جامعة الملك عبدالله
للعلوم والتقنية

King Abdullah University of
Science and Technology

PROGRAM GUIDE

2019-2020

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General Information

Academic Calendar 2019-2020

	Sun, Aug 4, 2019	On-boarding of students and cultural orientation starts
	Sat, Aug 10, 2019	On-boarding of students and cultural orientation ends
	Sun, Aug 11, 2019	Eid Al-Adha break starts
	Thu, Aug 15, 2019	Eid Al-Adha break ends
	Sun, Aug 18, 2019	Academic orientation starts
	Thu, Aug 22, 2019	Academic orientation ends
FALL	Sun, Aug 25, 2019	First day of classes
	Tue, Aug 27, 2019	Academic convocation
	Thu, Sep 5, 2019	Last day to add a class Last day to drop a class without a W grade Last day for graduating Ph.D. and M.Sc. thesis students to declare a fall dissertation defense date
	Sun, Sep 22, 2019	University holiday
	Mon, Sep 23, 2019	Saudi National Day
	Thu, Oct 24, 2019	Last day to drop a class with a W grade (no drops permitted after this date)
	Sun, Oct 27, 2019	Mid-semester break
	Mon, Oct 28, 2019	Mid-semester break
	Thu, Nov 7, 2019	Ph.D. dissertation and M.Sc. thesis defense examination result forms due for graduating Ph.D.'s
	Thu, Nov 21, 2019	Last day to submit Ph.D. dissertations and M.Sc. theses to the Office of the Registrar for format checking
	Thu, Nov 28, 2019	Ph.D. dissertation and M.Sc. theses library receipt forms due to the Office of the Registrar
	Thu, Dec 5, 2019	Last day of classes
	Sun, Dec 8, 2019	Exams start
	Tue, Dec 10, 2019	Exams end / semester ends
	Fri, Dec 13, 2019	Commencement
WEP	Sun, Jan 12, 2020	Winter Enrichment Program starts
	Sat, Jan 25, 2020	Winter Enrichment Program ends
SPRING	Sun, Jan 26, 2020	First day of classes
	Thu, Feb 6, 2020	Last day to add a class Last day to drop a class without a W grade Last day for graduating Ph.D. and M.Sc. thesis students to declare a spring dissertation defense date
	Sun, Mar 22, 2020	Mid-semester break
	Mon, Mar 23, 2020	Mid-semester break
	Thu, Mar 26, 2020	Last day to drop a class with a W grade (no drops permitted after this date)
	Thu, Apr 9, 2020	Ph.D. dissertation and M.Sc. thesis defense examination result forms due for graduating Ph.D.'s
	Thu, Apr 23, 2020	Last day to submit Ph.D. dissertations and M.Sc. theses to the Office of the Registrar for format checking
	Thu, Apr 30, 2020	Ph.D. dissertation and M.Sc. thesis library receipt forms due to the Office of the Registrar
	Thu, May 7, 2020	Last day of classes
	Sun, May 10, 2020	Exams start
	Wed, May 13, 2020	Exams end / semester ends
	Sun, May 24, 2020	Eid Al-Fitr break starts
	Thu, May 28, 2020	Eid Al-Fitr break ends
SUMMER	Sun, May 31, 2020	First day of classes

Tue, Jun 2, 2020	Last day to add a class and/or drop a class without a W grade
Thu, Jun 11, 2020	Spring graduation date *
Thu, Jul 2, 2020	Last day to drop a class with a W grade
Thu, Jul 23, 2020	Last day of classes / session ends
	Ph.D. dissertation and M.Sc. thesis library receipt forms due to the Office of the Registrar
Sun, Aug 2, 2020	Eid Al-Adha break starts
Thu, Aug 6, 2020	Eid Al-Adha break ends

** Reflects the official graduation date for those students who have completed their degree requirements since the December Commencement Ceremony.*
This calendar may be subject to change without prior notice. Please consult the online version for the current academic calendar here. .

University Information

Our vision at King Abdullah University of Science and Technology (KAUST) is to aspire to be a destination for scientific and technological education and research. By inspiring discoveries to address global challenges, we strive to serve as a beacon of knowledge that bridges people and cultures for the betterment of humanity.

The KAUST program guide provides information about academic programs and requirements for applicants, students, faculty, and staff at the University. Students are expected to follow the program requirements outlined in the program guide of the academic year they started their program. The senior academic leadership team consisting of the division deans, associate deans, and the dean of graduate affairs along with the Office of the Registrar are responsible for the academic policies in the program guide and reserve the right to make changes at any time on behalf of the University.

The program guide reference to "students" is general and the plural pronoun throughout the text is chosen for simplicity and ease of language, but has no further implications.

The Office of the Registrar

The Office of the Registrar is the custodian of official student information and records. It is responsible for registration, course enrollment management, classroom assignment, final exam scheduling, grade processing academic and administrative policy monitoring, information dissemination, maintaining student records, and providing certified documents, including transcripts and diplomas. The Office of the Registrar publishes the course schedule, available before registration for each semester/session. Information about registration procedures, time and location of courses, faculty, and course prerequisites and requirements are provided to students prior to the beginning of the semester/session. The Office of the Registrar is responsible for supporting strategic enrollment by analyzing student progression and retention, graduation, and academic trends for long-term admissions and operational planning for the University.

Contact Information
Office of the Registrar
Building 9, Level 3
4700 King Abdullah University of Science and Technology
Thuwal 23955-6900 Saudi Arabia
Phone: +966 12 808 0505
Email: registrarhelpdesk@kaust.edu.sa
Website:
https://academicaffairs.kaust.edu.sa/registrar/

Divisions and Programs

There are three academic divisions, each headed by a division dean. Within each division are various programs headed by program directors.

Graduate Program Coordinators

Graduate program coordinators (GPCs) are administrative division/program representatives who work with students, faculty, and staff to support students and programs. These include graduate program student advisors, graduate program advisors, and graduate program coordinators. The term GPC is used as a placeholder in the program guide as divisions assign different titles to these positions.

Graduate Affairs

Graduate Affairs includes the Admissions Office, Graduate Development and Services, Graduate Operations, and Alumni Services. The Dean of Graduate Affairs is the head of Graduate Affairs.

Degrees and Programs

KAUST offers the following degree programs exclusively as full-time degree programs.

- Master of Science (M.Sc.) with thesis
- Master of Science (M.Sc.) non-thesis
- Doctor of Philosophy (Ph.D.)

KAUST has three academic divisions:

Division of Biological and Environmental Science and Engineering (BESE)

- Bioengineering (BioE)
- Bioscience (B)
- Environmental Science and Engineering (EnSE)
- Marine Science (MarS)
- Plant Science (PS)

Division of Computer, Electrical and Mathematical Science and Engineering (CEMSE)

- Applied Mathematics and Computational Science (AMCS)
- Computer Science (CS)
- Electrical Engineering (EE)
- Statistics (STAT)

Division of Physical Science and Engineering (PSE)

- Applied Physics (AP)
- Chemical Engineering (CE)
- Chemical Science (ChemS)
- Earth Science and Engineering (ErSE)
- Energy Resources and Petroleum Engineering (ERPE)
- Material Science and Engineering (MSE)
- Mechanical Engineering (ME)

Academic Information

Academic Semesters and Sessions

KAUST offers two semesters and two sessions. The two semesters include the fall semester, 15 weeks from August/September to December, and the spring semester, 15 weeks from January/February to May/June.

The two sessions include the summer session, eight weeks from June to August, and the winter session, two weeks from January to February.

Regular classes are scheduled during the fall and spring semesters and the summer session. The winter session is reserved for the Winter Enrichment Program (WEP).

Registration

Each regularly scheduled course has a credit value of 3.0 credits, for 3.0 contact hours per week in the fall and spring semesters, and 6.0 contact hours per week in the summer session. Research credits vary from 3.0 credits to 12.0 credits per fall and spring semester and 3.0 credits to 6.0 credits in the summer session. Graduate seminars are 0.0 credit courses, and are required as per program requirements.

Students are expected to maintain full-time registration in every semester and summer session until they have completed their degree requirements. Fall and spring semesters require 12.0 credits of registration and summer session requires 6.0 credits of registration to maintain full-time status. Applications for permission to register in more or less than full-time status are permitted only under exceptional circumstances. Students should contact their GPC for further information.

Students are responsible for ensuring their registration is accurate for each semester/session of registration and for determining the requirements of their program. Students are strongly encouraged to read the relevant program requirements as listed in the program guide. Further information about program requirements is available from the appropriate GPC.

Students are expected to prepare for and attend all scheduled classes during the semester/session. Students are expected to treat one another respectfully, and to offer constructive criticism in course discussions about their classmates' work. Participation in class is strongly encouraged. Punctuality is required.

Winter Enrichment Program (WEP)

The Winter Enrichment Program (WEP) is a graduation requirement for all students (M.Sc. and Ph.D.). All students must satisfactorily complete the WEP requirement for credit at least once during their studies at KAUST.

WEP is a two-week program entirely designed and produced by KAUST and takes place during an interlude in the academic semester in January when courses are not offered. WEP includes keynote lecture series, AI master class and AI programs, field trips, exhibitions, science fairs, opening nights, and final galas. The program hosts KAUST speakers, eminent international guest speakers, Nobel Laureates, entrepreneurs, academics, as well as distinguished local and regional leaders and decision-makers.

For more information about WEP visit the Enrichment website.

Transfer Credit

Master's students may petition to transfer graduate credits from another university upon approval of the academic advisor, program director, and the Office of the Registrar. Courses already used for another degree cannot be used as transfer credit.

The following rules apply:

- Up to three graduate level courses not to exceed 9.0 credits may be approved
- The course grade for any course to be transferred must be a B (or equivalent) or above
- Courses transferred must have been taken within three years prior to admission to KAUST
- Students must submit a completed transfer credit form and include a course syllabus for every course
- Students must submit an official transcript no more than three months old in English or accompanied by a certified English translation

Doctoral students transferring from other Ph.D. programs may receive dissertation research and coursework credits on a case-by-case basis.

Grading

The KAUST grading system is a 4.0 scale utilizing letter grades and these are the only grades that will be assigned:

Passing grades

A	=	4.00
A-	=	3.67
B+	=	3.33
B	=	3.00
B-	=	2.67

Failing grades

C+	=	2.33
C	=	2.00
C-	=	1.67

D+	=	1.33
D	=	1.00
D-	=	0.67
F	=	0.00

Grades with no GPA

I	=	Incomplete
IP	=	In progress
W	=	Withdrew
S	=	Satisfactory
U	=	Unsatisfactory
WF	=	Withdrew-failed

Individual courses require a minimum of a B- for course credit.

Incomplete Grades

Students who complete the majority of the requirements for a course but are unable to finish the course may receive an incomplete (I) grade. A grade of incomplete will be assigned only with the consent of instructors after instructors and students have agreed on the academic work that needs to be completed and the date it is due. When the requirements for the course are completed, instructors will submit a grade that will replace the incomplete grade. Incomplete grades not completed by the end of the second week of the following semester will be changed to failing grades.

Incomplete grades are granted to individual students on a case-by-case basis. Incomplete grades should not be used as a mechanism to extend the course past the end of the semester.

Graduating Student Grades

Note that any incomplete grades (as well as fail grades) will mean students will not graduate or receive a diploma during the commencement ceremony.

In Progress Grades

Master's thesis research (297) and doctoral dissertation research (397) are graded as in progress (IP) for each semester/session. Students who complete their research will receive a satisfactory (S) grade in the last semester/session at the end of their program.

Grade Appeal

Students have the right to appeal their final grade in a course, but must do so by the end of the third week after the start of the following semester. Students should first discuss the issue informally with their instructor. If the matter cannot be resolved this way, students may initiate an appeal to their academic advisor outlining the reasons in writing. Copies of the appeal will be forwarded to the dean. The dean will assign a faculty member in the same subject matter to review the grade. The final decision is made by the dean. If a change of the final grade is approved, the new grade will be recorded and the disputed grade will be removed.
Note: grades may only be appealed when students believe there has been an error in evaluating their work. Grade appeals are not to be used as a mechanism for attempting to improve poor grades.

Repeating Failed Courses

A course in which the final grade is C+ or lower may be repeated. If the second grade is higher, the original grade may be excluded from the GPA calculation with the prior approval of the dean. The original grade will remain on the official transcript. Repeating failed courses is normally restricted to one course only.

If a course is approved to be repeated, any academic sanctions will still apply until the course has been successfully repeated.

Course Changes (Add or Drop)

A course may be added through the portal during the first week of the semester. Students may add courses after the first week with the permission of the academic advisor and instructor. Instructors have the right to refuse admission to students if the instructor feels that students will not have the time to sufficiently master the material due to adding the course late. Course changes forms are also used for students requesting permission to waive prerequisites for a course or requesting dean approval to register above the maximum number of credits per semester/session.

A course may be dropped without penalty before the last day to drop a class without a W grade as per the Academic Calendar, but students must ensure they maintain full-time registration for the semester/session. Between the last day to drop without a W and the last day to drop with a W, students can drop a course or drop below 12.0 credits with the approval of the instructor, academic advisor, and the dean. After the last day to drop with a W, courses may be dropped only under exceptional circumstances. Students should note that dropping courses may delay graduation and this will be taken into consideration by the program when reviewing course drop requests.

Change of Program or Advisor

Students who would like to change advisors should consult with their GPC prior to requesting a change. Once confirmed, students will need to complete the change of advisor form which requires approval from both the previous advisor and the new advisor. Students who are changing degree programs may be required to change their advisors to an affiliated advisor in the new program of study. Approval from the program director is required for changes within the division, approval from the dean is required for changes to a new division.

Leaves of Absence

Students are expected to maintain continual enrollment at the University until completion of their graduation requirements. Students may take vacation days during each academic year, as defined by the Academic Calendar. Unused vacation days do not carry over to the following year. Master's thesis and doctoral students may be granted additional vacation leave, which must be discussed with academic advisors at least four weeks prior to the proposed vacation (no formal leave of absence request is required for vacation leave).

Under personal or exceptional circumstances, students may apply for a leave of absence with the understanding that the student will return to the University at the end of the leave period. There are five types of voluntary leave and any leave of absence requests are approved by the dean. Students who plan to apply for a leave of absence should consult with their GPC prior to requesting a leave of absence.

General Leave of Absence

Students are allowed only one general leave of absence which may be approved for up to one year. Applications for a leave of absence must be received by the Office of the Registrar prior to the leave date, or students may receive a failing grade for courses enrolled for that semester. This may also affect benefit entitlements. The course change policy and add/drop deadlines will be applied, for information on deadlines, please see Course Changes (Add or Drop).

Students on a general leave of absence do not receive a stipend and must vacate housing if the absence is greater than 90 days. Upon approved return to the University, housing will be reallocated according to availability. At least two weeks prior to return to the University, students must confirm their return date with Graduate Operations, GPC and academic advisor. Students who do not return to the University by the approved return date will be withdrawn.

Medical Leave

Students who suffer from an illness or disability that requires frequent or lengthy absences that impact the ability to complete academic requirements are able to apply for a medical leave for up to one year. Students must consult with their GPC and academic advisor regarding medical leave. Detailed medical reports must be supplied as part of the request for leave of absence.

Maternity Leave

Enrolled female students may be eligible for six week maternity leave with evidence of an expected delivery date. Commencement of maternity leave should begin no earlier than two weeks prior to the birth of the child, however, exceptions will be considered on a case-by-case basis. While on maternity leave, students will receive full stipend and will retain benefits, including housing, medical insurance, and school privileges for eligible dependents. Students seeking additional leave (such as the remainder of a semester), may apply for an additional general leave of absence for this period. Following an approved maternity leave, students must confirm their return date to Graduate Operations, GPC and academic advisor.

Students are not eligible for maternity leave and its associated benefits in their first semester of study. Students who have given birth prior to the onset of the academic year are permitted to begin studies if no more than the first two weeks of the semester are missed. Students who are pregnant upon acceptance to the University but have not yet enrolled may apply for a deferral of maximum one year due to maternity leave. If the deferral application is approved, no stipend would be paid during the deferral period. Absences of more than one year requires students to reapply for admission.

Bereavement Leave

The University recognizes that students may be unable to attend to their academic studies due to the death of a child, spouse, or parent. In these situations and supported by appropriate documentation, a short bereavement leave with no effect on student status or stipend may be approved. Bereavement leave is seven days, exclusive of travel days. Students requesting additional time may also apply for compassionate leave. Upon return to the University, students must provide Graduate Affairs Operations with a copy of an official death certificate or similar document.

Compassionate Leave

The University recognizes that students may encounter extenuating personal circumstances that make them unable to attend to their academic studies. In certain situations and supported by appropriate documentation, compassionate leave may be approved.

Involuntary Leave of Absence

The Dean of Graduate Affairs may place a student on an involuntary leave of absence at any time if such an action is deemed reasonably necessary for the protection of the University community or for the personal safety or welfare of the student involved.

Traveling Scholar

Students are able to apply as a traveling scholar during their studies when resources are not available at KAUST. External institutions must offer course work or facilities relevant to research interests and degree programs at KAUST. There is generally a one semester/session limit for all off campus work, although additional time may be granted.

To be eligible as a traveling scholar, students must be in good academic standing must have successfully completed at least one semester/session at KAUST. Division specific requirements may also apply. Applications for traveling scholar may be denied if it is determined that degree completion will be delayed by traveling. Traveling scholars are also expected to maintain full-time KAUST registration and satisfactory progress toward their degree while completing the requirements of their approved traveling scholar arrangement.

To apply as a traveling scholar, students need to complete the application for traveling scholar with a full description of the course or research to be completed, why it is necessary to work off campus, and the expected outcomes. The KAUST academic advisor must provide support for the need to work off campus, explain how work will be evaluated, and approve the application. The external institution must confirm attendance and students must provide periodic progress reports to their KAUST academic advisors. Final approval is made by the dean. Students are expected to apply for traveling scholar and obtain approval 30 days before they leave the University.

Students and advisors will be responsible for funding for travel, housing, and any miscellaneous expenses. For information on travel and possible reimbursements, see the Academic Travel Guidelines and Procedure at policy.kaust.edu.sa. If the travel is more than 90 days, students will be required to surrender housing and must contact Graduate Affairs Operations at gradopsexiting@kaust.edu.sa. Upon returning to KAUST, students must contact Graduate Affairs Operations at gradopsonboarding@kaust.edu.sa 30 days before their approved entry so new housing can be assigned. As with student leave, students are responsible for ensuring their passport, iqama, or relevant visas will not expire during any period they may be out of the country.

For students interested in work experience opportunities, information on internships can be obtained through GPCs and/or graduate affairs. More information is available under Internships.

Internships

Students wishing to engage in an external internship experience can register with approval from their academic advisor. M.Sc. students generally register for summer internships for 6.0 credit hours (XX 295). Ph.D. students are able to apply for internships at any time throughout their program. An internship that qualifies for earned credit hours, or is intended to fulfill any other academic requirement must be approved prior to the start of the internship by the designated academic advisor, the dean, the dean of graduate affairs, and the Office of the Registrar.

Students applying for an internship opportunity must have a minimum grade point average of 3.0. If students fail to maintain a cumulative GPA of 3.0 through the semester/session preceding an arranged internship, students must obtain new approval from their academic advisor in order to proceed with the internship.

For information about credit, funding, insurance, and sponsor requirements, please contact the Office of Professional Development in Graduate Affairs.

Time Limits and Extensions

M.Sc. thesis students and students completing M.Sc. thesis requirements during their Ph.D., who request an extension past three semesters require justification and support for an extension. Students requesting a second extension (or longer) require approval from the dean of graduate affairs. Students not granted an extension but who have met the requirements of a master's without thesis will be able to graduate from the non-thesis option.

The extension form must be completed and include the following:

- A statement on the remaining scope of work (including thesis writing and defense) and whether it is achievable by the end of the following semester
- Approval from the dean

Students entering the Ph.D. program with a master's degree should finish their Ph.D. in two and a half to four years. Students entering the Ph.D. program with a bachelor's degree should finish the Ph.D. in three and a half to six years. Ph.D. students have a maximum of seven years beyond the master's degree to complete all degree requirements.

Completing In Absentia

In absentia status applies to students who are completing final degree requirements after exiting from the University and permanently leaving the campus. Students whose only remaining academic requirements can be completed off campus may apply for in absentia status. Applications require the approval of the academic advisor and dean and are generally approved for a maximum of one year.

Students in absentia will be registered for 3.0 research credits. In absentia status students will cease to receive stipend and award payments and any other on campus benefits.

Withdrawal from the University

Students are strongly advised to discuss a withdrawal with both their GPC and academic advisor before submitting a withdrawal form. Students who withdraw before the last day to drop classes without a W for the semester/session will have their courses removed from the transcript. Students who withdraw by the last day to drop a class with a W grade for the semester/session will receive a W for all their courses. Students are not permitted to withdraw after the last day to drop with a W grade unless there are exceptional circumstances and the dean has granted permission. To withdraw in good standing from KAUST, all withdrawals must be approved by the academic advisor, division dean, and dean of graduate affairs. In addition, students must successfully meet all departure clearance requests through Graduate Operations. For more information, please see the Student Handbook.

