory courses to choose between MAA 308 to MAA 311 and ECO 303 to ECO 309 for the double major Math/Economics

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Measure and Integration – Condensed (MAA 310)

**Professor(s):** C. Valcu
**ECTS Credits:** 2

**Prerequisite:** MAA 202

MAA 310 is the condensed version of the course MAA 301, devoted to the modern theory of integration.

Mandatory for all students who have not followed MAA 301 or equivalent course

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Topology and Differential Calculus – Condensed (MAA 311)

**Professor(s):** I. Pasquinelli
**ECTS Credits:** 2

**Prerequisite:** MAA 202

MAA 311 is the condensed version of the course MAA 302, devoted mostly to the theory of metric and topological spaces in an abstract setting.

Mandatory for all students who have not followed MAA 302 or equivalent course
MATHEMATICS

Numerical Methods for ODEs (MAA 312)

Prerequisite: MAA 106, MAA 208
In MAA 312 “Numerical Methods for ODEs”, we will introduce numerical scheme to simulate ordinary differential equations. We will start by Euler schemes (explicit and implicit) and understand how the notions of stability and consistency can be used to study these methods. We will then consider Runge-Kutta schemes and apply the different methods to particular applications, e.g. the N-body problem.

Professor(s): N. Spillane
ECTS Credits: 2
At least 3 Mandatory courses to choose between MAA 306, MAA 312, PHY 306 and PHY 307 for the double major Math/Physics

Seminar: Mathematical Models (MAA 313)

The course Seminar: mathematical models (MAA 313) covers simulation and statistics, while introducing students to PDEs and numerical optimization. During this course, students are asked to present scientific papers on different problems of mathematical modeling. Each presentation requires not only a deep understanding of the considered paper, but also a practical implementation of the numerical method proposed in the article. Students are free to focus on some more specific part or even to explore different ideas that might be of their own. This therefore requires a lot of autonomy, clarity, imagination and personal investment.

Professor(s): N. Spillane, L Gérin
ECTS Credits: 2
Mandatory for the double major Math/CS
COMPUTER SCIENCE

2 Mandatory courses to choose between CSE 304, CSE 305 and CSE 306 for the double major Math/CS

Complexity (CSE 304)

Professor(s): O. Bournez
ECTS Credits: 4

Prerequisites: CSE 103, CSE 203, CSE 207
Theoretical Computer Science has shown that computational problems can be classified according to how difficult they are to solve. We now know that some problems are intrinsically impossible to solve in a reasonable amount of time, or with a reasonable amount of resources. This course describes the rigorous model of computation required to compare and classify computational problems and their difficulty, giving an introduction to the theory of computational complexity and the standard complexity classes.

Concurrent and Distributed Computing (CSE 305)

Professor(s): E. Goubault
ECTS Credits: 4

Prerequisite: CSE 103, CSE 201, CSE 202
Today’s programs and calculations operate not on one computer at a time, but rather on groups of processors or machines working together in concert. But ensuring efficiency and cooperation among the threads of a program is a deeply subtle, and fascinating, problem. This course aims to provide the techniques required to master efficient distributed programming, avoiding the many pitfalls that arise when computations share their resources.

Computer Graphics (CSE 306)

Professor(s): 
ECTS Credits: 4

Prerequisite: CSE 103, CSE 201
This course explores fundamental concepts in 2D and 3D computer graphics, including digital images, 2- and 3-dimensional geometry, curves and surfaces, perspective, ray tracing, filtering and antialiasing, the graphics pipeline, and human visual perception.
ECONOMICS

Game Theory (ECO 303)

This course introduces students to game theory and its applications to economics. Topics covered include strategic and extensive form games, dominant strategies, Nash equilibrium, subgame-perfect equilibrium, and Bayesian equilibrium. The theory is applied to repeated games, voting, auctions, and bargaining with examples from economics and political science.

Textbook:
➤ *An Introduction to Game Theory* by Martin J. Osborne
➤ *Game Theory* by Maschler, Solan and Zamir.

Professor(s):
X. Venel
ECTS Credits: 2

At least 6 Mandatory courses to choose between MAA 308 to MAA 311 and ECO 303 to ECO 309 for the double major Math/Economics

Industrial Organization (ECO 304)

This course provides students the ability to analyze the behavior and performance of firms in markets, with a particular focus on strategic interactions. Topics include monopoly power, behavior of firms in oligopoly markets, static and dynamic measurement of market performance, pricing and product choice decisions, advertising, research and development, and theory of the firm.