Students who are M.Sc./Ph.D. and choose to withdraw before completion of the Ph.D. will also need to complete a withdrawal form. Failure to submit a withdrawal form will result in students being dismissed for abandonment of program. To return to KAUST after a withdrawal, students will be required to reapply for admission.

Once withdrawals are approved, students will have one week to access their KAUST accounts and portal before access is removed.

Dismissal for Abandonment of Program

Students who do not enroll for classes in a given semester by the last day to add courses (fall, spring, summer), without permission to withdraw or take a leave of absence, will be dismissed for abandonment of program. To return to KAUST after a dismissal, students will be required to reapply for admission.

Academic Standing

Academic standing is based on a cumulative performance assessment of the grade point average (GPA) and U grades including credit, non-credit, and ESL courses. The division at any time may recommend to the Office of the Registrar to place students on academic sanction based on unsatisfactory research performance. Division recommendations for academic probation or dismissal must be approved by the dean.

Students are assessed each semester/session as per the criteria below:

GPA Cumulative Assessment
3.00 – 4.00 – Good Standing
2.33 – 2.99 – Academic Probation
Below 2.33 – Academic Dismissal

U Grade Cumulative Assessment
*includes 100 level courses, ESL, graduate seminars, directed research, and lab rotations.
Three U grades – Academic Dismissal

Research Assessment
Satisfactory performance – Good Standing
Unsatisfactory performance as determined by the division – Academic Sanction

Appeal Process for Dismissal
Students who are eligible to appeal must submit a written explanation why the dismissal should be rescinded along with any supporting documentation. The Academic Performance Committee will hear the appeal and make a decision to grant or deny the appeal based on the appeal and documentation, past performance and the likelihood that students are capable of successfully completing their academic program. If the appeal is denied, students will be required to leave the University. The decision of the committee is final and no additional appeals are permitted. Once students have been notified that the appeal has been unsuccessful, the appeal process is at an end.

Academic Integrity

As a member of the KAUST campus community, students are expected to demonstrate integrity in all academic endeavors and will be evaluated on their own merits. Be proud of your academic accomplishments and help to maintain and promote academic integrity at KAUST.

Student Information Release and Access

Students may access education records, with the exception of records that students have waived their right to access, such as letters of recommendation. A written request to access specific records is required. This request is available from the Office of the Registrar. Review of records should be done in person. However, if it is not possible for students to review the records in person, copies can be provided (mailed). Any documents submitted to the University are the property of the University. The University may charge a fee for copying and mailing these records.

Students may grant access to any information that they can access, based on a signed and dated release form specifying specifically what information is to be released. Release forms will be valid for one year and maintained in students' academic folder. Release forms are available from the Office of the Registrar.

Student education records or information may be released without the permission of students to University officials, as well as outside agencies acting on behalf of the University, accrediting agencies, institutions of higher education in which students are enrolled or seek to enroll, or institutions from which students receive financial aid.

For more information, see Student Information Release and Access Policy.

Ombuds for Student Matters

The Office of the Ombuds for Student Matters at KAUST has been established by the president to provide confidential, impartial and informal advice about and dispute resolution services for student matters. The office functions to assist visitors in reaching mutually acceptable agreements in order to find fair and equitable resolutions to concerns that arise at the University.

The services are available to faculty, staff, and visiting students, postdocs and others at KAUST who require assistance with student matters.

For more information, see Charter of the Office of the Ombuds for Student Matters.

English Support

The Skills Lab provides courses and services to graduate students that facilitate their overall academic success. Courses in the English for Specific Purposes program target specific skills such as research writing, academic presentation skills, and speaking and pronunciation. Instructors are also available to work one-on-one with students who would like assistance with academic writing, and will proofread and edit manuscripts, including M.Sc. theses and Ph.D. dissertations. Instructors in the Skills Lab also teach credit bearing courses in the English as a Second Language (ESL) program and are responsible for the administration of the English language test for the admissions office. Graduate students can make appointments for individual consultations by contacting: skillslab@kaust.edu.sa

Graduate Affairs

For detailed information on academic services provided by Graduate Affairs, including housing, recreation, travel, and alumni please see the Student Handbook.

General Admissions

For admissions related questions please email admissions@kaust.edu.sa.

There are three available entry points for all applicants: fall semester, spring semester, and summer session. (For more information, see Academic Semesters).

Students are strongly encouraged to apply early in order to receive an earlier decision and have enough time for visa processing (international students).

For students requesting transfer credit to a KAUST degree program, please see policy on Transfer Credit.

Application Requirements

1. English language proficiency. KAUST requires a minimum TOEFL score of 79 on the IBT (Internet Based Test) or 6.0 on the IELTS (International English Language Testing System). Only official TOEFL or IELTS scores will be accepted. A TOEFL or IELTS score is not required if the applicant received a degree from an accredited institution in the United States, Canada, the United Kingdom, Ireland, Australia, or New Zealand.

2. Official, complete university transcript/mark sheets/graduation certificate/academic record from every institution previously attended. A scan of the official transcript provided by the university in the native language must be uploaded into the online application along with the certified English translation. Transcripts must include the university grading scale for all documents submitted. If offered admission, an official final transcript must be sent to the Office of Admissions prior to arrival (during the onboarding process) in a sealed envelope.

3. Three letters of recommendation submitted on your behalf. Recommendation letters should be submitted through the application directly from the recommender. Recommenders should provide details about how they know your work, as well as comparative statements (e.g., top 1% of class, best in past five years, etc.), and insight into research ability.

4. Curriculum vitae (CV).

More information on application requirements and financial support is available here.

Admission to Master of Science

Admission to the Master of Science (M.Sc.) program requires the satisfactory completion of an undergraduate science degree in a relevant or related area, such as engineering, mathematics or the physical, chemical and biological sciences.

Admission to M.Sc./Ph.D. Program

The M.Sc./Ph.D. program is an attractive option for students looking for fast entry into the world of research. Students can apply for the Ph.D. program after completing a bachelor's degree and are engaged in exciting research from the beginning of their program. The program typically takes four to five years to complete and students may complete a M.Sc. degree on the way to their Ph.D.

Admission to Doctor of Philosophy

Admission to the Doctor of Philosophy (Ph.D.) program requires the satisfactory completion of an undergraduate or master's degree in science in a relevant or related area, such as engineering, mathematics or the physical, chemical and biological sciences.

There are three phases and associated milestones for Ph.D. students:

- Passing a qualifying exam (if applicable)
- Passing an oral defense of the dissertation proposal
- Dissertation phase with a final defense

Admission to Dual Degree (Cotutelle) Program

A dual degree (cotutelle) program is a partnership with another university under which students may, after meeting each university's expectations, receive two diplomas, one from each institution. Dual degree programs share a common research program and often share coursework.

Students wishing to enter into a dual degree Ph.D. agreement should contact the International Programs Office at vsrp@kaust.edu.sa.

Visiting Students

The Visiting Student Research Program (VSRP) is an exciting opportunity for highly qualified students in their baccalaureate or post-baccalaureate studies to be engaged in research with faculty mentors in selected areas of research. The program typically lasts between three to six months, depending on the research project.

VSRP interns may participate in the program through one of the University's three academic divisions: Biological and Environmental Science and Engineering; Computer, Electrical and Mathematical Science and Engineering; or Physical Science and Engineering.

Currently enrolled KAUST students, KAUST alumni and students currently in a Ph.D. program, or those who have earned a Ph.D. are not eligible to participate. VSRP students who become regular admitted KAUST students are not eligible for transfer credit.

For more information about VSRP, please see Visiting Student Policy or contact vsrp@kaust.edu.sa.

Assessment Test

Admitted students may be required to take a written assessment exam when they arrive at KAUST at the discretion of the division. The purpose of the assessment is to determine whether students have mastered the prerequisites for undertaking graduate level courses taught in the program. The academic advisor works with admitted students to develop a study plan if needed. Students are encouraged to prepare for the assessment by refreshing the general knowledge gained from their undergraduate education before arriving at KAUST. The study plan requirements must be satisfactorily completed, in addition to University degree requirements.

Master of Science University Degree Requirements

It is the responsibility of students to plan their graduate program in consultation with their program and advisors. Students are expected to follow the program requirements outlined in the program guide of the academic year they started their program. Students should be aware that most core courses are offered only once per year.

The master's degree (M.Sc.) is awarded upon successful completion of a minimum of 36 credit hours. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit. Students are expected to complete the M.Sc. degree in three semesters and one summer session.

The M.Sc. degree has the following components:

- Core courses
- Elective courses
- Research/capstone experience
- Graduate seminars
- Winter Enrichment Program (WEP)

Divisions and/or programs may have additional program requirements. Please see detailed program information.

M.Sc. Thesis Option

To successfully complete a master's degree with thesis, all master's thesis students must complete the thesis application and the thesis defense. Individual programs may have additional program requirements that must be met to graduate, please see division/program requirements for further details.

M.Sc. Thesis Application

Students pursuing the thesis option should have at least a 3.2 cumulative GPA. All thesis applications require approval of the dean.

Students will be expected to complete their thesis by the end of the third semester (not including summer session). Students who require additional time to complete their thesis will be required to apply for an extension. The selected academic advisor must be a full-time program-affiliated assistant, associate or full professor at KAUST. This advisor can only become project affiliated for the specific thesis project with program director approval.

The application for thesis should include a well-constructed thesis proposal endorsed by the academic advisor, including a time line for completion not to exceed three semesters (not including summer session). If the advisor recommends a longer time frame, not to exceed the end of the fourth semester, the advisor will be responsible for covering student and experimental costs accrued during this period. The program of study should be structured to allow students to change to a master's without thesis and finish the degree by the end of the third semester. Students who withdraw from the thesis option will be required to complete a thesis withdrawal form. Students who withdraw from the thesis option after the last day to drop will receive a W on their official record.

M.Sc. Thesis Defense Committee

The thesis defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than four members. At least two of the required members must be affiliated with students program of study. Please see individual programs for thesis defense committee requirements.

M.Sc. Thesis Defense Requirements

A thesis oral defense is required, although a public presentation and all other details are left to the discretion of the thesis committee. Students are responsible for scheduling the thesis defense date with their thesis committee.

A written thesis is required. It is advisable that students submit their final thesis to the thesis committee members no later than two weeks prior to the defense date. Students are required to comply with the University formatting guidelines provided by the Office of the Registrar.

There are four possible outcomes for this thesis defense:

- Pass
- Pass with conditions
- Fail with retake
- Fail without retake

A pass is achieved when the committee agrees with no more than one dissenting vote, otherwise the outcome is a fail. In the instance of a pass with conditions, the entire committee must agree on the required conditions and if they cannot, the dean decides. The deadline to complete the conditions is up to one month after the defense date, unless the committee unanimously agrees to change it. If more than one member casts a negative vote, one retake of the defense is permitted if the entire committee agrees. The deadline to complete the retake is as decided by the defense committee with a maximum of six months after the defense date, unless the committee unanimously agrees to reduce it. In the instance of a fail without retake, the decision of the committee must be unanimous. Students who fail without retake or who fail the retake will be dismissed from the University.

The final signed approval form must be submitted to the Office of the Registrar by the deadline for M.Sc. thesis library receipt forms as indicated on the Academic Calendar. Failure to submit by the deadline will result in students being graduated the following semester.

M.Sc. Non-Thesis Option

Students wishing to pursue the non-thesis option must complete a minimum of 6.0 credits of directed research (299).

Students must complete the remaining credits through one or a combination of the options listed below:

- Broadening experience courses: courses that broaden the master's experience
- Internship: research-based internship (295)
- Ph.D. courses: courses numbered at the 300 level

M.Sc. Graduation Requirements

To successfully graduate with a master's degree from KAUST all students must meet the minimum University graduation requirements and be approved by the Office of the Registrar and division dean. Individual programs may have additional requirements, which must be met to graduate, please see division/program requirements for further details. Programs cannot require less than the minimum degree requirements or waive university degree requirements. If there is any perceived conflict between program and university degree requirements, the university degree requirements will prevail.

The M.Sc. degree has the following minimum graduation requirements:

- Minimum 36.0 overall credits
- Minimum 12.0 research/capstone credits
- Minimum two graduate seminars
- Cumulative GPA of 3.0 or above
- Successful completion of one Winter Enrichment Program (WEP)

Doctor of Philosophy University Degree Requirements

The Doctor of Philosophy (Ph.D.) degree is designed to prepare students for research careers in academia and industry. Students are expected to follow the program requirements outlined in the program guide of the academic year they started their program. Students should be aware that most core courses are offered only once per year.

There is a minimum residency requirement at KAUST of three and a half years for students entering with a bachelor's degree and two and a half years for students entering with a master's degree. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit.

Once admitted, Ph.D. students are required to designate an academic advisor. The selected academic advisor must be a full-time, program-affiliated professor at KAUST. Students may also select an advisor from another program at KAUST. This advisor can only become project affiliated for the specific dissertation project with program-level approval. Project affiliation approval must be completed prior to commencing research.

The Ph.D. degree includes the following components:

- Designate an academic advisor
- Coursework (as listed in the program-specific guidelines)
- Advancement to candidacy
    - Pass the qualifying examination (if applicable)
    - Pass the dissertation proposal defense
- Successful defense and submission of a doctoral dissertation

View a list of faculty and their affiliations here.

Ph.D. Course Requirements

The required coursework varies for students entering the Ph.D. program with a bachelor's degree or a master's degree. Students holding a bachelor's degree must complete all program core/mandatory courses and elective courses outlined in the master's degree section and are also required to complete the Ph.D. courses below. Students entering with a bachelor's degree will qualify to earn a master's degree by satisfying the master's degree requirements.

Students entering the Ph.D. degree with a relevant master's degree must complete the requirements below, though additional courses may be required by the program (see program-specific guidelines) or academic advisor.

- At least two 300-level courses
- Completion of one Winter Enrichment Program (WEP) – students who completed WEP while earning the M.Sc. are not required to enroll in a full WEP for a second time during the Ph.D.
- Graduate seminar(s) – see program requirements for details

Ph.D. Candidacy Requirements

Students are designated as Ph.D. students when they enter the program. Students become Ph.D. candidates by qualifying for and advancing to candidacy by:

- Successfully passing the required Ph.D. coursework
- Successfully passing the qualifying exam (if applicable – see program requirements)
- Writing and orally defending the research proposal

Students must advance to candidacy within one to three years of their doctoral program. See individual program requirements for more information on candidacy timelines and requirements.

Ph.D. Qualifying Examination

The purpose of the qualifying examination is to test students' knowledge of the subject matter within their field of study. Each division is responsible for setting the qualifying examination requirements. For more information, please see division/program requirements.

Ph.D. Dissertation Proposal Defense Committee

The Ph.D. dissertation proposal defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than six members. The chair, plus one additional faculty member must be affiliated with the student's program. Please see individual programs for defense committee requirements.

Ph.D. Dissertation Proposal Defense

The purpose of the dissertation proposal defense is to demonstrate that students have the ability and are adequately prepared to undertake Ph.D. level research in the proposed area. This preparation includes necessary knowledge of the chosen subject, a review of the literature and preparatory theory or experiment as applicable. The proposal defense committee must be approved by the dean prior to the proposal defense.

The dissertation proposal defense is part of the candidacy milestone that must be completed to become a Ph.D. candidate. Ph.D. students are required to complete the dissertation proposal defense within one to three years of doctoral studies, see individual program requirements for more information. The dissertation proposal defense includes two aspects: a written research proposal and an oral research proposal defense.

There are four possible outcomes for the dissertation proposal defense:

- Pass
- Pass with conditions
- Fail with retake
- Fail without retake

A pass is achieved when the committee agrees with no more than one dissenting vote, otherwise the outcome is a fail. In the instance of a pass with conditions, the entire committee must agree on the required conditions and if they cannot, the dean decides. The deadline to complete the conditions is one month after the defense date, unless the committee unanimously agrees to change it. If a retake is approved, the deadline to complete the retake is as decided by the defense committee with a maximum of six months after the defense date, unless the committee unanimously agrees to change it. In the instance of a fail without retake, the decision of the committee must be unanimous. Students who fail without retake or who fail the retake will be dismissed from the University.

Students who successfully pass the dissertation proposal defense are deemed Ph.D. candidates.

Ph.D. Defense

To graduate, Ph.D. candidates must form a Ph.D. dissertation defense committee and successfully defend a Ph.D. dissertation.

Ph.D. Dissertation Defense Committee

The Ph.D. dissertation defense committee, which must be approved by the dean, must consist of at least four members and typically includes no more than six members. At least three of the required members must be KAUST faculty and one must be an external examiner who is external to KAUST. The chair, plus one additional faculty member must be affiliated with the student's program. The external examiner is not required to attend the defense, but must write a report on the dissertation and may attend the dissertation defense at the discretion of the program. Please see individual programs for defense committee requirements.

Ph.D. Dissertation Defense

The Ph.D. degree requires the passing of the defense and acceptance of the dissertation. The final defense is a public presentation that consists of an oral defense followed by questions and may last a maximum of three hours.

Students must determine the defense date with agreement of all the members of the dissertation committee, meet deadlines for submitting graduation forms and inform the committee of their progress. It is the responsibility of students to submit the required documents to their GPC by the second week of the semester/session they intend to defend. It is also expected that students submit their written dissertation to the committee at least two months prior to the defense date in order to receive feedback.

The written dissertation is required to comply with the University formatting guidelines.

There are four possible outcomes for this dissertation final defense:

- Pass
- Pass with conditions
- Fail with retake
- Fail without retake

A pass is achieved when the committee agrees with no more than one dissenting vote, otherwise the outcome is a fail. If more than one member casts a negative vote, one retake of the oral defense is permitted if the entire committee agrees. In the instance of a pass with conditions, the entire committee must agree on the required conditions, and if they cannot, the dean decides. The deadline to meet conditions is generally one month after the defense date, unless the committee unanimously agrees to change it. The deadline to complete the retake is as decided by the defense committee with a maximum of six months after the defense date, unless the committee unanimously agrees to change it. Students who fail without retake or who fail the retake will be dismissed from the University.

Evaluation of the Ph.D. dissertation defense is recorded by submitting the result of Ph.D. dissertation defense form to the Office of the Registrar by the deadline in the Academic Calendar.

Ph.D. Graduation Requirements

To successfully graduate with a Ph.D. degree from KAUST all students must meet the minimum University graduation requirements and be approved by the Office of the Registrar and the division dean. Individual programs may have additional requirements, which must be met to graduate (see division/program requirements for further details). Programs cannot require less than the minimum degree requirements or waive university degree requirements. If there is any perceived conflict between program and university degree requirements, the university degree requirements will prevail.

The Ph.D. degree has the following minimum graduation requirements:

- Minimum 6.0 credits at the 300 level

- Minimum residency requirement of two and half years for Ph.D. only, and three and a half years for M.Sc./Ph.D.
- Cumulative grade point average (GPA) of 3.0 or above
- Completion of one Winter Enrichment Program (WEP) (can be taken during the master's degree)
- Successful defense and approval of doctoral dissertation

Division of Biological and Environmental Science and Engineering (BESE)

To accomplish its mission and establish a knowledge and advanced technology platform, the BESE division organizes its research around six focal areas: environmental systems; epigenetics; functional biology; genomics; imaging/structural biology; and marine science.

These research areas build on interdisciplinary competences that are essential for studying the mechanisms through which living organisms and their environments interact, providing opportunities for new technological developments to optimize such interactions to improve the quality of life.

Researchers in BESE focus on topics relevant to the effects of the environment on organisms, the sustainable production of food, the use of high-salinity or poor-quality water, the optimization of energy used in the production of water and food, and the study and preservation of marine and coastal environments.

Research in the BESE division is driven by independent faculty labs and two research centers with which faculty can affiliate to perform applied, goal-oriented research. Centers affiliated with the division include:

- Red Sea Research Center (RSRC)
- Water Desalination and Reuse Center (WDRC)

In addition, from time to time, the division undertakes additional exploratory and collaborative research initiatives, with current activity in the following areas: desert agriculture; neuro-inspired high-performance computing; and nutrition, metabolism, adaptation and epigenetics.

BESE Programs

Bioengineering (BioE)
Bioscience (B)
Environmental Science and Engineering (EnSE)
Marine Science (MarS)
Plant Science (PS)

Bioengineering (BioE)

Aims and Scope
A bioengineer develops and applies engineering principles to life sciences. The field focuses on the development and application of engineering concepts, principles, and methods to biological systems. We aim to model, monitor, and treat disorders and disabilities that affect living organisms, to develop algorithms which aid understanding biological systems and to engineer living systems in order to enhance their performance. The technologies that are generated in this area might include synthetic tissues or organs, sensors that are wired to human body and prosthetics that mimic the natural function of a limb, smart algorithms and end-to-end data analytical engines, bioreactors that improve the quality of treated wastewater and bacteria engineered to produce resources. Bioengineering integrates elements of electrical and mechanical engineering, biochemistry, chemistry, computer science and materials science with biology. Thanks to this multidisciplinary nature, the field of bioengineering often creates out-of-the-box solutions addressing and solving challenges in effect augmenting the well-being of living systems.

M.Sc. Program

It is the sole responsibility of students to plan their graduate program in consultation with their academic advisor. Students are required to meet all deadlines. Students should be aware that most core courses are offered only once per year.

The Master of Science (M.Sc.) degree is awarded upon successful completion of a minimum of 36.0 credit hours. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit. Students are expected to complete the M.Sc. degree in three semesters. Satisfactory participation in every KAUST summer session is mandatory.

The M.Sc. Requirements:

- Core courses (12.0 credits)
- Elective courses (12.0 credits)
- Research/capstone experience (12.0 credits)
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for every semester of the program they attend
- Completion of one Winter Enrichment Program (WEP)

Core Courses (12 credits) Mandatory for ALL tracks.

BioE 201– Foundations of Bioengineering
BioE 202– Foundations of Synthetic Biology
BioE 230– Foundations of Bioengineering Lab
B 241 – Molecular and Cellular Biology Lab

These core courses are designed to provide students with the background needed to establish a solid foundation in the program area.

Elective Courses (12 credits)

Track 1: Biosensors and Bioelectronics
EE 202 – Monolithic Amplifier Circuits
EE 205 – Introduction to MEMS
EE 208 – Optoelectronics
ME 222A/B – Mechatronics and Intelligent Systems (same as EE 272A/B)
MSE 201 – Fundamentals of Materials Science and Engineering
MSE 225 – Electronic Properties of Materials
B 319 – Biomaterials and biomedical devices
B 316 – Foundations in Bioimaging
MSE 318 – Nanomaterials
MSE 322 – Semiconductor Materials
EE 305 – Advanced MEMS
EE 304 – Integrated Microsystems
EE 310 – Integrated Sensors
MSE 324 – Photophysics of Organic Semiconductors
Others upon approval of the academic advisor

Track 2: Bioinformatics and Machine Learning
CS 220 – Data Analytics
STAT 210 – Applied Stat/Data
B 322 – Computational Bioscience and Machine Learning
CS 229 – Machine Learning
B 390N – Special Topics in Genomics, Medicine and Digital Health/Wellness Using Machine Learning
Others upon approval of the academic advisor

Track 3: Biomaterials and Tissue Engineering
EnSE 310 – Colloids, Interfaces, and Surfaces
B 320 – Stem Cells and Molecular Medicine
B 319 – Biomaterials and Biomedical Devices
B 318 – Tissue Engineering & Regenerative Med.
ChemS 210 – Materials Chemistry I
ChemS 215 – Polymers and Polymerization Processes
MSE 201 – Fundamentals of Materials Science and Engineering
MSE 318 – Nanomaterials
MSE 310 – Materials for Energy
MSE 225 – Electronic Properties of Materials
ChemS 360 – Advanced Physical Chemistry
Others upon approval of the academic advisor

Track 4: Synthetic Biology
PS302 – Biochemistry and Metabolic Engineering
EnSE 314 – Public Health Microbiology
EnSE 341 – Processes in Environmental Biotechnology
B317 – Advanced Environmental Microbiology
B204 – Genomics
B206 – Synthetic Biology and Biotechnology
B306 – Synthetic Biology and Biotechnology
Others upon approval of the academic advisor

The elective courses (which exclude research and internship credits) are designed to allow students to tailor their educational experience to meet individual research and educational objectives, with the permission of the academic advisor.

M.Sc. Thesis

Students wishing to pursue the thesis option must complete a minimum of 12.0 credits of thesis research (297).

The thesis defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than four members. At least two of the required members must be KAUST faculty. The chair plus one additional faculty member must be affiliated with the student's program. This membership can be summarized as:

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty or approved research scientist	Outside program
4	Additional faculty or research scientist	Inside or outside KAUST

Notes:
- Members 1-3 are required, member 4 is optional
- Co-chairs may serve as member 2, 3, or 4, but may not be a research scientist
- Members 2 and 3 must use primary affiliation only
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 4 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 4

View a list of faculty and their affiliations here.

M.Sc. Non-Thesis

Students wishing to pursue the non-thesis option must complete a total of 12.0 research/capstone credits, with a minimum of 6.0 credits of directed research (299).

Students must complete the remaining credits through one or a combination of the options listed below:
- Broadening experience courses: courses that broaden a student's M.Sc. experience
- Internship: research-based summer internship (295) – students are only allowed to take one internship
- Ph.D. courses: courses numbered at the 300 level
- Additional directed research

Ph.D. Program

The Doctor of Philosophy (Ph.D.) degree is designed to prepare students for research careers in academia and industry.

There is a minimum residency requirement at KAUST of three and a half years for students entering with a bachelor's degree and two and a half years for students entering with a master's degree. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit.

The Ph.D. degree includes the following steps:
- Securing an academic advisor
- Successful completion of program coursework
- Passing the dissertation proposal defense to obtain candidacy status
- Preparing, submitting and successfully defending a doctoral dissertation

Ph.D. Course Requirements

The required coursework varies for students entering the Ph.D. degree with a bachelor's degree or a relevant master's degree. Students holding a bachelor's degree must complete all program core/mandatory courses and elective courses outlined in the master's degree section and are also required to complete the Ph.D. courses below. Students entering with a bachelor's degree will qualify to earn a master's degree by satisfying the master's degree requirements.

Students entering the Ph.D. degree with a relevant M.Sc. degree must complete the requirements below, though additional courses may be required by the academic advisor.

Ph.D. Courses
- At least two 300-level courses
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for every semester of the program they attend
- Winter Enrichment Program (WEP) – students who completed WEP while earning the M.Sc. are not required to enroll in a full WEP for a second time during the Ph.D.

Ph.D. Proposal Defense Committee

To advance to candidacy, students must successfully complete the Ph.D. proposal defense. Once students have pass the proposal defense, students are designated as Ph.D. or doctoral candidates.

The Ph.D. dissertation proposal defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than six members. The chair, plus one additional faculty member must be affiliated with the student's program.

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty	Outside program
4	Approved research scientist	Inside KAUST

Notes:

- Members 1-3 are required, member 4 is optional
- Co-chairs may serve as members 2 or 3
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2 or 3 depending upon their affiliation with the student's program, they may also serve as co-chairs

Once constituted, the composition of the proposal committee can only be changed with the approval of both the academic advisor and the dean.

View a list of faculty and their affiliations here.

Ph.D. Final Defense Committee

The Ph.D. dissertation defense committee, which must be approved by the dean, must consist of at least four members and typically includes no more than six members. At least three of the required members must be KAUST faculty and one must be an external examiner who is external to KAUST. The chair, plus one additional faculty member must be affiliated with the student's program. The external examiner is not required to attend the defense, but must write a report on the dissertation and may attend the dissertation defense at the discretion of the program.

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty	Outside program
4	External examiner	Outside KAUST
5	Approved research scientist	Inside KAUST
6	Additional faculty	Inside or outside KAUST

Notes:

- Members 1-4 are required, members 5 and 6 are optional
- Co-chairs may serve as either members 2, 3 or 6
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 6 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 6, but not as the external examiner

The only requirement with commonality with the proposal committee is the academic advisor, although it is expected that other members will carry forward to this committee.

Co-supervisors can be considered one of the above four members required, provided they come under the categories listed (i.e. meets the requirements of the position).

View a list of faculty and their affiliations here.

Bioscience (B)

Aims and Scope

The Bioscience (B) program plays a key role in tackling many of the global challenges being addressed by KAUST, with a general emphasis on 'adaptive biology', i.e. the study of the mechanisms that allow organisms to adapt to their environment. Understanding and engineering these complex mechanisms is critical in areas such as global food security or health care, and requires combining in-depth knowledge with advanced methodology and out-of-the-box thinking.

To prepare students to be innovative contributors to life sciences, the Bioscience program comprises courses in cell and molecular biology, biophysics and computer science. Moreover, it interfaces smoothly with bioengineering as well as plant and marine sciences, and allows the choice of electives across all divisions.

The program is comprised of two tracks of self-contained courses consisting of lectures, seminars and laboratory classes. Each course provides an in-depth review of the subject and examples of current research in the field. In addition, the Bioscience program provides substantial and versatile hands-on research experience.

M.Sc. Program

It is the responsibility of students to plan their graduate program in consultation with their academic advisor. Students are required to meet all deadlines. Students should be aware that most core courses are offered only once per year.

The Master of Science (M.Sc.) degree is awarded upon successful completion of a minimum of 36 credit hours. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit. Students are expected to complete the M.Sc. degree in three semesters. Satisfactory participation in every KAUST summer session is mandatory.

The M.Sc. Requirements:

- Core courses (9.0 credits)
- Elective courses (6.0 credits)
- Lab rotation (3.0 credits)
- Research/capstone experience (18.0 credits)
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for every semester of the program they attend
- Completion of one Winter Enrichment Program (WEP)

Core Courses (9.0 credits)

Track 1: Cell and Molecular Biology (choose 3 of 4)
B 204 – Genomics
B 224 – The Cell: Structure, Development and Physiology I
B 213 – The Cell: Structure, Development and Physiology II
B 241 – Molecular and Cellular Biology Lab (not optional)

Track 2: Biophysics and Bioimaging (choose 3 of 4)
B 214 – Biomolecular Structure and Function
B 241 – Molecular and Cellular Biology Lab (not optional)
B 290 – Special Topics: Biophysics
B 316 – Foundations in Bioimaging

These core courses are designed to provide students with the background needed to establish a solid foundation in the program area.

Elective Courses (6.0 credits)

Track 1: Cell and Molecular Biology
B 206 – Synthetic Biology and Biotechnology
B 211 – Fundamentals of Molecular Microbiology
B 214 – Biomolecular Structure and Function
B 316 – Foundations in Bioimaging
B 317 – Advanced Environmental Microbiology
B 320 – Stem Cells and Molecular Medicine
B 321 – Epigenetics and Chromatin
B 322 – Computational Bioscience and Machine Learning
Others upon approval of the academic advisor

Track 2: Biophysics and Bioimaging
B 204 – Genomics
B 206 – Synthetic Biology and Biotechnology
B 211 – Fundamentals of Molecular Microbiology
B 213 – The Cell: Structure, Development and Physiology II
B 224 – The Cell: Structure, Development and Physiology I
B 318 – Tissue Engineering and Regenerative Medicine
B 319 – Biomaterials and Biomedical Devices
B 390 – Special Topics: Advanced Bioimaging
Others upon approval of the academic advisor

The elective courses (which exclude research and internship credits) are designed to allow students to tailor their educational experience to meet individual research and educational objectives, with the permission of the academic advisor.

Compulsory lab rotation (B 296): in addition, all incoming M.Sc. students are required to enroll into a rotation course during their first semester in the program. The goal of this course is to introduce students to various bioscience research groups in order to aid them in the selection of an academic advisor. Rotation assignments will be made by the mutual approval of designated faculty and students.

M.Sc. Thesis

Students wishing to pursue the thesis option must complete total of 18.0 research/capstone credits, with a minimum of 12.0 credits of thesis research (297).

The thesis defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than four members. At least two of the required members must be KAUST faculty. The chair plus one additional faculty member must be affiliated with the student's program. This membership can be summarized as:

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty or approved research scientist	Outside program
4	Additional faculty or research scientist	Inside or outside KAUST

Notes:

- Members 1-3 are required, member 4 is optional
- Co-chairs may serve as member 2, 3, or 4, but may not be a research scientist
- Members 2 and 3 must use primary affiliation only
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 4 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 4

View a list of faculty and their affiliations here.

M.Sc. Non-Thesis

Students wishing to pursue the non-thesis option must complete a total of 18.0 research/capstone credits, with a minimum of 6.0 credits of directed research (299).

Students must complete the remaining credits through one or a combination of the options listed below:

- Broadening experience courses: courses that broaden a student's M.Sc. experience
- Internship: research-based summer internship (295) – students are only allowed to take one internship
- Ph.D. courses: courses numbered at the 300 level
- Additional directed research

Ph.D. Program

The Doctor of Philosophy (Ph.D.) degree is designed to prepare students for research careers in academia and industry.

There is a minimum residency requirement at KAUST of three and a half years for students entering with a bachelor's degree and two and a half years for students entering with a master's degree. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit.

The Ph.D. degree includes the following steps:

- Securing an academic advisor
- Successful completion of program coursework
- Passing the dissertation proposal defense to obtain candidacy status
- Preparing, submitting and successfully defending a doctoral dissertation

Ph.D. Course Requirements

The required coursework varies for students entering the Ph.D. degree with a bachelor's degree or a relevant master's degree. Students holding a bachelor's degree must complete all program core/mandatory courses and elective courses outlined in the master's degree section and are also required to complete the Ph.D. courses below. Students entering with a bachelor's degree will qualify to earn a master's degree by satisfying the master's degree requirements.

Students entering the Ph.D. degree with a relevant M.Sc. degree must complete the requirements below, though additional courses may be required by the academic advisor.

Ph.D. Courses

- At least two 300-level courses
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for every semester of the program they attend
- Winter Enrichment Program (WEP) – students who completed WEP while earning the M.Sc. are not required to enroll in a full WEP for a second time during the Ph.D.

Ph.D. Proposal Defense Committee

To advance to candidacy, students must successfully complete the Ph.D. proposal defense. Once students have pass the proposal defense, students are designated as Ph.D. or doctoral candidates.

The Ph.D. dissertation proposal defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than six members. The chair, plus one additional faculty member must be affiliated with the student's program.

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program

3	Faculty	Outside program
4	Approved research scientist	Inside KAUST

Notes:

- Members 1-3 are required, member 4 is optional
- Co-chairs may serve as members 2 or 3
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2 or 3 depending upon their affiliation with the student's program, they may also serve as co-chairs

Once constituted, the composition of the proposal committee can only be changed with the approval of both the academic advisor and the dean.

View a list of faculty and their affiliations here.

Ph.D. Final Defense Committee

The Ph.D. dissertation defense committee, which must be approved by the dean, must consist of at least four members and typically includes no more than six members. At least three of the required members must be KAUST faculty and one must be an external examiner who is external to KAUST. The chair, plus one additional faculty member must be affiliated with the student's program. The external examiner is not required to attend the defense, but must write a report on the dissertation and may attend the dissertation defense at the discretion of the program.

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty	Outside program
4	External examiner	Outside KAUST
5	Approved research scientist	Inside KAUST
6	Additional faculty	Inside or outside KAUST

Notes:

- Members 1-4 are required, members 5 and 6 are optional
- Co-chairs may serve as either members 2, 3 or 6
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 6 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 6, but not as the external examiner

The only requirement with commonality with the proposal committee is the academic advisor, although it is expected that other members will carry forward to this committee.

Co-supervisors can be considered one of the above four members required, provided they come under the categories listed (i.e. meets the requirements of the position).

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Environmental Science and Engineering (EnSE)

Aims and Scope

The Environmental Science and Engineering Program (EnSE) prepares students to work on many of the world's most pressing challenges related to water security and the environment, focusing around the intersection of water, energy and food nexus, and sustainable processes.

This program comprises four focus areas: Water Quality, Chemistry, and Treatment; Environmental Microbiology and Biotechnology; Environmental Systems and Analysis; and Materials for Environmental Science and Engineering.

Students entering the program enroll in a set of core courses and then take technical elective courses that cover important areas in water and wastewater treatment technologies, water desalination, biotechnologies for resource recovery from waste streams, microbiological safety of water reuse, sustainability and management, surface science and materials for water, energy and environment. The core-plus elective courses will equip a student for a successful and productive career in these fields.

M.Sc. Program

It is the responsibility of students to plan their graduate program in consultation with their academic advisor. Students are required to meet all deadlines. Students should be aware that most core courses are offered only once per year.

The Master of Science (M.Sc.) degree is awarded upon successful completion of a minimum of 36 credit hours. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit. Students are expected to complete the M.Sc. degree in three semesters. Satisfactory participation in every KAUST summer session is mandatory.

The M.Sc. Requirements:

- Core courses (9.0 credits)
- Elective courses (thesis: 9.0 credits; non-thesis: 15.0 credits)
- Research/capstone experience (thesis: 18.0 credits; non-thesis 12.0 credits)
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for every semester of the program they attend
- Completion of one Winter Enrichment Program (WEP)

Core Courses (9.0 credits)

EnSE 202 – Aquatic Chemistry
EnSE 203 – Fundamentals of Environmental Microbiology
EnSE 205 – Principles of Environmental Sustainability

These core courses are designed to provide students with the background needed to establish a solid foundation in the program area.

Elective Courses (thesis: 9.0 credits; non-thesis: 15.0 credits)

EnSE 310 – Colloids, Interfaces, and Surfaces
EnSE 314 – Public Health Microbiology
EnSE 325 – Water Desalination
EnSE 341 – Processes in Environmental Biotechnology
EnSE 342 – Physical/Chemical Treatment Processes
Others upon approval of the academic advisor

The elective courses (which exclude research and internship credits) are designed to allow students to tailor their educational experience to meet individual research and educational objectives, with the permission of the academic advisor.

M.Sc. Thesis

Students wishing to pursue the thesis option must complete 9.0 credits of elective courses and a total of 18.0 research/capstone credits, with a minimum of 12.0 credits of thesis research (297).

The thesis defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than four members. At least two of the required members must be KAUST faculty. The chair plus one additional faculty member must be affiliated with the student's program. This membership can be summarized as:

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty or approved research scientist	Outside program
4	Additional faculty or research scientist	Inside or outside KAUST

Notes:

- Members 1-3 are required, member 4 is optional
- Co-chairs may serve as member 2, 3, or 4, but may not be a research scientist
- Members 2 and 3 must use primary affiliation only
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 4 depending

upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 4

View a list of faculty and their affiliations here.

M.Sc. Non-Thesis

Students wishing to pursue the non-thesis option must complete a total of 15 elective courses, of which three courses must be from EnSE, and a total of 12.0 research/capstone credits, with a minimum of 6.0 credits of directed research (299).

Students must complete the remaining credits through one or a combination of the options listed below:
- Broadening experience courses: courses that broaden a student's M.Sc. experience
- Internship: research-based summer internship (295) – students are only allowed to take one internship
- Ph.D. courses: courses numbered at the 300 level
- Additional directed research

Ph.D. Program

The Doctor of Philosophy (Ph.D.) degree is designed to prepare students for research careers in academia and industry.

There is a minimum residency requirement at KAUST of three and a half years for students entering with a bachelor's degree and two and a half years for students entering with a master's degree. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit.

The Ph.D. Degree includes the following steps:
- Securing an academic advisor
- Successful completion of program coursework
- Passing the dissertation proposal defense to obtain candidacy status
- Preparing, submitting and successfully defending a doctoral dissertation

Ph.D. Course Requirements

The required coursework varies for students entering the Ph.D. degree with a bachelor's degree or a relevant master's degree. Students holding a bachelor's degree must complete all program core/mandatory courses and elective courses outlined in the master's degree section and are also required to complete the Ph.D. courses below. Students entering with a bachelor's degree will qualify to earn a master's degree by satisfying the master's degree requirements.

Students entering the Ph.D. degree with a relevant M.Sc. degree must complete the requirements below, though additional courses may be required by the academic advisor.

Ph.D. Courses
- At least two 300-level courses
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for every semester of the program they attend
- Winter Enrichment Program (WEP) – students who completed WEP while earning the M.Sc. are not required to enroll in a full WEP for a second time during the Ph.D.

Ph.D. Proposal Defense Committee

To advance to candidacy, students must successfully complete the Ph.D. proposal defense. Once students have passed the proposal defense, students are designated as Ph.D. or doctoral candidates.

The Ph.D. dissertation proposal defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than six members. The chair, plus one additional faculty member must be affiliated with the student's program.

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty	Outside program
4	Approved research scientist	Inside KAUST

Notes:
- Members 1-3 are required, member 4 is optional
- Co-chairs may serve as members 2 or 3
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2 or 3 depending upon their affiliation with the student's program, they may also serve as co-chairs

Once constituted, the composition of the proposal committee can only be changed with the approval of both the academic advisor and the dean.

View a list of faculty and their affiliations here.

Ph.D. Final Defense Committee

The Ph.D. dissertation defense committee, which must be approved by the dean, must consist of at least four members and typically includes no more than six members. At least three of the required members must be KAUST faculty and one must be an external examiner who is external to KAUST. The chair, plus one additional faculty member must be affiliated with the student's program. The external examiner is not required to attend the defense, but must write a report on the dissertation and may attend the dissertation defense at the discretion of the program.