Textbook:
➤ *Introduction to Industrial Organization* by Luis M.B. Cabral
➤ *The Theory of Industrial Organization* by Jean Tirole

Professor(s):
R. de Nijs
ECTS Credits: 2

At least 6 Mandatory courses to choose between MAA 308 to MAA 311 and ECO 303 to ECO 309 for the double major Math/Economics
ECONOMICS

Social and Environmental Responsibility of Business (ECO 305)

Professor(s):
P. Crifo
ECTS Credits: 2

At least 6 Mandatory courses to choose between MAA 308 to MAA 311 and ECO 303 to ECO 309 for the double major Math/Economics

This course introduces the economics of corporate social responsibility (CSR), and the determinants for businesses, acting on a voluntary basis, to incorporate social, environmental, and ethical concerns into their economic activities and interactions with their stakeholders. It consists in three parts. The first part presents the basic stylized facts about CSR and the role of governments and investors in promoting responsible behaviors. The second part presents the three main models which explain CSR decisions. The third part covers the data and impact analysis of CSR.

Textbook:
➤ Corporate Environmentalism and Public Policy by Thomas P. Lyon & John W. Maxwell (Cambridge University Press)
➤ The Market for virtue: the potential and limits for CSR by David Vogel (Brookings institution press)

International Trade (ECO 306)

Professor(s):
G. Corcos
ECTS Credits: 2

At least 6 Mandatory courses to choose between MAA 308 to MAA 311 and ECO 303 to ECO 309 for the double major Math/Economics

This course introduces students to the economics of international trade. It consists of three parts. The first part presents facts about trade flows and trading firms and introduces the widely-used gravity equation. The second part covers three standard trade theories which explain trade patterns. The last part presents trade policy, with some focus on recent trade disputes.

Textbook:
➤ International Economics, Krugman, Obstfeld & Melitz (Pearson)
➤ International Economics, Feenstra & Taylor (Worth Palgrave MacMillan)
ECONOMICS

Introduction to Research Frontiers A, B (ECO 307, ECO 308)

This course introduces students to the research frontiers in economics. Each week, a researcher from the laboratory CREST would present a central topic of his/her research. Students are expected to see how researchers tackle problems using the tools and concepts developed in economics. Topics include traditional microeconomics, macroeconomics, and econometrics, as well as recent interdisciplinary developments such as blockchain technology, and machine learning.

Professor(s): G. Corcos
ECTS Credits: 2+2
At least 6 Mandatory courses to choose between MAA 308 to MAA 311 and ECO 303 to ECO 309 for the double major Math/Economics

Computational Economics (ECO309)

This course is designed to provide economists with elements of modern scientific computing using the open-source Julia language. It covers several topics in numerical analysis and programming, and applies them to several economic modeling fields (dynamic programming, macro modeling, IO models). Special emphasis is given to performance and reproducibility. Approximately half of the sessions will consist in hands-on tutorials.

Professor(s): P. Winant
ECTS Credits: 2
At least 6 Mandatory courses to choose between MAA 308 to MAA 311 and ECO 303 to ECO 309 for the double major Math/Economics
Thermodynamics and Statistical Physics (PHY 305)

The most dramatic success of thermodynamics is to provide us with a universal description of macroscopic physical systems. It equally applies to systems as various as molecular gases, magnetic materials, stellar systems, and electromagnetic radiation to name a few. It was later realized that the laws of thermodynamics can be established from a statistical description. The statistical approach represented a genuine paradigm shift in our understanding of physical systems and paved the way to major advances in many fields. The aim of this course is to give a theoretical background to thermodynamics and statistical physics, as well as applications in a variety of contexts, from classical to quantum.