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty	Outside program
4	External examiner	Outside KAUST
5	Approved research scientist	Inside KAUST
6	Additional faculty	Inside or outside KAUST

Notes:

- Members 1-4 are required, members 5 and 6 are optional
- Co-chairs may serve as either members 2, 3 or 6
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 6 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 6, but not as the external examiner

The only requirement with commonality with the proposal committee is the academic advisor, although it is expected that other members will carry forward to this committee.

Co-supervisors can be considered one of the above four members required, provided they come under the categories listed (i.e. meets the requirements of the position).

View a list of faculty and their affiliations here.

Marine Science (MarS)

Aims and Scope

The Marine Science (MarS) program takes advantage of KAUST's location on the Red Sea, a living laboratory with great potential for exciting science. The program addresses the biology and ecology of the multitude of marine life forms. There is an intentional focus on the local Red Sea system, both as a primary study system and as a system with which general concepts from other marine systems can be compared.
The goal of the Marine Science program is to develop an integrated understanding of the Red Sea's ecosystem as well as marine ecosystems in general, including fundamental biology at the molecular and genomic levels, symbiosis with algae and prokaryotes (bacteria and archaea), associated communities of fish and corals and the physical and chemical environment that impacts and shapes them. This understanding could have an impact on global carbon cycling, endangered species and how we manage the harvesting of resources from the oceans.

M.Sc. Program

It is the responsibility of students to plan their graduate program in consultation with their academic advisor. Students are required to meet all deadlines. Students should be aware that most core courses are offered only once per year.

The Master of Science degree (M.Sc.) is awarded upon successful completion of a minimum of 36 credit hours. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit. Students are expected to complete the M.Sc. degree in three semesters. Satisfactory participation in every KAUST summer session is mandatory.

The M.Sc. Requirements:

- Core courses (9.0 credits)
- Elective courses (0-15.0 credits)
- Research/capstone experience (12.0-24.0 credits)
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for every semester of the program they attend
- Completion of one Winter Enrichment Program (WEP)

Core Courses (9.0 credits)

MarS 221 – Marine Life
MarS 335 – Oceanography
MarS 323 – Pelagic Ecology**
B 204 – Genomics**
B 211 – Fundamentals of Molecular Microbiology**
**Choose at least 1 of 3

These core courses are designed to provide students with the background needed to establish a solid foundation in the program area.

Elective Courses (0-15.0 credits)

MarS 326 – Coral Reef Ecology
MarS 329 – Marine Microbial Ecology
MarS 330 – Marine Ecological Genomics
MarS 332 – Optical Oceanography
Others upon approval of the academic advisor

The elective courses (which exclude research and internship credits) are designed to allow students to tailor their educational experience to meet individual research and educational objectives, with the permission of the academic advisor.

M.Sc. Thesis

Students wishing to pursue the thesis option must complete total of 12.0-27.0 research/capstone credits, with a minimum of 12.0 credits of thesis research (297).

The thesis defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than four members. At least two of the required members must be KAUST faculty. The chair plus one additional faculty member must be affiliated with the student's program. This membership can be summarized as:

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty or approved research scientist	Outside program
4	Additional faculty or research scientist	Inside or outside KAUST

Notes:

- Members 1-3 are required, member 4 is optional
- Co-chairs may serve as member 2, 3, or 4, but may not be a research scientist
- Members 2 and 3 must use primary affiliation only
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 4 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 4

View a list of faculty and their affiliations here.

M.Sc. Non-Thesis

Students wishing to pursue the non-thesis option must complete a total of 12.0-24.0 research/capstone credits, with a minimum of 6.0 credits of directed research (299).

Students must complete the remaining credits through one or a combination of the options listed below:

- Broadening experience courses: courses that broaden a student's M.Sc. experience
- Internship: research-based summer internship (295) – students are only allowed to take one internship
- Ph.D. courses: courses numbered at the 300 level
- Additional directed research

Ph.D. Program

The Doctor of Philosophy (Ph.D.) degree is designed to prepare students for research careers in academia and industry.

There is a minimum residency requirement at KAUST of three and a half years for students entering with a bachelor's degree and two and a half years for students entering with a master's degree. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit.

The Ph.D. degree includes the following steps:

- Securing an academic advisor
- Successful completion of program coursework
- Passing the dissertation proposal defense to obtain candidacy status
  Preparing, submitting and successfully defending a doctoral dissertation

Ph.D. Course Requirements

The required coursework varies for students entering the Ph.D. degree with a bachelor's degree or a relevant master's degree. Students holding a bachelor's degree must complete all program core/mandatory courses and elective courses outlined in the master's degree section and are also required to complete the Ph.D. courses below. Students entering with a bachelor's degree will qualify to earn a master's degree by satisfying the master's degree requirements.

Students entering the Ph.D. degree with a relevant M.Sc. degree must complete the requirements below, though additional courses may be required by the academic advisor.

Ph.D. Courses

- At least two 300-level courses
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for every semester of the program they attend
- Winter Enrichment Program (WEP) – students who completed WEP while earning the M.Sc. are not required to enroll in a full WEP for a second time during the Ph.D.

Ph.D. Proposal Defense Committee

To advance to candidacy, students must successfully complete the Ph.D. proposal defense. Once students have pass the proposal defense, students are designated as Ph.D. or doctoral candidates.

The Ph.D. dissertation proposal defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than six members. The chair, plus one additional faculty member must be affiliated with the student's program.

Member	Role	Program Status
1	Chair	Within program
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Once constituted, the composition of the proposal committee can only be changed with the approval of both the academic advisor and the dean.

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Ph.D. Final Defense Committee

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- Visiting professors may serve as member 6, but not as the external examiner

The only requirement with commonality with the proposal committee is the academic advisor, although it is expected that other members will carry forward to this committee.

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Plant Science (PS)

Aims and Scope

The goal of the Plant Science (PS) program is to develop a thorough understanding of plant growth and function under challenging environmental conditions, such as those found in Saudi Arabia. The fundamental biology of plants is studied at a range of levels (e.g. genomic, proteomic, metabolomics), and the interactions of plants with their environment, both abiotic (heat, salt and drought) and biotic (pathogens and symbionts) are investigated. Application of this knowledge will allow development of plants with enhanced tolerance to environmental stresses and help to establish sustainable agriculture systems in arid regions of the world.

M.Sc. Program

It is the responsibility of students to plan their graduate program in consultation with their academic advisor. Students are required to meet all deadlines. Students should be aware that most core courses are offered only once per year.

The Master of Science (M.Sc.) degree is awarded upon successful completion of a minimum of 36 credit hours. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit. Students are expected to complete the M.Sc. degree in three semesters. Satisfactory participation in every KAUST summer session is mandatory.

The M.Sc. Requirements:

- Core courses (12.0 credits)
- Elective courses (6.0-12.0 credits)
- Research/capstone experience (12.0-18.0 credits)
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for every semester of the program they attend
- Completion of one Winter Enrichment Program (WEP)

Core Courses (12.0 credits)

PS 201 – Concepts of Developmental Biology and Genetics
PS 202 – Plant Physiology and Adaptation
B 211 – Fundamentals of Molecular Microbiology
B 241 – Molecular and Cellular Biology Lab

These core courses are designed to provide students with the background needed to establish a solid foundation in the program area.

Elective Courses (6.0-12.0 credits)

B 204 – Genomics
B 206 – Synthetic Biology and Biotechnology
B 209 – Molecular Genetics
Others upon approval of the academic advisor.

The elective courses (which exclude research and internship credits) are designed to allow students to tailor their educational experience to meet individual research and educational objectives, with the permission of the academic advisor.

M.Sc. Thesis

Students wishing to pursue the thesis option must complete total of 12.0-18.0 research/capstone credits, with a minimum of 12.0 credits of thesis research (297).

The thesis defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than four members. At least two of the required members must be KAUST faculty. The chair plus one additional faculty member must be affiliated with the student's program. This membership can be summarized as:

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- Visiting professors may serve as member 4

View a list of faculty and their affiliations here.

M.Sc. Non-Thesis

Students wishing to pursue the non-thesis option must complete a total of 12.0-18.0 capstone credits, with a minimum of 6.0 credits of directed research (299).

Students must complete the remaining credits through one or a combination of the options listed below:

- Broadening experience courses: courses that broaden a student's M.Sc. experience

- Internship: research-based summer internship (295) – students are only allowed to take one internship
- Ph.D. courses: courses numbered at the 300 level
- Additional directed research

Ph.D. Program

The Doctor of Philosophy (Ph.D.) degree is designed to prepare students for research careers in academia and industry.

There is a minimum residency requirement at KAUST of three and a half years for students entering with a bachelor's degree and two and a half years for students entering with a master's degree. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit.

The Ph.D. degree includes the following steps:
- Securing an academic advisor
- Successful completion of program coursework
- Passing the dissertation proposal defense to obtain candidacy status
- Preparing, submitting and successfully defending a doctoral dissertation

Ph.D. Course Requirements

The required coursework varies for students entering the Ph.D. degree with a bachelor's degree or a relevant master's degree. Students holding a bachelor's degree must complete all program core/mandatory courses and elective courses outlined in the master's degree section and are also required to complete the Ph.D. courses below. Students entering with a bachelor's degree will qualify to earn a master's degree by satisfying the master's degree requirements.

Students entering the Ph.D. degree with a relevant M.Sc. degree must complete the requirements below, though additional courses may be required by the academic advisor.

Ph.D. Courses

- At least two 300-level courses
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for every semester of the program they attend
- Winter Enrichment Program (WEP) – students who completed WEP while earning the M.Sc. are not required to enroll in a full WEP for a second time during the Ph.D.

Ph.D. Proposal Defense Committee

To advance to candidacy, students must successfully complete the Ph.D. proposal defense. Once students have pass the proposal defense, students are designated as Ph.D. or doctoral candidates.

The Ph.D. dissertation proposal defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than six members. The chair, plus one additional faculty member must be affiliated with the student's program.

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Once constituted, the composition of the proposal committee can only be changed with the approval of both the academic advisor and the dean.

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Ph.D. Final Defense Committee

The Ph.D. dissertation defense committee, which must be approved by the dean, must consist of at least four members and typically includes no more than six members. At least three of the required members must be KAUST faculty and one must be an external examiner who is external to KAUST. The chair, plus one additional faculty member must be affiliated with the student's program. The external examiner is not required to attend the defense, but must write a report on the dissertation and may attend the dissertation defense at the discretion of the program.

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Notes:

- Members 1-4 are required, members 5 and 6 are optional
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- Visiting professors may serve as member 6, but not as the external examiner

The only requirement with commonality with the proposal committee is the academic advisor, although it is expected that other members will carry forward to this committee.

Co-supervisors can be considered one of the above four members required, provided they come under the categories listed (i.e. meets the requirements of the position).

View a list of faculty and their affiliations here.

Division of Computer, Electrical and Mathematical Science and Engineering (CEMSE)

Smart man-engineered environment is no longer the realm of science fiction. We are surrounded by intelligent machines that follow our algorithms and improve the quality of our life. We predict highly complex natural phenomena, such as climate, with mathematical models of ever-increasing accuracy. We use our understanding, translated in the form of mathematical computations, to design novel materials and to optimize important processes that help us resolve big issues such as availability of clean water and energy. Computer, electrical,
and mathematical sciences and engineering are cornerstones of modern life, they help us ensure the continuity and sufficiency of the supply of water, food, energy in a sustainable environment; they drive our industrial production lines, they give us new materials for upcoming technologies and better healthcare. This is what CEMSE is for.

Research in the CEMSE division is driven by independent faculty labs and three research centers with which faculty can affiliate to perform applied, goal-oriented research. Centers affiliated with the division include:

- Computational Bioscience Research Center (CBRC)
- Extreme Computing Research Center (ECRC)
- Visual Computing Center (VCC)

In addition, from time to time, the division undertakes special exploratory and collaborative research initiatives, currently in sensors and uncertainty quantification.

CEMSE Programs

Applied Mathematical and Computational Science (AMCS)
Computer Science (CS)
Electrical Engineering (EE)
Statistics (STAT)

Applied Mathematics and Computational Science (AMCS)

Aims and Scope
The Applied Mathematics and Computational Sciences (AMCS) program educates students to construct and solve mathematical and computational models of real-world problems. Two degree programs are offered: the M.Sc. degree (under either a thesis or a non-thesis option) and the Ph.D. degree. Admission to a degree program does not guarantee transfer to another.

The AMCS program offers specializations in two distinct directions (called "tracks"): applied mathematics (AM) and computational science and engineering (CSE).

The requirements for the different tracks are outlined below. All students in the M.Sc. program are guided by an academic advisor to develop their program of study. It is the responsibility of students to plan their graduate program in consultation with their academic advisor. Students are required to meet all deadlines.

Assessment Test (M.Sc. and Ph.D.)
Students are admitted to KAUST from a wide variety of programs and backgrounds. To design an appropriate study plan for students, all incoming students are required to take an assessment during orientation week. There is no grade for the assessment.

The purpose of this assessment is to determine whether students have mastered the prerequisites for undertaking graduate-level courses taught in the program. The academic advisor uses the results of the assessments to design a study plan with a list of courses aimed at addressing content areas that may impede a student from successful completion of the degree requirements. Students are encouraged to prepare for the assessment by refreshing the general knowledge gained from their undergraduate education before arriving at KAUST. The study plan requirements must be satisfactorily completed in addition to the University degree requirements.

Credits
All students are required to be enrolled in 12.0 credits each semester and 6.0 credits during the summer session. These credits can comprise coursework, dissertation research, directed research, thesis credits or internships.

M.Sc. Program

It is the responsibility of students to plan their graduate program in consultation with their academic advisor. Students are required to meet all deadlines. Students should be aware that most core courses are offered only once per year.

The Master of Science (M.Sc.) degree is awarded upon successful completion of a minimum of 36 credit hours. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit. Students are expected to complete the M.Sc. degree in three semesters. Satisfactory participation in every KAUST summer session is mandatory.

The M.Sc. Requirements:
- Core courses (6.0-15.0 credits)
- Elective courses (9.0-18.0 credits)
- Research/capstone experience (12.0 credits)
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for the first two semesters
- Completion of one Winter Enrichment Program (WEP)

Winter Enrichment Program
Students are required to satisfactorily complete at least one full winter enrichment program (WEP).

Core Courses (6.0-15.0 credits)

Applied Mathematics (AM) Track (15.0 credits)
AMCS 231 – Applied Partial Differential Equations (*)
STAT 220 – Probability and Statistics or AMCS 241/STAT 250: Stochastic Processes (*)
AMCS 251 – Numerical Linear Algebra (*)
AMCS 252 – Numerical Analysis of Differential Equations
AMCS 235 – Real Analysis

Computational Science and Engineering (CSE) Track (6.0 credits)
Students must fulfil at least two of the four core courses below:
AMCS 231 – Applied Partial Differential Equations (*)
STAT 220 – Probability and Statistics or AMCS 241/STAT 250: Stochastic Processes (*)
AMCS 251 – Numerical Linear Algebra (*)
AMCS 252 – Numerical Analysis of Differential Equations

These core courses are designed to provide students with the background needed to establish a solid foundation in the program area. Students should be aware that most core courses are offered only once per year.

*The Ph.D. qualifying exam consists of three written subject exams, one in each of the core courses of AM or CSE marked with an asterisk in the core curriculum above. See Subject-Based Qualifying Examination for details.

Elective Courses (15.0 credits)

Applied Mathematics (AM) Track
9.0 credits of elective courses not necessarily within the AMCS program. Some credits may be taken outside the

AMCS program subject to the approval of the academic advisor.

Computational Science and Engineering (CSE) Track
Students in the CSE track must take an additional eighteen credits of course work made up of:

- 6.0 credits of computer science courses
- 6.0 credits in applications of modelling. Eligible application courses include AMCS 332 (mathematical modelling) and courses from .other programs. At least one of the modelling courses should be from outside AMCS. In case both courses are from outside AMCS, it is recommended that they be drawn from the same track.
- 6.0 credits from AMCS courses

The elective courses (which exclude research, internship credits, and IED courses) are designed to allow students to tailor their educational experience to meet individual research and educational objectives, with the permission of the academic advisor.

M.Sc. Thesis

The thesis defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than four members. At least two of the required members must be KAUST faculty. The chair plus one additional faculty member must be affiliated with the student's program. This membership can be summarized as:

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty or approved research scientist	Outside program
4	Additional faculty or research scientist	Inside or outside KAUST

Notes:

- Members 1-3 are required, member 4 is optional
- Co-chairs may serve as member 2, 3, or 4, but may not be a research scientist
- Members 2 and 3 must use primary affiliation only
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 4 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 4

View a list of faculty and their affiliations here.

M.Sc. Non-Thesis

Students wishing to pursue the non-thesis option must complete a total of 12.0 capstone credits, with a maximum of 6.0 credits of directed research (299).

Students must complete the remaining credits through one or a combination of the options listed below:

- Broadening experience courses: courses that broaden a student's M.Sc. experience
- Internship: research-based summer internship (295) – students are only allowed to take one internship
- Ph.D. courses: courses numbered at the 300 level

Ph.D. Program

The Doctor of Philosophy (Ph.D.) degree is designed to prepare students for research careers in academia and industry.

There is a minimum residency requirement at KAUST of three and a half years for students entering with a bachelor's degree and two and a half years for students entering with a master's degree. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit.

The Ph.D. degree includes the following steps:

- Securing an academic advisor
- Successful completion of program coursework
- Passing the qualifying examination
- Passing the dissertation proposal defense to obtain candidacy status
- Preparing, submitting and successfully defending a doctoral dissertation

Ph.D. Course Requirements

The required coursework varies for students entering the Ph.D. degree with a bachelor's degree or a relevant master's degree. Students holding a bachelor's degree must complete all program core/mandatory courses and elective courses outlined in the master's degree section and are also required to complete the Ph.D. courses below. Students entering with a bachelor's degree will qualify to earn a master's degree by satisfying the master's degree requirements.

Students entering the Ph.D. degree with a relevant M.Sc. degree must complete the requirements below, though additional courses may be required by the academic advisor.

Ph.D. Courses

- At least four courses of which at least two must be from the AMCS 300 level course list
- Graduate seminar 398 (non-credit) – all students are required to register and receive a

satisfactory grade for the first two semesters unless they have fulfilled this requirement during a M.Sc. at KAUST
- Winter Enrichment Program (WEP) – students who completed WEP while earning the M.Sc. are not required to enroll in a full WEP for a second time during the Ph.D.

Academic (Dissertation) Advisor

The selected academic or dissertation advisor must be a full-time program-affiliated assistant, associate or full professor at KAUST. Students may also select an advisor from another program at KAUST. This advisor can only become project-affiliated for the specific dissertation project with program level approval. Project affiliation approval must be completed prior to commencing research.

Ph.D. Candidacy

In addition to the coursework requirements, students must successfully complete the required Ph.D. candidacy milestones to progress towards Ph.D. candidate status. These milestones consist of the subject-based qualifying examination and Ph.D. proposal defense. Once students have advanced to candidacy, students are designated as Ph.D. or doctoral candidates.

Subject-Based Qualifying Examination

The qualifying exam consists of three written subject exams, one in each of the core courses of AM or CSE marked with an asterisk in the core curriculum above (see M.Sc. Core Courses). Students have two attempts to take each exam and can pass them in any combination. Students are required to pass all three qualifying exams within one year. Students in the CSE track can replace one of the qualifying exams with a CSE related qualifying exam in another academic program, following the rules of that program. The one-year restriction to fulfill the requirement still applies in this case.

The qualifying exam is offered twice a year: during the final exams of the fall semester and immediately after the final exams of the spring semester. The fall semester qualifying exam is the final exam of each of the abovementioned courses given during the fall semester. The spring semester exam is a three-hour exam per subject prepared by the faculty representative. Students are encouraged to take all three qualifiers in their first semester of the Ph.D. program.

Students that are enrolled in 100 level classes during their first semester as Ph.D. students can ask for an extension of a semester to complete the qualifying exams. This extension does not increase the number of attempts. No further extensions will be given except for extenuating circumstances.

Ph.D. Proposal Defense Committee

The Ph.D. dissertation proposal defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than six members. The chair, plus one additional faculty member must be affiliated with the student's program.

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty	Outside program
4	Approved research scientist	Inside KAUST

Notes:
- Members 1-3 are required, member 4 is optional
- Co-chairs may serve as members 2 or 3
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2 or 3 depending upon their affiliation with the student's program, they may also serve as co-chairs

Once constituted, the composition of the proposal committee can only be changed with the approval of both the academic advisor and the dean.

View a list of faculty and their affiliations here.

Ph.D. Dissertation Proposal Defense

The purpose of the dissertation proposal defense is to demonstrate that students have the ability and are adequately prepared to undertake Ph.D. level research in the proposed area. This preparation includes necessary knowledge of the chosen subject, a review of the literature and preparatory theory or experimentation as applicable. The dissertation proposal defense is the second part of the qualification milestones that must be completed to become a Ph.D. candidate. Ph.D. students are required to complete the dissertation proposal defense within one year after passing the qualifying exam. The dissertation proposal defense includes two aspects: a written research proposal and an oral research proposal defense. Students should discuss with their academic advisor the form and venue of the defense, and whether the proposal discussion will be public or not.

There are four possible outcomes from this dissertation proposal defense:
- Pass
- Pass with conditions

- Fail with retake
- Fail without retake

A pass is achieved when the committee agrees with no more than one dissenting vote, otherwise the outcome is a fail. In the instance of a pass with conditions, the entire committee must agree on the required conditions and if they cannot, the dean will make a final decision. The deadline to complete the conditions is one month after the defense date, unless the committee unanimously agrees to change it. In the instance of a fail without retake, the decision of the committee must be unanimous. The deadline to complete the retake is six months after the defense date, unless the committee unanimously agrees to reduce it. Students who fail the dissertation proposal defense, or who fail the retake, will be dismissed from the University. Students who successfully pass the dissertation proposal defense are deemed Ph.D. candidates. At the end of the proposal defense, a Ph.D. proposal results form must be completed and handed out to the GPC.

Ph.D. Final Defense Committee

The Ph.D. dissertation defense committee, which must be approved by the dean, must consist of at least four members and typically includes no more than six members. At least three of the required members must be KAUST faculty and one must be an external examiner who is external to KAUST. The chair, plus one additional faculty member must be affiliated with the student's program. The external examiner is not required to attend the defense, but must write a report on the dissertation and may attend the dissertation defense at the discretion of the program.

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty	Outside program
4	External examiner	Outside KAUST
5	Approved research scientist	Inside KAUST
6	Additional faculty	Inside or outside KAUST

Notes:

- Members 1-4 are required, members 5 and 6 are optional
- Co-chairs may serve as either members 2, 3 or 6
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 6 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 6, but not as the external examiner

The only requirement with commonality with the proposal committee is the academic advisor, although it is expected that other members will carry forward to this committee.

Co-supervisors can be considered one of the above four members required, provided they come under the categories listed (i.e. meets the requirements of the position).

View a list of faculty and their affiliations here.

Computer Science (CS)

Aims and Scope

The Computer Science (CS) program educates students to become world-class researchers and thought leaders in the field of computer science. The program is designed to prepare students for a career in academia, industrial research or advanced positions in industry.

The program offers two degrees: the Doctor of Philosophy (Ph.D.) degree and the Master of Science (M.Sc.) degree. The M.Sc. degree can be obtained by taking courses only or by a combination of courses and writing a thesis. Students who are interested in a research career are encouraged to apply directly to the Ph.D. program. A master's degree is not a pre-requisite to enroll in the Ph.D. program.

Students who complete the Ph.D. degree will have demonstrated original research that is published in world-class prestigious conferences, journals and other research forums. This degree is appropriate for those who want to pursue a career in research either in academia or industry. Students who complete the M.Sc. degree by taking courses and writing a thesis will have demonstrated ability to perform directed research and complete a research project. This degree is appropriate for students who wish to pursue a Ph.D. degree later.

Students who complete the M.Sc. degree by taking only courses will have demonstrated strong performance in graduate-level courses that prepares students for careers of advanced research and development in industry.

The scope of research in the computer science program at KAUST includes the following areas:

- Artificial Intelligence and Machine Learning
- Computational Biosciences
- Computer Systems and Databases
- High Performance Computing
- Theoretical Computer Science
- Visual Computing

Definitions

To describe the course requirements, we use the following terms:

A *200-level* course has a course number in the closed interval [200 – 299].
A *300-level* course has a course number in the closed interval [300 – 399].

The *course prefix* is the abbreviation at the beginning of a course number used to describe the program that offers the course, e.g., CS for computer science courses and EE for electrical engineering courses.

A *CS course* is a course with CS prefix. A *CEMSE course* is a course with a CS, AMCS, EE, or STAT prefix. A BESE/CEMSE/PSE course is a course offered by any of the three divisions.

The term *regular course* excludes special courses such as:

- CS 295 Internship, CS 297 Master Thesis Research, CS 299 Directed Research, or similar courses in other programs
- CS 397 Doctoral Dissertation Research, CS 398 Graduate Seminar, CS 399 Doctoral Directed Research, or similar courses in other programs
- Courses that CS students cannot take for credit, such as CS 207 Programming Methodology and Abstractions
- Courses with a ESL, IED, WE prefix

Note that special courses such as CS 290 Special Topics, CS 294 Contemporary Topics, CS 390 Special Topics, and CS 394 Contemporary Topics are included in the definition of a regular course.

Requirements for All CS Students

All students have to fulfill the following requirements in addition to the requirements listed below:

- A minimum GPA of 3.0 must be achieved to graduate.
- Individual courses require a minimum of a B- for course credit.
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for the first two semesters at KAUST
- Completion of one Winter Enrichment Program (WEP)

A rule for all CS students is that any course choice needs to be approved by the academic advisor. The academic advisor should check if a course has an appropriate difficulty level and if it fits the educational mission of the CS program. Most importantly, taking courses offered outside of the CS program, especially outside the CEMSE division, requires some justification. Students should take such courses mainly to support an interdisciplinary research project.

M.Sc. Program

The Master of Science (M.Sc.) degree is awarded upon successful completion of a minimum of 36 credit hours. Students are expected to complete the M.Sc. degree in three semesters (non-thesis option) or four semesters (thesis option). Satisfactory participation in every KAUST summer semester is mandatory. Summer semester courses are credit bearing and apply towards the degree.

The M.Sc. Requirements:

- Core courses (9.0 credits)

- Elective courses (15.0 credits)
- Research/capstone experience (12.0 credits)

Core Courses (9.0 credits)

Core courses are all *regular CS 200-level courses* with the following exception:

- Special courses such as CS 290 Special Topics, CS 294 Contemporary Topics

Elective Courses (15.0 credits)

Elective courses are *regular 200-level* and *regular 300-level courses*. The following rules apply:

- 3.0 credits have to be *CS* courses
- 6.0 credits have to be *CEMSE* courses
- 6.0 credits have to be BESE/CEMSE/PSE courses

Note that a student can take 15.0 credits of CS courses to fulfill this requirement.

M.Sc. Thesis

The thesis defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than four members. At least two of the required members must be KAUST faculty. The chair plus one additional faculty member must be affiliated with the student's program. This membership can be summarized as:

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty or approved research scientist	Outside program
4	Additional faculty or research scientist	Inside or outside KAUST

Notes:

- Members 1-3 are required, member 4 is optional
- Co-chairs may serve as member 2, 3, or 4, but may not be a research scientist
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 4 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 4

View a list of faculty and their affiliations here.

M.Sc. Non-Thesis

Students wishing to pursue the non-thesis option must complete a total of 12.0 capstone credits. All students must take exactly 6.0 credits of directed research (299). At the discretion of the program director, students may substitute some or all of the 6.0 directed research credits with *regular CS courses*. This exception is mainly intended for students who cannot find a directed research advisor despite their best efforts.

Students must complete the remaining 6.0 credits through one or a combination of the options listed below:

- IED 210 Technology Innovation and Entrepreneurship
- IED 220 New Venture and Product Innovation Challenge
- CS 295 Internship
- Regular 300-level courses. One 300 level course can be a regular BESE/CEMSE/PSE course. An eventual second 300-level course has to be a regular CEMSE course.

Ph.D. Program

The Doctor of Philosophy (Ph.D.) degree is designed to prepare students for research careers in academia and industry.

There is a minimum residency requirement at KAUST of three and a half years for students entering with a bachelor's degree and two and a half years for students entering with a master's degree. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit.

The Ph.D. degree includes the following steps:

- Securing a academic advisor
- Successful completion of program coursework
- Passing the qualifying examination
- Passing the dissertation proposal defense to obtain candidacy status
- Preparing, submitting and successfully defending a doctoral dissertation

Ph.D. Course Requirements

The required coursework varies for students entering the Ph.D. degree with a bachelor's degree or a relevant master's degree. Students holding a bachelor's degree must complete all program core/mandatory courses and elective courses outlined in the master's degree section and are also required to complete the Ph.D. courses below. Students entering with a bachelor's degree will qualify to earn a master's degree by satisfying the master's degree requirements.

Students entering the Ph.D. degree with a relevant master's degree must complete the requirements below, though additional courses may be required by the academic advisor and the qualifying exam.

Ph.D. Courses

- Two 300-level courses: one course can be a BESE/CEMSE/PSE course; one needs to be a CS course.

Ph.D. Qualifying Examination

The qualifying examination (qualifier) is course based. Students have to pass four courses to pass the qualifier:

- Two courses are for the depth requirement and two courses for the breadth requirement.
- The two courses for the depth requirement have to be in the area of specialization and close to the area of the student's research.
- The two courses for the breadth requirement have to be in an area outside of the specialization and should be sufficiently different from the depth requirement courses.
- The two courses for the depth requirement have to be passed with a grade of A- or A.
- The two courses for the breadth requirement have to be passed with a grade of B+ or better.
- Three courses need to be CS courses. One course for the depth requirement can be a BESE/CEMSE/PSE course.
- The courses can be regular 200 level or 300 level courses.
- One of the courses needs to have a substantial programming component.

The procedure for the qualifier is as follows:

- Upon entry into the Ph.D. program, students need to discuss the selection of the four courses with the academic adviser. Students can provide input, but the academic adviser is ultimately deciding on the course list.
- Within the first two weeks of classes, students need to submit the list of four courses to the GPC together with the approval of the advisor. The list needs to specify which two courses are for the depth requirement and which courses are for the breadth requirement.
- The GPC then runs the list by the program director and dean/associate dean for approval.
- The courses cannot be changed during the semester. If students fail a course or has not attempted to take a course, then they can submit a change of courses between semesters in the same manner as above.
- M.Sc./Ph.D. students can use courses obtained during their M.Sc. studies to count towards their qualifier.
- If students fail to meet the requirements after three regular semesters in the Ph.D. program they will be dismissed from the program.

Ph.D. Candidacy

In addition to the coursework requirements, students must successfully complete the required Ph.D. candidacy milestones to progress towards Ph.D. candidate status. Once students have advanced to candidacy, students are designated as Ph.D. or doctoral candidates.

Ph.D. Proposal Defense Committee

The Ph.D. dissertation proposal defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than six members. The chair, plus one additional faculty member must be affiliated with the student's program.

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty	Outside program
4	Approved research scientist	Inside KAUST

Notes:

- Members 1-3 are required, member 4 is optional
- Co-chairs may serve as members 2 or 3
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2 or 3 depending upon their affiliation with the student's program, they may also serve as co-chairs

Once constituted, the composition of the proposal committee can only be changed with the approval of both the academic advisor and the dean.

View a list of faculty and their affiliations here.

Ph.D. Final Defense Committee

The Ph.D. dissertation defense committee, which must be approved by the dean, must consist of at least four members and typically includes no more than six members. At least three of the required members must be KAUST faculty and one must be an external examiner who is external to KAUST. The chair, plus one additional faculty member must be affiliated with the student's program. The external examiner is not required to attend the defense, but must write a report on the dissertation and may attend the dissertation defense at the discretion of the program.

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty	Outside program
4	External examiner	Outside KAUST
5	Approved research scientist	Inside KAUST

6	Additional faculty	Inside or outside KAUST

Notes:

- Members 1-4 are required, members 5 and 6 are optional
- Co-chairs may serve as either members 2, 3 or 6
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 6 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 6, but not as the external examiner

The only requirement with commonality with the proposal committee is the academic advisor, although it is expected that other members will carry forward to this committee.

Co-supervisors can be considered one of the above four members required, provided they come under the categories listed (i.e. meets the requirements of the position).

View a list of faculty and their affiliations here.

Electrical Engineering (EE)

Aims and Scope

Electrical Engineering (EE) plays an important role in the fields of engineering, applied physics and computational sciences. A significant portion of advancement in technology originates from cutting-edge research performed in the field of EE. At KAUST the EE program is bound to this tradition: it aims for preparing students for a multitude of professional paths and advancing world-class research and research-based education through interdisciplinary partnering within engineering and science.

The EE program encompasses technical areas of solid-state electronics, microsystems, electromagnetics, photonics, communication, networking, signal processing, computer vision and control.

M.Sc. Program

It is the responsibility of students to plan their graduate program in consultation with their academic advisor. Students are required to meet all deadlines. Students should be aware that most core courses are offered only once per year.

The Master of Science (M.Sc.) degree is awarded upon successful completion of a minimum of 36 credit hours. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit. Students are expected to complete the M.Sc. degree in three semesters. Satisfactory participation in every KAUST summer session is mandatory.

The M.Sc. Requirements:

- Core courses (12.0 credits)
- Elective courses (12.0 credits)
- Research/capstone experience (12.0 credits)
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for the first two semesters
- Completion of one Winter Enrichment Program (WEP)

Core Courses (12.0 credits)

This portion of the degree is designed to provide students with the background needed to establish a solid foundation in the program area:

Core Courses:

- EE 202, EE206, EE 208, EE 221, EE 231, EE 242, EE 251, and EE 271A
- AMCS 211, AMCS 241

Elective Courses (12.0 credits)

One additional elective course (3.0 credits) in EE. Courses from any EE track can be used to fulfill this requirement. Two additional courses (6.0 credits) from any 200- or 300-level course in any degree program at KAUST. If a core course is from AMCS or STAT, then this course can fulfill the applied mathematics/statistics requirement. In this case, the elective curriculum requirement would need to increase to four courses (12.0 credits). Course selection process, including core courses, applied mathematics/statistics requirement, and elective EE courses, should be done with the consent of the academic advisor. Students must also register for EE 398 (non-credit seminar course) for the first two semesters of the degree program.

The elective courses (which exclude research, internship credits, and IED courses) are designed to allow students to tailor their educational experience to meet individual research and educational objectives, with the permission of the academic advisor.

M.Sc. Thesis

The thesis defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than four members. At least two of the required members must be KAUST faculty. The chair plus one additional faculty member must be affiliated with the student's program. This membership can be summarized as:

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty or approved research scientist	Outside program
4	Additional faculty or research scientist	Inside or outside KAUST

Notes:

- Members 1-3 are required, member 4 is optional
- Co-chairs may serve as member 2, 3, or 4, but may not be a research scientist
- Members 2 and 3 must use primary affiliation only
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 4 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 4

View a list of faculty and their affiliations here.

M.Sc. Non-Thesis

Students wishing to pursue the non-thesis option must complete a total of 12.0 capstone credits, with a minimum of 6.0 credits of directed research (299).

Students must complete the remaining credits through one or a combination of the options listed below:

- Broadening experience courses: courses that broaden a student's M.Sc. experience (maximum 6.0 credits can be applied to master degree requirements)
- Internship: research-based summer internship (295) – students are only allowed to take one internship
- Ph.D. courses: courses numbered at the 300 level
- Directed research (299) – master's level supervised research (maximum 6.0 credits can be applied to master degree requirements)

Ph.D. Program

The Doctor of Philosophy (Ph.D.) degree is designed to prepare students for research careers in academia and industry..

There is a minimum residency requirement at KAUST of three and a half years for students entering with a bachelor's degree and two and a half years for students entering with a master's degree. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit.

The Ph.D. degree includes the following steps:

- Securing an academic advisor
- Successful completion of program coursework
- Passing the qualifying examination
- Passing the dissertation proposal defense to obtain candidacy status
- Preparing, submitting and successfully defending a doctoral dissertation

Ph.D. Course Requirements

The required coursework varies for students entering the Ph.D. degree with a bachelor's degree or a relevant master's degree. Students holding a bachelor's degree must complete all program core/mandatory courses and elective courses outlined in the master's degree section and are also required to complete the Ph.D. courses below. Students entering with a bachelor's degree will qualify to earn a master's degree by satisfying the master's degree requirements.

Students entering the Ph.D. degree with a relevant M.Sc. degree must complete the requirements below, though additional courses may be required by the academic advisor.

Ph.D. Courses

- At least two 300-level courses
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for the first two semesters
- Winter Enrichment Program (WEP) – students who completed WEP while earning the M.Sc. are not required to enroll in a full WEP for a second time during the Ph.D.

Ph.D. Candidacy

In addition to the coursework requirements, students must successfully complete the required Ph.D. candidacy milestones to progress towards Ph.D. candidate status. These milestones consist of the subject-based qualifying examination and Ph.D. proposal defense. Once students have advanced to candidacy, students are designated as Ph.D. or doctoral candidates.

Students have up to two attempts to pass the Ph.D. qualifying exam, which must be taken within the first year of their Ph.D. studies.

Ph.D. Proposal Defense Committee

The Ph.D. dissertation proposal defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than six members. The chair, plus one additional faculty member must be affiliated with the student's program.

Member	Role	Program Status
1	Chair	Within program
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Notes:

- Members 1-3 are required, member 4 is optional
- Co-chairs may serve as members 2 or 3
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- Professors of practice and research professors may serve as members 2 or 3 depending upon their affiliation with the student's program, they may also serve as co-chairs

Once constituted, the composition of the proposal committee can only be changed with the approval of both the academic advisor and the dean.

View a list of faculty and their affiliations here.

Ph.D. Final Defense Committee

The Ph.D. dissertation defense committee, which must be approved by the dean, must consist of at least four members and typically includes no more than six members. At least three of the required members must be KAUST faculty and one must be an external examiner who is external to KAUST. The chair, plus one additional faculty member must be affiliated with the student's program. The external examiner is not required to attend the defense, but must write a report on the dissertation and may attend the dissertation defense at the discretion of the program.

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- Visiting professors may serve as member 6, but not as the external examiner

The only requirement with commonality with the proposal committee is the academic advisor, although it is expected that other members will carry forward to this committee.

Co-supervisors can be considered one of the above four members required, provided they come under the categories listed (i.e. meets the requirements of the position).

View a list of faculty and their affiliations here.

Statistics (STAT)

Aims and Scope

The Statistics (STAT) program educates students to analyze and model complex real-world problems arising in modern statistical data science. Two degrees are offered: the M.Sc. degree (under either a thesis or a non-thesis option) and the Ph.D. degree. Admission to one degree does not guarantee transfer to another. All students in the M.Sc. and Ph.D. programs are guided by an academic advisor to develop their program of study.

M.Sc. Program

Assessment Test

Students are admitted to KAUST from a wide variety of programs and backgrounds. To facilitate the design of an appropriate study plan for each individual student, all admitted students without an M.Sc. are required to take a written assessment exam when they arrive on campus. The purpose of the assessment is to determine whether students have mastered the prerequisites for undertaking graduate-level courses taught in the program. The academic advisor works with admitted students to develop a study plan if needed. Students are encouraged to prepare for the assessment by refreshing the general knowledge gained from their undergraduate education before arriving at KAUST. The study plan requirements must be satisfactorily completed, in addition to the university degree requirements. The topics covered by the assessment test are: calculus of one and multiple variables, linear algebra, probability, and statistics, at an undergraduate level.

It is the responsibility of students to plan their graduate program in consultation with their academic advisor. Students are required to meet all deadlines. Students should be aware that most core courses are offered only once per year.

The Master of Science (M.Sc.) degree is awarded upon successful completion of a minimum of 36 credit hours. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit. Students are expected to complete the M.Sc. degree in three semesters. Satisfactory participation in every KAUST summer session is mandatory.

The M.Sc. Requirements:

- Core courses (12.0 credits)
- Elective courses (12.0 credits)
- Research/capstone experience (12.0 credits)
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for the first two semesters
- Completion of one Winter Enrichment Program (WEP) – typically during the first year of enrollment

Core Courses (12.0 credits)

Students enrolled toward the M.Sc. degree are required to complete the following 12.0 credits of core courses:

- STAT 220 Probability and Statistics
- STAT 230 Linear Models
- STAT 240 Bayesian Statistics
- STAT 250 Stochastic Processes

The core courses are designed to cover the basic skills and competencies that are expected of students holding an advanced degree. STAT 220, 230, 250 are part of the Ph.D. qualifying examination.

Elective Courses (12.0 credits)

The elective courses (which exclude research, internship credits, and IED courses) are designed to allow students to tailor their educational experience to meet individual research and educational objectives, with the permission of the academic advisor.