The following subjects are expected to be treated:
- Axiomatic thermodynamics (reminder and complements; laws 0-3, energy, entropy, universality)
- Phase transitions
- Statistical description of isolated systems
- From isolated to open systems: The canonical Gibbs ensembles
- Statistical physics of the ideal classical gas
- Ideal quantum gases: fermions and bosons (Bose-Einstein condensation and Fermi seas)
- Other applications of thermodynamics and statistical physics.
**Fluid Mechanics (PHY 306)**

**Prerequisite:** PHY102, PHY 105, PHY206

The motion of fluids plays a critical role in many phenomena or processes that are the center of our daily life or engineering systems, ranging from the flight and/or propulsion of aircrafts and vessels, the generation of electricity from wind-turbines, the flow of blood in our arteries, the atmospheric and ocean circulations guiding our climate or microscopic flows in lab-on-a-chip systems. This course will provide the students the fundamental tools to model, understand and analyze the motion of such fluid flows in three dimensions, and evaluate the resulting forces on the bounding surfaces. The material covered in this course will build upon several courses of the program including Mechanics and Heat (PHY 101), Mathematical Methods for Physicists I and II (PHY 102 and PHY 105), Classical Mechanics (PHY 201) and Waves and Heat Transfer in Geophysics (PHY 206).

The following subjects are expected to be treated:

- Eulerian description of motion of 3D flows
- Mass and momentum conservation
- Hydrostatic pressure
- Viscosity and viscous stresses
- Motion of a Newtonian fluid: Navier-Stokes equations
- Non-dimensional analysis and scalings
- Parallel and weakly-non parallel flows
- Inviscid flows and potential flow theory
- Vorticity
- Introduction to boundary layers.

**Professor(s):** S. Michelin

**ECTS Credits:** 4

At least 3 Mandatory courses to choose between MAA 306, MAA 312, PHY 306 and PHY 307 for the double major Math/Physics
The quest for finding the ultimate constituents of matter has revealed that matter has a nested structure: quarks at scales that differ by many orders of magnitude: atoms contain electrons and nuclei; nuclei are made up of nucleons, which in turn are composed of. Nowadays, particle physicists are more concerned with the fundamental laws that govern the interactions of elementary particles. The most emblematic question is "how do particles acquire mass"; and the discovery of the Higgs boson in 2012 is an important clue that we are on the right path to answering this question.

This course will give a pedestrian introduction to nuclear and particle physics, illustrating in a balanced fashion theoretical underpinnings, experimental activities and technological aspects of subatomic physics. The basis for this course will be the PHY 205 and PHY 301 (introductory and advanced quantum physics) as well as PHY 204 (theoretical electrodynamics).

The following subjects are expected to be treated:

- the big picture of the structure of matter and the great discoveries
- nuclear binding energy; nuclear models (droplet model; fermi-gas model); isotopic spin
- particle accelerators and colliders
- decay of elementary and subatomic particles decay
- scattering experiments: nucleus, nucleons, quarks
- the nonrelativistic quark-model and the magnetic moment of the nucleons
- neutrino oscillations.
BIOLOGY

Cancer Biology (BIO 301)

**Prerequisite:** BIO 202
The cancer biology course will include a series of lectures covering the molecular and cellular mechanisms of cancer development and current anti-cancer strategies. In parallel, students will actively participate in a new ambitious research and teaching program developed at Ecole Polytechnique thanks to the sponsoring of the pharmaceutical company Servier and the biotechnology company Cellectis. This experimental project aims at reconstituting the tumoral process of cancer development using only the mutation repertoire found in a single breast cancer patient.

**Professor(s):**

ECTS Credits: 3
Required for the Biology minor

CHEMISTRY

Mastering the Synthesis and Transformation of Molecules (CHE 302)

**Prerequisite:** CHE 202
Mastering the transformation of organic matter is key to tackle societal challenges such as the synthesis of new pharmaceutical drugs, the design of functional polymers and the recycling of wastes to value-added products. CHE 302 is an intermediate-level chemistry course that introduces the reactivity and transformation of organic chemicals, based on quantum chemistry. From the description of the electronic structures and bonding interactions in molecules (using molecular orbitals and Hückel theory), the transformation of organic and inorganic compounds is introduced, as well as the reactivity of organic functionalities (carbonyls, alkenes and aromatics) and the concepts of catalysis. This interactive course explores these topics through lectures, tutorials and labs.

**Professor(s):**

ECTS Credits: 3
Required for the Chemistry minor
Fundamentals of Organizations (MIE 301)

This course covers the concepts and theories related to the management of organizations (culture, power, innovation…). The course includes a discussion of the main theories, which are useful to understand business problems and empirical situations. Upon completion of this course, students will demonstrate their ability to apprehend business situation and to understand typical human and organizational problems in various industries.

Course materials include written case studies, videos and simulations.
PERSONAL DEVELOPMENT

TBC (PDV303)

TBC

Professor(s): M. Bresson
ECTS Credits: 1

Eligible as a supplementary course