Students enrolled toward the M.Sc. degree are required to complete 12.0 credits of elective courses. Courses from other programs can be taken as elective courses as agreed with the academic advisor. Relevant courses from faculty affiliated to the STAT program are listed below (but not limited to):

- AMCS 206 Applied Numerical Methods
- AMCS 211 Numerical Optimization
- AMCS 308 Stochastic Numerics with Application in Simulation and Data Science
- AMCS 336 Numerical Methods for Stochastic Differential Equations
- AMCS 350 Spectral Methods for Uncertainty Quantifications

- CS 207 Programming Methodology and Abstractions
- CS 220 Data Analytics
- CS 229 Machine Learning
- CS 320 Probabilistic Graphical Models
- CS 340 Computational Methods in Data Mining
- CS 390FF Special Topics in Data Sciences
- CS 394D Contemporary Topics in Machine Learning

- EE 242 Digital Communications and Coding
- EE 251 Digital Signal Processing and Analysis
- EE 341 Information Theory
- EE 353 Adaptive Signal Processing
- EE 354 Introduction to Computer Vision
- EE 355 Estimation, Filtering and Detection

- ErSE 213 Inverse Problems
- ErSE 253 Data Analysis in Geosciences
- ErSE 353 Data Assimilation

Note: For STAT students, STAT 210 can only be taken on a pass/fail basis. Moreover, at most one course among AMCS 201, 202, 206 can be taken on a letter grade basis with approval of the academic advisor (students must declare that at the beginning of the semester at the time of registration). STAT Ph.D. students cannot take any of the STAT 210, AMCS 201, 202, 206 courses on a letter grade basis.

M.Sc. Thesis

The thesis defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than four members. At least two of the required members must be KAUST faculty. The chair plus one additional faculty member must be affiliated with the student's program. This membership can be summarized as:

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty	Outside program, Inside KAUST
4	Additional faculty or research scientist	Inside or outside KAUST

Notes:

- Members 1-3 are required, member 4 is optional
- Co-chairs may serve as member 2, 3, or 4, but may not be a research scientist
- Members 2 and 3 must use primary affiliation only
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 4 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 4

View a list of faculty and their affiliations here.

M.Sc. Non-Thesis

Students wishing to pursue the non-thesis option must complete a total of 12.0 capstone credits, with a maximum of 6.0 credits of directed research (299).

Students must complete the remaining credits through one or a combination of the options listed below:

- Broadening experience courses: courses that broaden a student's M.Sc. experience
- Internship: research-based summer internship (295) – students are only allowed to take one internship
- Ph.D. courses: courses numbered at the 300 level

Ph.D. Program

The Doctor of Philosophy (Ph.D.) degree is designed to prepare students for research careers in academia and industry.

There is a minimum residency requirement at KAUST of three and a half years for students entering with a bachelor's degree and two and a half years for students entering with a master's degree. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit.

The Ph.D. degree includes the following steps:

- Securing an academic advisor
- Successful completion of program coursework
- Passing the qualifying examination
- Passing the dissertation proposal defense to obtain candidacy status
- Preparing, submitting and successfully defending a doctoral dissertation

Ph.D. Course Requirements

The required coursework varies for students entering the Ph.D. degree with a bachelor's degree or a relevant master's degree. Students holding a bachelor's degree must complete all program core/mandatory courses and elective courses outlined in the master's degree section and are also required to complete the Ph.D. courses below. Students entering with a bachelor's degree will qualify to earn a master's degree by satisfying the master's degree requirements.

Students entering the Ph.D. degree with a relevant M.Sc. degree must complete the requirements below, though additional courses may be required by the academic advisor.

Ph.D. Courses

- At least four courses of which at least two must be from the STAT 300 level course list. Courses have to be approved by the academic advisor. Core courses, 100-level courses, or courses taken during and used toward the M.Sc. degree cannot be used to fulfill this requirement.
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for the first two semesters
- Winter Enrichment Program (WEP) – students who completed WEP while earning the M.Sc. are not required to enroll in a full WEP for a second time during the Ph.D.

Ph.D. Candidacy

In addition to the coursework requirements, students must successfully complete the required Ph.D. candidacy milestones to progress towards Ph.D. candidate status. These milestones consist of the subject-based qualifying examination and Ph.D. proposal defense. Once students have advanced to candidacy, students are designated as Ph.D. or doctoral candidates.

Subject-Based Qualifying Examination

The qualifying exam consists of three written subject exams, one in each of the core courses STAT 220, 230, 250. It is given twice per year: during the final exams of the fall semester and immediately after the final exams of the spring semester, or as feasible. The fall semester qualifying exam is the final exam of each of the core courses given during the fall semester. The spring semester exam is a 3-hour exam per subject prepared by the faculty teaching the core courses. The exams are given over the course of a few days in both spring and fall.

Students are encouraged to take all three (3) qualifiers in their first semester of the Ph.D. program. Students have two chances to take each exam and can retake only those exams they did not pass. They are required to pass all three qualifying exams within one year. No extension is given except under extenuating circumstances. Each exam is passed if students obtain a score of at least 70% in that exam. If students at the end of the first year of Ph.D. have only passed 2 out of 3 qualifiers then the case is reviewed by the qualifying exam committee and it is decided if students can proceed with the Ph.D. For more details related to the Ph.D. qualifying exam, contact the STAT program coordinator.

It is the responsibility of students to inform the dissertation defense committee of their progress, deadlines for submitting graduation forms, the defense date, etc. It is required that students submit their dissertation to the STAT program coordinator nine weeks prior to the defense date in order to receive feedback from the committee members in a timely manner.

Note: M.Sc./Ph.D. students who pass the final exam of a qualifying exam course with a score of 70% or higher during their M.Sc. do not have to retake that exam during their Ph.D. as a qualifying exam. Moreover, exams taken during the M.Sc. do not count towards the two attempts, provided these correspond to courses in which students are enrolled. Students can choose to take the final exam for a course in which they are not enrolled. In that case, the exam counts towards the two attempts. The deadline to pass all qualifying exams is unchanged, one year after starting the Ph.D. regardless of the qualifying exams passed during the M.Sc.

Ph.D. Proposal Defense Committee

The Ph.D. dissertation proposal defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than six members. The chair, plus one additional faculty member must be affiliated with the student's program.

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty	Outside program, inside KAUST
4	Additional faculty or research scientist	Inside or outside KAUST

Notes:

- Members 1-3 are required, member 4 is optional
- Co-chairs may serve as members 2 or 3
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2 or 3 depending upon their affiliation with the student's program, they may also serve as co-chairs

Once constituted, the composition of the proposal committee can only be changed with the approval of both the academic advisor and the dean.

View a list of faculty and their affiliations here.

Ph.D. Final Defense Committee

The Ph.D. dissertation defense committee, which must be approved by the dean, must consist of at least four members and typically includes no more than six members. At least three of the required members must be KAUST faculty and one must be an external examiner who is external to KAUST. The chair, plus one additional faculty member must be affiliated with the student's program. The external examiner is not required to attend the defense, but must write a report on the dissertation and may attend the dissertation defense at the discretion of the program.

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty	Outside program
4	External examiner	Outside KAUST
5	Approved research scientist	Inside KAUST
6	Additional faculty	Inside or outside KAUST

Notes:

- Members 1-4 are required, members 5 and 6 are optional
- Co-chairs may serve as either members 2, 3 or 6

- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 6 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 6, but not as the external examiner

The only requirement with commonality with the proposal committee is the academic advisor, although it is expected that other members will carry forward to this committee.

Co-supervisors can be considered one of the above four members required, provided they come under the categories listed (i.e. meets the requirements of the position).

View a list of faculty and their affiliations here.

Division of Physical Science and Engineering (PSE)

The mission of the Physical Science and Engineering (PSE) division is to create knowledge pertaining to matter at all scales (nano, meso, macro) and in all forms (from bulk to divided colloids to fluids) and to seek understanding of the interaction of matter with external stimuli to design new materials/technologies addressing the issues of our times.

Research in the division includes areas such as theoretical physics and physical chemistry; catalysis and bioengineering; polymers and composites; energy production, storage and conversion; water purification and environmental protection; novel materials, nanodevices and systems; sensors and smart devices for the detection of pollutants and the purification of air, water, and food; earth sciences, mechanics and geomechanics; oil exploration and recovery; and CO2 sequestration.

Research in the PSE division is driven by independent faculty labs and five research centers with which faculty can affiliate to perform applied, goal-oriented research. Centers affiliated with the division include:

- Advanced Membranes and Porous Materials Research Center (AMPMC)
- Ali I. Al-Naimi Petroleum Engineering Research Center (ANPERC)
- Clean Combustion Research Center (CCRC)
- KAUST Catalysis Center (KCC)
- KAUST Solar Center (KSC)

PSE Programs

Applied Physics (AP)
Chemical Engineering (CE)
Chemical Science (ChemS)
Earth Science and Engineering (ErSE)
Energy Resources and Petroleum Engineering (ERPE
Mechanical Engineering (ME)
Material Science and Engineering (MSE)

Applied Physics (AP)

Aims and Scope

Faculty and students in the Applied Physics (AP) program at KAUST engage in interdisciplinary research at the interface between fundamental physical concepts and cutting-edge technologies. They strive for exploiting basic physical phenomena at the meso- and nanoscale to design innovative solutions in several applied physics specialties, such as optics and photonics, semiconductor devices, quantum electronics, and novel materials for energy applications.

The AP program for both M.Sc. and Ph.D. students aims at providing firm knowledge on basic science to apprehend the physics taking place at the meso- and nanoscale, and tools to apply this knowledge to nurture technological and scientific breakthroughs in applied physics. The program focuses on device physics, photonics, and quantum electronics. Students in this program receive broad training in basic scientific concepts in condensed matter physics, quantum mechanics, electrodynamics, and statistical physics. Students participate in scientific research activities that may include laboratory studies and computational modeling. Ph.D. candidates focus on original research driven to advance the boundaries of knowledge. Employability of AP graduates ranges from academic research institutions to R&D positions in high-tech industrial or entrepreneurial environments.

M.Sc. Program

The Master of Science (M.Sc.) degree is awarded upon successful completion of a minimum of 36 credit hours with a minimum of 3.0 cumulative GPA. Individual courses require a minimum of a B- for course credit. Students are expected to complete the M.Sc. degree in four semesters. Satisfactory participation in every KAUST summer semester is mandatory.

It is the sole responsibility of students to plan their graduate program in consultation with their academic advisor. Students should be aware that most core courses are offered only once per year.

Before students start creating their study plan, they will be required to take the program assessment test.

Assessment Test

Students are admitted to KAUST from a wide variety of programs and backgrounds. In order to facilitate the design of an appropriate study plan for each individual student, all M.Sc. and M.Sc./Ph.D. incoming students will be required to take an assessment during orientation week. There is no grade for the assessment. The purpose of the assessment is to determine whether students have mastered the prerequisites for undertaking graduate level courses taught in the program. The academic advisor uses the results of the assessments to design a study plan with a list of courses aimed to help the students to complete successfully the degree requirements. More information regarding the assessment test is available on AP Academics webpage.

M.Sc. Degree Requirements

The M.Sc. degree has the following components:

- Core courses (12.0 credits)
- Elective courses (12.0 credits)
- Graduate seminar (AP 398) (non-credit)
- Completion of one Winter Enrichment Program (WEP)
- Research/capstone experience (12.0 credits)

Core Courses (12.0 credits)

The AP core courses are designed to provide students with the background needed to establish a solid foundation in the program area. M.Sc. students are required to complete 12.0 credits (four courses) to fulfill the core requirements. Students must take the following four courses:

AP Core Courses

EE 221 – Electromagnetic Theory
MSE 225 - Electronic Properties of Materials
AP 220 – Statistical Physics
AP 228 – Advanced Quantum Mechanics

Elective Courses (12.0 credits)

The elective courses are designed to allow students to tailor their educational experience to meet individual research and educational objectives with the permission of the academic advisor. Electives can be selected from either AP or any other related program.

The following list of courses contains those courses most appropriate to complete the AP degree, organized by themes. Students may select four courses from any 200 or 300 level courses. Research credits, internship credits, and IED courses will not count toward electives.

Fundamentals in Physics

- MSE 226 - Thermodynamics & Equilibrium Processes
- MSE 227 - Applied Quantum Mechanics
- AP 230 - Condensed Matter Physics
- ME 308 - Introduction to Plasma Physics and Magneto-hydrodynamics

Experimental Techniques and Characterization

- EE 203 - Solid-State Devices Fabrication
- EE 390 Solid State Devices Laboratory
- AP 210 - Spectroscopy of Solids
- ME 348 - Introduction to Spectroscopy and Laser Diagnostics
- MSE 307 - Materials Characterization

- MSE 315 - Thin Film Science and Engineering

Materials

- MSE 228 – Biomaterials
- MSE 229 - Polymeric Materials
- MSE 310 - Materials and Energy
- MSE 311 - Soft Materials
- MSE 313 - Functional Oxides
- MSE 316 - Magnetic Materials
- MSE 318 - Nanomaterials
- MSE 320 - Solar Cell Materials and Devices
- MSE 322 - Semiconductor Materials
- MSE 324 – Photophysics of Organic Semiconductors
- ME 317 A, B – Mechanics of Composite Materials and Structures

Device Physics

- AP 320 - Introduction to Nanoelectronics
- AP 390 – Contemporary Topics in Applied Physics
- EE 206 - Device Physics
- EE 306 - Electronic and Optical Properties of Semiconductors

Optoelectronics and Photonics

- EE 231 - Principles of Optics
- EE 208 - Semiconductor Optoelectronic Devices
- EE 332 - Lasers
- EE 390B - Special Topics in Solid State Devices
- MSE 321 - Optical Properties of Materials

Theoretical and Computational Physics

- AMCS 201 - Applied Mathematics I
- AMCS 202 - Applied Mathematics II
- AMCS 231 - Applied Partial Differential Equations I
- AMCS 331 - Applied Partial Differential Equations II
- AMCS 252 - Numerical Analysis of Differential Equations
- AMCS 255 - Advanced Computational Physics
- CS 229 – Machine Learning
- AP 330 - Many-Body Theory in Condensed Matter
- MSE 314 - Ab-initio Computational Methods
- AMCS 353 - Advanced Topics in Wave Propagation
- ME 305 A, B – Computational Fluid Dynamics
- ME 319 A, B – Computational Solid Mechanics

Graduate Seminar (AP 398)

M.Sc. students are required to register in three AP graduate seminars and receive a satisfactory grade to fulfill the seminar requirements for M.Sc. degree.

Winter Enrichment Program

Students are required to satisfactorily complete at least one full Winter Enrichment Program (WEP).

Research/Capstone Experience (12.0 credits)

Designation of Academic Advisor

The first step for students applying for thesis is to identify an M.Sc. academic (thesis) advisor. Students are required to select a faculty member affiliated with the program to supervise the thesis research. The list of faculty members affiliated with the AP program is available on the Applied Physics program main page, click here.

Students may choose to do thesis research with a non-affiliated faculty member. The potential non-affiliated academic (thesis) advisor must request the program's approval to become a project-affiliated advisor for the specific thesis project before commencing the research work.

Thesis Credits Registration

Students are required to complete a minimum of 12.0 credits of thesis research (AP 297). Students are permitted to register for more than 12.0 credits of M.Sc. thesis research as necessary and with the permission of the academic (thesis) advisor.

M.Sc. Thesis Timeline and Extension

M.Sc. students and their academic advisors need to define the thesis timeline at the time the thesis application is submitted. Students are expected to complete the M.Sc. thesis degree requirements by the end of their second fall semester (third semester).

M.Sc. students may apply to extend into the spring semester (fourth semester) by submitting the request for extension to complete the M.Sc. thesis.

Thesis Defense and Submission

M.Sc. students are expected to form a thesis examination committee, submit a written thesis document, and defend their thesis to complete the thesis research requirements.

M.Sc. Thesis Committee Formation

Once the thesis is ready to be examined/defended, students have to form the thesis examination committee and set the date for the oral defense.

Students are required to submit the thesis formation committee form at the beginning of the semester in which they intend to defend their thesis.

Thesis Committee Members Selection Criteria

The thesis defense committee must consist of at least three members and typically includes no more than four members as:

Member	Role	Program Status
1	Committee Chair	Affiliated faculty member
2	KAUST faculty	Affiliated faculty member
3	KAUST faculty	Non-affiliated faculty member
4	Additional faculty or research scientist	Inside or outside KAUST

Notes:

- Members 1-3 are required, member 4 is optional
- Member 1: committee chair must be AP faculty member or KAUST faculty member affiliated with AP program
- Member 2: must be AP faculty member
- Member 3: KAUST faculty member not affiliated with the program
- Co-chairs may serve as member 2, 3, or 4, but may not be a research scientist
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 4 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 4

Thesis Defense

An oral defense of the M.Sc. thesis is required, although it may be waived by the dean's office under exceptional circumstances. Public presentation and all other details related to the format of the oral defense are left to the discretion of the thesis committee.

The oral thesis defense must be completed two weeks before the last day of classes of the graduating semester. Students must set the date of the thesis defense with the committee members by the time students submit their thesis committee formation form.

Thesis Document

Students must follow the KAUST Thesis and Dissertation Guidelines available on the KAUST Library website when they write their thesis.

The division urges students to submit the thesis to the examining committee no later than two weeks prior to the defense. However, the committee chair sets the final requirement for the submission timeline.

Thesis Defense Evaluation

Students defending their thesis will receive one of these two outcomes, pass or fail. A pass is achieved when the committee agrees with no more than one dissenting vote, otherwise the outcome is a fail.

In case of a pass, students are required to send a copy of the M.Sc. thesis approval form within two days after the thesis defense to the GPC.

In the case of a fail, the academic (thesis) advisor must inform the GPC immediately to take the necessary action.

Ph.D. Program

The Doctor of Philosophy (Ph.D.) degree is designed to prepare students for research careers in academia and industry. It is offered exclusively as a full-time program.

There is a minimum residency requirement at KAUST of three and a half years for students entering with a bachelor's degree and two and a half years for students entering with a master's degree. A minimum GPA of 3.0 must be achieved to graduate.

The Ph.D. degree includes the following steps:

- Securing an academic advisor
- Successful completion of program coursework
- Passing the qualifying exam
- Passing the dissertation proposal defense to obtain candidacy status
- Preparing, submitting, and successfully defending a doctoral dissertation

Designation of Academic Advisor

The academic advisor must be a full-time program-affiliated assistant, associate or full professor at KAUST. The list of faculty members affiliated with AP program is available on the program website.

Students may also select a non-affiliated advisor from another program at KAUST. The academic advisor may request to become a project-affiliated advisor for the specific dissertation project with program level approval. Project affiliation approval must be completed prior to commencing research.

Ph.D. Course Requirements

The required coursework varies for students entering the Ph.D. degree with a bachelor's degree or a relevant master's degree. Students holding a bachelor's degree must complete all program core/mandatory courses and elective courses outlined in the master's degree section and are also required to complete the Ph.D. courses below. Students entering with a bachelor's degree will qualify to earn a master's degree by satisfying the master's degree requirements.

Students entering the Ph.D. degree with a relevant master's degree must complete the requirements below, though additional courses may be required by the academic advisor.

Ph.D. Courses

- At least two 300-level courses, including AP 300 – Research Methodology in Applied Physics. Individual courses require a minimum of a B- for course credit.
- Graduate seminar AP 398 (non-credit) – all students are required to register and receive a satisfactory grade for four semesters of the program's graduate seminar.
- Winter Enrichment Program (WEP) – students are required to satisfactorily complete at least one full Winter Enrichment Program (WEP). Students who completed WEP while earning the M.Sc. are not required to enroll in a full WEP for a second time during the Ph.D.

Students entering the program with an M.Sc. degree from KAUST may transfer unused coursework toward the Ph.D. program requirements subject to program level approval. Students transferring from another university's Ph.D. program may receive some dissertation research and coursework credit on a case-by-case basis for related work performed at the original institution upon approval by the dean. However, such students must still satisfy the qualifying exam and dissertation proposal defense requirements at KAUST.

Ph.D. Candidacy

In addition to the coursework requirements, students must successfully complete the required Ph.D. qualification milestones to progress towards Ph.D. candidacy status. These milestones consist of the subject-based qualifying exam and Ph.D. proposal defense.

Ph.D. Qualifying Exam

The purpose of the subject-based qualifying exam is to test students' knowledge of the subject matter within the field of study.

All students entering the Ph.D. program with a bachelor's degree must take this exam within two years of their admission. Students admitted to the program with a master's degree must take this exam within one year.

The requirements to complete the AP qualifying exam are available on AP academics webpage.

Ph.D. Dissertation Proposal

The dissertation proposal defense is the second part of the qualification milestones that must be completed to become a Ph.D. candidate. The purpose of the dissertation proposal defense is to demonstrate that students have the ability and are adequately prepared to undertake Ph.D. level research in the proposed area. This preparation includes necessary knowledge of the chosen subject, a review of the literature, and preparatory theory or experiments as applicable.

Ph.D. students are required to complete the dissertation proposal defense within one year after passing the qualifying exam. The proposal defense date will be determined by students and their academic advisor.

Ph.D. students are expected to form the Ph.D. dissertation proposal defense committee and present the dissertation proposal.

Formation of Ph.D. Proposal Defense Committee

Ph.D. students must submit the request to form the dissertation committee and present a Ph.D. proposal two weeks prior to the Ph.D. proposal defense date.

The Ph.D. dissertation proposal defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than five members. The criteria to select the committee members are as follows:

Member	Role	Program Status
1	Chair	Affiliated faculty member
2	Faculty	Affiliated faculty member
3	Faculty	Non-affiliated faculty member
4	Faculty	Inside KAUST (optional)
5	Faculty	Inside or Outside KAUST (optional)

Notes:

- Members 1-3 are required, members 4 and 5 are optional
- Co-chairs may serve as members 2 or 3
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2 or 3 depending upon their affiliation with the student's program, they may also serve as co-chairs

Once constituted, the composition of the proposal committee can only be changed with the approval of both the academic advisor and the dean.

Ph.D. Dissertation Proposal Defense

The dissertation proposal defense includes two aspects: a written research proposal and an oral research proposal defense.

There are four possible outcomes of the dissertation proposal defense:

- Pass
- Pass with conditions
- Fail with retake

- Fail without retake

A pass is achieved when the committee agrees with no more than one dissenting vote, otherwise the outcome is a fail. Students who successfully pass the dissertation proposal defense are deemed Ph.D. candidates.

In the instance of a pass with conditions, the entire committee must agree on the required conditions and if they cannot, the dean decides. The deadline to complete the conditions is one month after the defense date, unless the committee unanimously agrees to change it.

The deadline to complete the retake is six months after the defense date, unless the committee unanimously agrees to reduce it. Students who fail the retake will be dismissed from the University.

In the instance of a fail without retake, the decision of the committee must be unanimous. Students who fail the proposal will be dismissed from the University.

The outcome of the Ph.D. dissertation proposal defense is recorded by submitting the Ph.D. dissertation proposal evaluation form within three days after the proposal defense date.

Ph.D. Dissertation Final Defense

The Ph.D. dissertation defense is the final milestone of the degree. Ph.D. students are required to complete the following to earn the degree:

- Form Ph.D. dissertation committee and petition to defend Ph.D. dissertation
- Defend Ph.D. dissertation
- Submit Ph.D. dissertation

Petition to Defend Ph.D. Dissertation and Formation of Dissertation Committee

Students must determine the defense date with agreement of all the members of the dissertation committee, meet deadlines for submitting graduation forms, and inform the committee of their progress. It is the responsibility of students to submit the required documents at the beginning of the semester they intend to defend, or two months before the date of the final defense. It is also expected that students submit their written dissertation to the committee about the same time as submitting the petition form.

Formation of Ph.D. Final Defense Committee

The Ph.D. dissertation defense committee, which must be approved by the dean, must consist of at least four members, one of which must be an external to KAUST, and typically includes no more than six members. At least three of the required members must be KAUST faculty and one must be an examiner who is external to KAUST. The chair, plus one additional faculty member, must be affiliated with the student's program. The external examiner is not required to attend the defense, but must write a report on the dissertation, assessing the quality of the research and scientific maturity of the student and including recommendations and questions prior to the final defense. The external examiner may attend the dissertation defense at the discretion of the program.

The criteria to select the committee members are as follows:

Member	Role	Program Status
1	Chair	Affiliated faculty member
2	Faculty	Affiliated faculty member
3	Faculty	Non-Affiliated faculty member
4	External examiner	Outside KAUST
5	Approved research scientist	Inside KAUST (optional)
6	Additional faculty	Inside or outside KAUST (optional)

Notes:

- Members 1-4 are required, members 5 and 6 are optional
- Co-chairs may serve as either members 2, 3 or 6
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 6 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 6, but not as the external examiner

The only requirement with commonality with the proposal committee is the academic advisor, although it is expected that other members will carry forward to this committee.

Co-supervisors can be considered one of the above four members required, provided they come under the categories listed (i.e. meets the requirements of the position).

View a list of faculty and their affiliations here.

Ph.D. Dissertation Defense

The Ph.D. dissertation final defense is a public presentation that consists of an oral defense followed by Q&A and committee examination. The defense may last a maximum of three hours.

There are four possible outcomes of the dissertation final defense:

- Pass

- Pass with conditions
- Fail with retake
- Fail without retake

A pass is achieved when the committee agrees with no more than one dissenting vote, otherwise the outcome is a fail.

In the instance of a pass with conditions, the entire committee must agree on the required conditions and if they cannot, the dean decides. The deadline to complete the conditions is one month after the defense date, unless the committee unanimously agrees to change it.

The deadline to complete the retake is six months after the defense date, unless the committee unanimously agrees to reduce it. Students who fail the retake will be dismissed from the University.

In the instance of a fail without retake, the decision of the committee must be unanimous. Students who fail the defense will be dismissed from the University.

The evaluation of the Ph.D. dissertation final defense is recorded by submitting the result of the Ph.D. dissertation defense examination form within three days after the defense date.

Ph.D. Dissertation Submission

Students are required to follow the KAUST Thesis and Dissertation Guidelines available on KAUST Library website when they write their dissertation.

Students may seek the help of the Writing Center for editorial assistance while writing their dissertation. Students can book a time by sending an email to Skills Lab, skillslab@kaust.edu.sa.

Once the post-examination corrections required by the dissertation committee and the format of the dissertation have been checked and finalized, Ph.D. students must submit the final draft of the dissertation to the program to conclude the submission process.

Chemical Engineering (CE)

Aims and Scope

The Chemical Engineering (CE) program aims to offer students opportunities to develop real-world solutions to global challenges by performing rigorous coursework studies and cutting-edge research in chemical engineering and biological engineering. These include the development of new materials and processes for gas and liquid separations, for water desalination, catalysis, sustainable energy and nanotechnology as well as the advancement of new ideas in process design and control and reactor design.

M.Sc. Program

It is the responsibility of students to plan their graduate program in consultation with their academic advisor. Students are required to meet all deadlines. Students should be aware that most core courses are offered only once per year.

The Master of Science (M.Sc.) degree is awarded upon successful completion of a minimum of 36 credit hours. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit. Students are expected to complete the M.Sc. degree in three semesters. Satisfactory participation in every KAUST summer session is mandatory.

The M.Sc. Requirements:

- Core courses (12.0 credits)
- Elective courses (12.0 credits)
- Research/capstone experience (12.0 credits)
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for every semester of the program they attend
- Completion of one Winter Enrichment Program (WEP)

Core Courses (12.0 credits)

To complete these twelve credit hours in CE, students should register for four core courses as listed below.

CE 201 – Chemical Thermodynamics
CE 202 – Advanced Transport Phenomena
CE 203 – Advanced Reaction Engineering
CE 336 – Membrane Science and Membrane Separation Processes

These core courses are designed to provide students with the background needed to establish a solid foundation in the program area.

Elective Courses (12.0 credits)

The elective courses (which exclude research, internship credits, and IED courses) are designed to allow students to tailor their educational experience to meet individual research and educational objectives, with the permission of the academic advisor.

M.Sc. Thesis

The thesis defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than four members. At least two of the required members must be KAUST faculty. The chair plus one additional faculty member must be affiliated with the student's program. This membership can be summarized as:

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty or approved research scientist	Outside program
4	Additional faculty or research scientist	Inside or outside KAUST

Notes:

- Members 1-3 are required, member 4 is optional
- Co-chairs may serve as member 2, 3, or 4, but may not be a research scientist
- Members 2 and 3 must use primary affiliation only
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 4 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 4

View a list of faculty and their affiliations here.

Ph.D. Program

The Ph.D. degree includes the following major steps (typical deadlines are specified below):

1. Securing an academic advisor
2. Successful completion of program coursework
3. Passing the qualifying examination
4. Passing the dissertation proposal defense to obtain candidacy status
5. Preparing, submitting and successfully defending a doctoral dissertation

KAUST requires a minimum residence time for Ph.D. graduates of 3.5 years for students entering with a bachelor's degree, and 2.5 years for students entering with a master's degree. Correspondingly, the required coursework may change, depending on whether or not students enter the Ph.D. with a bachelor's or master's in the chosen field of study at KAUST.

Designation of Ph.D. Academic Advisor

The (dissertation) academic advisor is assigned to students upon admission. Academic advisors must be fulltime program-affiliated assistant, associate or full professors at KAUST. Students may also select an advisor from another program at KAUST. This advisor can only become project-affiliated for the specific dissertation project with program level approval. Project-affiliation approval must be completed prior to commencing research.

Ph.D. Course Requirements

The required coursework varies for students entering the Ph.D. Degree with a bachelor's degree or a relevant master's degree. Students holding a bachelor's degree must complete all program core/mandatory courses and elective courses outlined in the master's degree section and are also required to complete the Ph.D. courses below. Students entering with a bachelor's degree may also qualify to earn a master's degree by satisfying the master's degree requirements; however, it is student's responsibility to declare their intentions to graduate with a master's.

Students entering the Ph.D. degree with a relevant master's degree must complete the requirements below, though additional courses may be required by the academic advisor. Students entering the Ph.D. degree with a master's degree out of chemical engineering must complete the requirements below, and all program core/mandatory courses outlined in the master's degree section, as well as additional courses required by the academic advisor.

Ph.D. Courses

- Two 300-level courses
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for every semester the program requires they attend
- Winter Enrichment Program – students are required to satisfactorily complete at least one full Winter Enrichment Program (WEP) as part of the degree requirements. Students who completed WEP requirements while earning a master's degree are not required to enroll in a full WEP for a second time in the Ph.D. degree.

Students entering the program with an M.Sc. from KAUST may transfer unused coursework toward the Ph.D. program requirements, subject to program level approval. Students transferring from another university's Ph.D. program may receive some dissertation research and coursework credit (not more than six credits) on a case-by-case basis for related work performed at the original Institution upon approval by the dean. However, such students must still satisfy the qualifying exam and dissertation proposal defense requirements at KAUST.

Ph.D. Candidacy

In addition to the coursework requirements, students must successfully complete the following required Ph.D. qualification milestones to progress towards Ph.D. candidacy status. These milestones consist of the subject-based qualifying examination and the Ph.D. dissertation proposal defense.

Ph.D. Qualifying Exam

Once students successfully complete the coursework requirements (typically within their first Ph.D.-year at KAUST), they can register for the qualifying exam (Q.E.).

The exam will be carried out twice a year. Typically, one will be held one at the end of May or early of June, and the other at the beginning of the spring semester.

Ph.D. students with a bachelor's degree or master's degree out of the CE program are recommended to take the Q.E. after one full academic year of studies, and must accomplish all three Q.E. exams at the end of their second academic year. Ph.D. students with a master's degree in CE program can take the Q.E. exam at any time when it is available, and must accomplish all three Q.E. exams at the end of the second academic year.

The Q.E. exam will be announced by the CE curriculum committee two months in advance. Students who wish to attend the exam need to register for the exam through their GPC and must be approved by the CE curriculum committee.

CE Q.E. exam includes three subjects: transport phenomena, thermodynamics, and reaction engineering. Students need pass all three subjects.

In each subject, the format of the Q.E. exam typically includes one-hour written exam followed by one-hour oral exam. In the written exam, students will work on a number of questions independently. Students are allowed to bring one A4-sized sheet of personal notes and a non-programmable calculator, but no electronic devices (such as computers or cell phones). In the following oral exam, students will present the answers to the CE Q.E. exam committee which is typically composed of two CE faculty members. During the oral exam, the exam faculty members may ask questions related to the subject.

Outcome of the Q.E. include (1) pass of all three subjects; (2) pass of two subjects; (3) fail of two subjects; (4) fail of all three subjects. Students in situation (2) have one chance to retake the failed subject. Students in situation (3) and (4) have one chance and are required/expected to retake all three subjects. All retakes must be completed before the end of the second year of studies.

Once students have successfully completed the qualifying exam, they work towards the dissertation proposal defense under the supervision of the academic advisor. It is highly recommended that right after the successful completion of the Q.E., the process of periodic review meetings begins, between student, academic advisor and a (small, possibly adhoc) faculty committee.

Ph.D. Dissertation Proposal Defense

The dissertation proposal defense is the second part of the qualification milestones that must be completed to become a Ph.D. candidate. Ph.D. students are required to complete the dissertation proposal defense within one year after passing the qualifying exam.

The purpose of the dissertation proposal defense is to demonstrate that students have the ability and are adequately prepared to undertake Ph.D.- level research in the proposed area. This preparation includes necessary knowledge of the chosen subject, a review of the literature and preparatory theory or experiment as applicable.

The proposal includes a written proposal and an oral presentation. The written proposal should be less than six pages, which include (1) background and motivation; (2) aims and objectives; (3) research plan and methodology; (4) significance and potential impact; and (5) time schedule. The oral presentation includes 30 minutes oral presentation followed by a 30 minutes Q&A session. During the Q&A session, the committee can ask questions related to the proposed work, but may also related to general knowledge related to the field of studies.

The proposal defense is administered by GPC. Ph.D. students must submit a petition form to GPC that includes the list of faculties who will serve on the committee to take the dissertation proposal defense at the end of the semester preceding when they will defend their proposals. The petition must be approved by the dean (or its designee).

The committee for the Ph.D. dissertation proposal defense comprises the academic advisor(s) who will also serve as chair of the committee, one faculty member with primary affiliation to the program, one faculty member outside the program, and optionally an additional member from inside KAUST (faculty or a research scientist approved by the dean).

Member	Role	Program Status
1	Chair	Academic advisor(s)
2	Faculty	Within program
3	Faculty	Outside program
4	Approved research scientist	Inside KAUST

This committee should also make itself available for subsequent periodic review meetings with students (see below Section Ph.D. Evaluation Meetings). The composition of the committee could change upon the approval of both the academic advisor and the dean.

Outcomes of the proposal defense include (1) pass; (2) conditional pass with changes; (3) fail with retake; (4) fail. Students in the second case should submit the revised proposal within one month from the presentation. Students in the third case should retake the presentation within the allowed time frame set by the committee. Students in the last case will be dismissed from the university. Student who successfully pass the dissertation proposal defense are deemed Ph.D. candidates.

Ph.D. Dissertation Defense

To graduate, the Ph.D. candidate has to form a Ph.D. dissertation defense committee, finalize the Ph.D. dissertation and successfully defend the Ph.D. dissertation.It is the responsibility of students to inform the dissertation defense committee on the defense arrangements and scheduling, to submit the complete dissertation at least six weeks prior to the defense date to the committee, and to meet all university or program deadlines for submitting graduation forms to the GPC.

Timing of Activities Prior to Scheduling the Defense

In the semester prior to the semester in which students plan to defend, the Ph.D. candidate should submit the dissertation defense petition to the GPC, along with (i) the list of proposed committee members, including the external examiner, (ii) a pre-proposal evaluation signed by at least three faculty members (two of from students' program) that outline if the dissertation research satisfies KAUST requirements for a Ph.D. dissertation, (iii) a current CV, (iv) a current transcript, (v) a list of publications. The petition indicates the planned date of the defense, and needs to be submitted at the end of the semester prior to the semester in which the defense is planned. The petition is subject to the dean's approval

Composition and Duties of the Dissertation Committee

The Ph.D. dissertation defense committee must be approved by dean. The dissertation committee comprises at least four members with qualified positions and background; at least two should be faculty members with primary affiliation within CE program, and at least one from outside of CE program; one should be outside of KAUST (the external committee member).

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program

3	Faculty	Outside program
4	External examiner	Outside KAUST
5	Approved research scientist	Inside KAUST
6	Additional faculty	Inside or outside KAUST

Academic advisors and students choose the external examiner, and supply supporting information (CV, publication record) to the dean for approval. The external committee member must be a leader in the field of the Ph.D. topic, and must agree to supply a written report on the Ph.D. dissertation. The external examiner should attend the dissertation defense in person; if this is not possible, a remote participation via video-conference is acceptable.

All Committee members must approve in writing (to the dean; 1-2 paragraph letter or email) two weeks prior to scheduling the Ph.D. defense that the dissertation is of sufficient quality to be defended.

The chair of the dissertation committee can be any committee members suggested by the academic advisor and approved by the dean, but not the academic advisor(s). The chair of the dissertation committee manages the dissertation defense, introduces the Ph.D. candidate, the committee, and explains the rules for the dissertation defense. The chair guides through the Q&A session, defines the order in which the examiners ask questions, ensures equal time allocation for each examiner to ask questions, and is responsible for a fair, transparent, non-hostile, defense and scientific debate between the Ph.D. candidate and the examiners. After the defense, the chair reports to the dean on the process and outcome of the defense.

Expectations on the Ph.D. Dissertation

The written dissertation is required to comply with the University formatting guidelines, which are on the library website.

- The complete version of the dissertation has to be sent to the dissertation defense committee at least six weeks prior to the targeted defense date.
- The PhD. dissertation must be written in fluent high-quality English using proper language, style, and appropriate methods of scientific reasoning
- Parts of the dissertation research should have been presented at international conferences
- The dissertation research must lead to high-quality scientific publications in international peer-reviewed journals, ideally leading journals of the field. At least two such journal publications are expected for each Ph.D. graduate in the Chemical Engineering program.

Procedure and Expectations for the Ph.D. Dissertation Defense

The Ph.D. degree requires the passing of the defense and acceptance of the dissertation. The final defense is a public event that consists of an oral presentation followed by questions from the audience and the committee.

- Ph.D. candidates present in 30-40 minute public presentation the key ideas, methods and results of the dissertation research, and puts into the context of previous work in this field. The presentation is followed by a 10-15 min Q&A session by general audience, after which the general audience leaves the room.
- The closed-doors Q&A session is taken with the dissertation committee. During this Q&A session, the dissertation committee members take turns in asking their questions, moderated by the dissertation committee chair who ensures that all members have about the same amount of time for questions, and that all aspects of the dissertation defense occur in a fair, collegial, respectful and transparent manner.
- For a successful defense, it is expected (i) that Ph.D. candidates clearly demonstrate deep knowledge and innovative research in the chosen field of research; (ii) that candidates can answer questions well, independently, with minimal help from committee members; (iii) that candidates are able to engage in a high-quality scientific debate with the committee and is able to truly defend the dissertation work.
- The Ph.D. dissertation defense concludes if the committee chair calls it closed, after having asked all committee members if they had any further questions or comments. The chair then asks the candidate to leave the room. The committee then decides on the outcome of the defense, which the chair communicates to the candidate.
- The outcome (pass, pass with conditions, fail with retake, fail) is documented in the appropriate form, including a reasonably detailed description of the conditions (if any), which is then communicated to the candidate. The report of the committee chair (to be submitted to the dean within three business days) contains a summary of the defense procedure and further details on the conditions (if any) on dissertation improvements.

Outcome of the Ph.D. Dissertation Defense

- Pass: minor modifications on the dissertation, as requested by committee, within one week.
- Pass with conditions: extended modifications on the dissertation, as requested by committee, within four weeks.
- Fail with retake: additional research and major modifications on dissertation, as requested by committee, within six months.

- Fail: dismissal from Ph.D. program according to the regulations of Graduate Affairs and the Registrar's Office.

Chemical Science (ChemS)

Aims and Scope

The KAUST Chemical Sciences (ChemS) program was established in 2010 to provide a modern, research-oriented education in chemistry. Leveraging the outstanding facilities at KAUST, the program distinguishes itself by a clear focus and strong emphasis on current research challenges related to catalysis and materials.

Within these two main interdisciplinary research thrusts, the following distinct research orientations are currently addressed

Materials	Catalysis
Micro- and mesoporous materials	Hetero- and homogeneous catalysis
Metal-organic material	Biocatalysis
Polymeric and Supramolecular material	Photo- and electro catalysis
Computation and modeling	Computation and modeling

M.Sc. Program

It is the responsibility of students to plan their graduate program in consultation with their academic advisor. Students are required to meet all deadlines. Students should be aware that most core courses are offered only once per year.

The Master of Science (M.Sc.) degree is awarded upon successful completion of a minimum of 36 credit hours. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit. Students are expected to complete the M.Sc. degree in three semesters. Satisfactory participation in every KAUST summer session is mandatory.

The M.Sc. Requirements:

- Core courses (12.0 credits)
- Elective courses (9.0 credits)
- Research/capstone experience (15.0 credits)
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for every semester of the program they attend
- Completion of one Winter Enrichment Program (WEP)

Core Courses (12.0 credits)

To complete these twelve credit hours, students should register for three core courses (12 credits) among those listed in the master's course List and compulsory lab rotation (three credits).

ChemS 320 – Advanced Organic Chemistry I
ChemS 330 – Advanced Inorganic Chemistry I
ChemS 340 – Advanced Organic Chemistry II
ChemS 350 – Advanced Inorganic Chemistry II
ChemS 360 – Advanced Physical Chemistry I
ChemS 370 – Advanced Physical Chemistry II

Compulsory lab rotation (ChemS 296): in addition, all incoming M.Sc. students are required to enroll into a rotation course during their first semester in the program. The goal of this course is to introduce students to various ChemS research groups in order to aid them in the selection of an academic advisor. Rotation assignments will be made by the mutual approval of designated faculty and students.

Students with a pre-identified advisor may spend their entire rotation period in a given lab with the approval of this advisor and program director.

These core courses are designed to provide students with the background needed to establish a solid foundation in the program area.

Elective Courses (9.0 credits)

ChemS 210 – Material Chemistry I
ChemS 212 – Spectroscopy Analysis
ChemS 214 – Nano-catalysis
ChemS 215 – Polymers and Polymerization Processes
ChemS 218 – Photo and Electro Catalysis
ChemS 220 – Organometallic Chemistry
ChemS 240 – Supramolecular Chemistry
ChemS 250 – Material Chemistry II
ChemS 301 – Crystallography and Diffraction
ChemS 319 – Bioinorganic Chemistry
ChemS 326 – Biocatalysis

The elective courses (which exclude research, internship credits, and IED courses) are designed to allow students to tailor their educational experience to meet individual research and educational objectives, with the permission of the academic advisor.

M.Sc. Thesis

The thesis defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than four members. At least two of the required members must be KAUST faculty. The chair plus one additional faculty member must be affiliated with the student's program. This membership can be summarized as:

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty or approved research scientist	Outside program

4	Additional faculty or research scientist	Inside or outside KAUST

Notes:

- Members 1-3 are required, member 4 is optional
- Co-chairs may serve as member 2, 3, or 4, but may not be a research scientist
- Members 2 and 3 must use primary affiliation only
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 4 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 4

View a list of faculty and their affiliations here.

M.Sc. Non-Thesis

Students wishing to pursue the non-thesis option must obtain approval of the program director under exceptional circumstances. Students wishing to pursue the non-thesis option must complete a total of 12.0 capstone credits, with a minimum of 6.0 credits of directed research (299).

Students must complete the remaining credits through one or a combination of the options listed below:

- Broadening experience courses: courses that broaden a student's M.Sc. experience
- Internship: research-based summer internship (295) – students are only allowed to take one internship
- Ph.D. courses: courses numbered at the 300 level

Ph.D. Program

The Doctor of Philosophy (Ph.D.) degree is designed to prepare students for research careers in academia and industry..

There is a minimum residency requirement at KAUST of three and a half years for students entering with a bachelor's degree and two and a half years for students entering with a master's degree. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit.

The Ph.D. degree includes the following steps:

- Securing an academic advisor
- Successful completion of program coursework
- Passing the qualifying examination
- Passing the dissertation proposal defense to obtain candidacy status
- Preparing, submitting and successfully defending a doctoral dissertation

Ph.D. Course Requirements

The required coursework varies for students entering the Ph.D. degree with a bachelor's degree or a relevant master's degree. Students holding a bachelor's degree must complete all program core/mandatory courses and elective courses outlined in the master's degree section and are also required to complete the Ph.D. courses below. Students entering with a bachelor's degree will qualify to earn a master's degree by satisfying the master's degree requirements.

Students entering the Ph.D. degree with a relevant M.Sc. degree must complete the requirements below, though additional courses may be required by the academic advisor.

Ph.D. Courses

- At least two 300-level courses
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for every semester of the program they attend
- Winter Enrichment Program (WEP) – students who completed WEP while earning the M.Sc. are not required to enroll in a full WEP for a second time during the Ph.D.

Ph.D. Candidacy

In addition to the coursework requirements, students must successfully complete the required Ph.D. candidacy milestones to progress towards Ph.D. candidate status. These milestones consist of the subject-based qualifying examination and Ph.D. proposal defense. Once students have advanced to candidacy, students are designated as Ph.D. or doctoral candidates.

Ph.D. Proposal Defense Committee

The Ph.D. dissertation proposal defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than six members. The chair, plus one additional faculty member must be affiliated with the student's program.

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty	Outside program
4	Approved research scientist	Inside KAUST

Notes:

- Members 1-3 are required, member 4 is optional
- Co-chairs may serve as members 2 or 3

- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2 or 3 depending upon their affiliation with the student's program, they may also serve as co-chairs

Once constituted, the composition of the proposal committee can only be changed with the approval of both the academic advisor and the dean.

View a list of faculty and their affiliations here.

Ph.D. Final Defense Committee

The Ph.D. dissertation defense committee, which must be approved by the dean, must consist of at least four members and typically includes no more than six members. At least three of the required members must be KAUST faculty and one must be an external examiner who is external to KAUST. The chair, plus one additional faculty member must be affiliated with the student's program. The external examiner is not required to attend the defense, but must write a report on the dissertation and may attend the dissertation defense at the discretion of the program.

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty	Outside program
4	External examiner	Outside KAUST
5	Approved research scientist	Inside KAUST
6	Additional faculty	Inside or outside KAUST

Notes:

- Members 1-4 are required, members 5 and 6 are optional
- Co-chairs may serve as either members 2, 3 or 6
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 6 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 6, but not as the external examiner

The only requirement with commonality with the proposal committee is the academic advisor, although it is expected that other members will carry forward to this committee.

Co-supervisors can be considered one of the above four members required, provided they come under the categories listed (i.e. meets the requirements of the position).

View a list of faculty and their affiliations here.

Earth Science and Engineering (ErSE)

Aims and Scope

In the Earth Science and Engineering (ErSE) program at KAUST, faculty and their students engage in interdisciplinary research to understand and model geophysical processes due to the complex and changing nature of our planet. The ErSE curriculum provides graduate-level education in geophysical sciences and their applications in two distinct specializations represented by two tracks:

Fluid Earth Systems
Solid Earth Systems

The program is rich with opportunities, for both M.Sc. and Ph.D. students, with a focus on modern computational and advanced data-analysis methods to study geophysical problems associated with atmospheric processes and ocean circulation, oil exploration and reservoir modelling, earthquake processes and crustal deformation. Students in this program receive broad training in numerical methods, mathematical modelling and geophysics. M.Sc. students have an option to participate in scientific research activities that include computational and mathematical modelling or field-study projects (M.Sc. with thesis). Ph.D. candidates in the program conduct original research publishable in international high-ranking peer-reviewed journals.

ErSE students must specify one of the available tracks as their major. Students in the fluid earth systems track study flow and transport processes both beneath and above the earth's surface, including subsurface, surface and atmospheric flows. Students in the solid earth systems track focus on seismology, geophysics, geodynamics and geomechanics.

M.Sc. Program

It is the responsibility of students to plan their graduate program in consultation with their academic advisor. Students are required to meet all deadlines. Students should be aware that most core courses are offered only once per year.

The Master of Science (M.Sc.) degree comprises thesis and non-thesis options. It is awarded upon successful completion of a minimum of 36 credit hours. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit. Students are expected to complete the M.Sc. degree in three semesters. Satisfactory participation in every KAUST summer session is mandatory.

The M.Sc. Requirements:

- Core courses (12.0 credits)
- Elective courses (12.0 credits)
- M.Sc. thesis research or research/capstone experience (12.0 credits)
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for every semester of the program they attend
- Completion of one Winter Enrichment Program (WEP)

Core Courses (12.0 credits)

Choose at least 4 - at least 2 from ErSE and at least one from AMCS:
ErSE 201 – Geophysical Fluid Dynamics I
ErSE 211 – Global Geophysics
ErSE 213 – Inverse Problems
ErSE 253 – Data Analysis in Geosciences
AMCS 206 – Applied Numerical Methods
AMCS 231 – Applied Partial Differential Equations I
AMCS 251 – Numerical Linear Algebra
AMCS 252 – Numerical Analysis of Differential Equations

These core courses are designed to provide students with the background needed to establish a solid foundation in the program area.

Elective Courses (12.0 credits)

Fluid Earth Systems Courses
ErSE 202 – Computational Groundwater Hydrology
ErSE 204/304 – Geophysical Continuum Mechanics
ErSE 209/309 – Thermodynamics of Subsurface Reservoirs
ErSE 301 – Geophysical Fluid Dynamics II
ErSE 303 – Numerical Methods of Geophysics
ErSE 305 – Multiphase Flows in Porous Media
ErSE 306 – Ocean Physics and Modelling
ErSE 307 – Atmospheric Chemistry and Transport
ErSE 330 – Pore-scale Modelling of Subsurface Flow
ErSE 353 – Data Assimilation

Solid Earth Systems Courses
ErSE 204/304 – Geophysical Continuum Mechanics
ErSE 210 – Seismology I
ErSE 212 – Geophysical Geodesy and Geodynamics
ErSE 214 – Seismic Exploration
ErSE 215 – Geomechanics I
ErSE 217 – Seismotectonics
ErSE 218 – Geophysical Field Methods
ErSE 225 – Physical Fields Methods in Geophysics I
ErSE 260 – Seismic Imaging
ErSE 310 – Seismology II
ErSE 315 – Geomechanics II
ErSE 325 – Physical Fields Methods in Geophysics II
ErSE 328 – Advanced Seismic Inversion I
ErSE 329 – Advanced Seismic Inversion II
ErSE 345 – Seismic Interferometry
ErSE 360 – Mathematical Methods for Seismic Imaging
ErSE 390 – Special Topics in Earth Science

Earth Systems Courses from Other Programs (for Both Tracks)

CE 202 – Transport Phenomena
ME 200a – Fluid Mechanics
ME 305 – Computational Fluid Dynamics
AMCS 312 – High Performance Computing
AMCS 350 – Spectral Methods for Uncertainty Quantification
CS 207 – Programming Methodology and Abstractions
CS 229 – Machine Learning
MSE 200 – Advanced Engineering Mathematics
EnSE 222 – Surface Hydrology

The elective courses (which exclude research, internship credits, and IED courses) are designed to allow students to tailor their educational experience to meet individual research and educational objectives, with the permission of the academic advisor.

Research/Capstone Experience (12.0 credits)

The details of this portion of the degree are uniquely determined by students with the permission of the academic advisor and will involve a combination of research and other capstone experiences. Students are expected to work weekly a minimum of 3 hours/week per each research credit they are registered for.
ErSE 295 – internship (M.Sc.)
ErSE 297 – master's thesis research
ErSE 299 – directed research (M.Sc. students)

M.Sc. Thesis

Students wishing to pursue the thesis option must have at least a 3.2 cumulative GPA. A minimum of 12.0 credits of thesis research (297) is required. Students are permitted to register for more than 12.0 credits of M.Sc. thesis research with the permission of the academic advisor. The selected academic advisor must be a fulltime program-affiliated assistant, associate or full professor at KAUST. This advisor can only become project-affiliated for the specific thesis project upon program level approval. Project-affiliation approval must be completed prior to commencing research.

A written thesis and an oral defense of the M.Sc. thesis are required. It is advisable that students submit a final copy of the thesis to the thesis committee members at least two weeks prior to the defense date.

The thesis defense committee, which must be approved by the dean, consists of three KAUST faculty. If additional expertise is needed the committee could be extended, subject to dean's approval. At least two committee members must be affiliated with the program. The chair may be any KAUST faculty familiar with the program rules. This membership can be summarized as:

Member	Role	Program Status
1	Chair	Within or outside program
2	Faculty	Within program
3	Faculty	Within or outside program
4	Additional faculty or research scientist	Within or outside program

Notes:

- Members 1, 2, and one of 3 or 4 are required
- Co-chairs may serve as member 2 or 3
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2 or 3 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 3

View a list of faculty and their affiliations here.

M.Sc. Non-Thesis

Students wishing to pursue the non-thesis option must complete a total of 12.0 capstone credits, with a minimum of 6.0 credits of directed research (299).

Students must complete the remaining credits through one or a combination of the options listed below:

- Broadening experience courses: courses that broaden a student's M.Sc. experience
- Internship: research-based summer internship (295) – students are only allowed to take one internship
- Ph.D. courses: courses numbered at the 300 level

Ph.D. Program

The Doctor of Philosophy (Ph.D.) degree is designed to prepare students for research careers in academia and industry.

There is a minimum residency requirement at KAUST of three and a half years for students entering with a bachelor's degree and two and a half years for students entering with a master's degree. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit.

The Ph.D. degree includes the following steps:

- Securing an academic advisor
- Successful completion of program coursework
- Passing the qualifying examination
- Passing the dissertation proposal defense to obtain candidacy status
- Preparing, submitting and successfully defending a doctoral dissertation

Ph.D. Course Requirements

The required coursework varies for students entering the Ph.D. degree with a bachelor's degree or a relevant master's degree. Students holding a bachelor's degree must complete all program core/mandatory courses and elective courses outlined in the master's degree section and are also required to complete the Ph.D. courses below. Students entering with a bachelor's degree will qualify to earn a master's degree by satisfying the master's degree requirements.

Students entering the Ph.D. degree with a relevant M.Sc. degree must complete the requirements below, though additional courses may be required by the academic advisor. Upon approval of the advisor, Ph.D. students are allowed to choose the relevant courses from the entire ErSE curriculum, as well as from the curriculums of other KAUST programs.

Ph.D. Courses

- At least three courses that comprise at least two 300-level courses, at least two courses should be from the ErSE curriculum for students coming with a master's from another university or a different KAUST program and at least one 300-level course from ErSE curriculum for students with M.Sc. from KAUST-ErSE
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for every semester of the program they attend
- Winter Enrichment Program (WEP) – students who completed WEP while earning the M.Sc. are not required to enroll in a full WEP for a second time during the Ph.D.

Ph.D. Candidacy

In addition to the coursework requirements, students must successfully pass the subject-based qualifying examination and Ph.D. proposal defense to progress towards Ph.D. candidacy status.

Ph.D. Qualifying Examination

The Ph.D. qualifying examination (Q.E.) is a subject-based examination – oral and written.
The Q.E. committee consists of three members. If additional expertise is required the committee could be extended. The chair can be any KAUST faculty member familiar with the program rules. At least two committee members should be affiliated with the program.

Member	Role	Program Status
1	Chair	Within or outside program
2	Faculty	Within or outside program
3	Faculty	Within program

Once students have successfully completed the qualifying exam, they work towards the dissertation proposal defense under the supervision of the academic advisor.

Ph.D. Dissertation Proposal Defense

The dissertation proposal defense is the second part of the qualification milestones that must be completed within one year after passing the qualifying exam to become a Ph.D. candidate. Students have to submit to the Ph.D. dissertation proposal committee a written research proposal and pass an oral research proposal defense.
The Ph.D. dissertation proposal defense committee, which must be approved by the dean, consists of three members. If additional expertise is required the committee could be extended, subject to dean's approval. The chair can be any KAUST faculty member familiar with the program rules. Two committee members must be KAUST faculty affiliated with the program and one must be a KAUST faculty outside the program.

Member	Role	Program Status
1	Chair	Within or outside program
2	Faculty	Within or outside program
3	Faculty	Outside program

Notes:

- Co-chairs may serve as members 2 or 3
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2 or 3 depending upon their affiliation with the student's program, they may also serve as co-chairs

Once constituted, the composition of the proposal committee can only be changed with the approval of both the academic advisor and the dean.

This committee should also make itself available for subsequent periodic review meetings with students. The composition of the committee could change over time.

View a list of faculty and their affiliations here.

Ph.D. Final Defense

To graduate, Ph.D. candidates have to finalize the Ph.D. dissertation, form a Ph.D. dissertation defense committee, and successfully defend a Ph.D. dissertation.

The Ph.D. dissertation defense committee, which must be approved by the dean, consists of four mandatory members. If additional expertise is required the committee could be extended, subject to the dean's approval. Three of the mandatory members must be KAUST faculty and one must be an external examiner who is external to KAUST. The chair can be any KAUST faculty familiar with the program rules. At least two committee members must be KAUST faculty affiliated with the program, and one must be a KAUST faculty outside the program. The external examiner must write a report on the dissertation and attend the dissertation defense either in person or remotely.

Member	Role	Program Status
1	Chair	Within or outside program
2	Faculty	Within program
3	Faculty	Within or outside program
4	External examiner	Outside KAUST

Notes:
- Co-chairs may serve as either members 2 or 3
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2 or 3 upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 2 or 3 depending upon their affiliation

The only requirement with commonality with the proposal committee is the academic advisor, although it is expected that other members will carry forward to this committee.

If students have a co-supervisor, this person can be considered one of the four mandatory members required, provided they come under the categories listed (i.e. meets the requirements of the position).

View a list of faculty and their affiliations here.

Energy Resources and Petroleum Engineering (ERPE)

Aims and Scope

King Abdullah University of Science and Technology (KAUST) advances science and technology through bold and collaborative research. It educates scientific and technological leaders, catalyzes the diversification of the Saudi Arabian economy and addresses challenges of regional and global significance, thereby serving the Kingdom, the region and the world. Research and education, as well as their transformative potential, are central to KAUST's mission. Through the synergy of science and technology, with a focus on innovation and enterprise, KAUST is a catalyst for transforming people's lives.

Faculty and students in the Energy Resources and Petroleum Engineering (ERPE) program at KAUST engage in interdisciplinary research to understand and model hydro-chemo-thermo-mechanical coupled processes in the subsurface, with emphasis on multiphase and reactive fluid flow (oil, gas, brine, water and steam).

The Energy Resources and Petroleum Engineering program for both M.Sc. and Ph.D. students focuses on modern reservoir description, engineering and management. Students in this program receive broad training in basic scientific concepts and thermodynamics, geology, geophysical characterization, and reservoir engineering. Students participate in scientific research activities that may include mathematical analyses, computational modeling, and/or laboratory/field studies. Ph.D. candidates focus on original research driven to advance the boundaries of knowledge.

Assessment Test

Students are admitted to KAUST from a wide variety of programs and backgrounds. In order to facilitate the design of an appropriate study plan for students, all admitted students without a master's degree are required to take a written assessment exam when they arrive on campus. The purpose of the assessment is to determine whether students have mastered the prerequisites for undertaking graduate-level courses taught in the program. The academic advisor works with admitted students to develop a study plan if needed. Students are encouraged to prepare for the assessment by refreshing the general knowledge gained from their undergraduate education before arriving at KAUST. The study plan requirements must be satisfactorily completed, in addition to the University degree requirements.

M.Sc. Program

The Master of Science (M.Sc.) degree is awarded upon successful completion of a minimum of 36 credit hours. A minimum GPA of 3.0 must be achieved to graduate.

The selected academic advisor must be a full-time program-affiliated assistant, associate or full professor at KAUST. The academic advisor can only become project affiliated for the specific thesis project upon program level approval. Project affiliation approval must be completed prior to commencing research.

It is the sole responsibility of students to plan their graduate program in consultation with their advisor. Students are required to meet all deadlines. Students should be aware that most core courses are offered only once per year.

Individual courses require a minimum of a 'B-' for course credit. Students are expected to complete the M.Sc. in three semesters and one summer session. Satisfactory participation in every KAUST's summer session is mandatory. Summer session courses are credit bearing and apply towards the degree.

The M.Sc. Requirements:

- Core courses (12.0 credits)
- Elective courses (12.0 credits)
- Research/capstone experience (12.0 credits)
- Graduate seminar
- Winter Enrichment Program (WEP)

Core Courses (12.0 credits)

Core courses are designed to provide students with the background needed to establish a solid foundation in the program area. Students must select a minimum of four ERPE core courses from the list below to satisfy program requirements.

ERPE 200 - Energy and the Environment
ERPE 210 - Fundamentals of Carbonate Geology
ERPE 220 - Sediments: Properties and Processes
ERPE 230 - Rock Mechanics for Energy Geo-Engineering
ERPE 240 - Fractals, Percolation and Pore-scale Flow
ERPE 250 - Reservoir Engineering Fundamentals and Applications

Elective Courses (12.0 credits)

Students may select four elective courses from any 200 or 300 level courses at KAUST. Courses above (under core courses) and those listed below are most often selected by ERPE students. Note: selections require approval from the academic advisor. The elective courses are designed to allow students to tailor their educational experience to meet individual and educational objectives.

ERPE 241 - Multiphase Flow in Porous Media

ERPE 310 - Stratigraphy
ERPE 350 - Thermodynamics of Subsurface Reservoirs
ERPE 351 - Modeling Naturally Fractured Reservoirs
ERPE 360 - Field Development Planning
ERPE 361 - Advanced Well Testing
ERPE 370 - Experimental Methods in Research

ErSE 210 - Seismology
ErSE 213 - Inverse Problems
ErSE 253 - Data Analysis in the Geosciences
ErSE 260 - Seismic Imaging

AMCS 201 - Applied Mathematics
AMCS 206 - Applied Numerical Methods
AMCS 231 - Applied Partial Differential Equations I
AMCS 243 - Probability and Statistics
AMCS 251 - Numerical Linear Algebra

STAT 210 - Applied Statistics and Data Analysis
STAT 220 - Probability and Statistics
STAT 230 - Linear Models
STAT 240 - Bayesian Statistics
STAT 250 - Stochastic Processes

Research/Capstone Experience (12.0 credits)

All M.Sc. students must complete a research/capstone experience. The research/capstone experience may involve thesis research at KAUST, a research-based summer internship or a combination to be defined by students and their academic advisor:

- ERPE 295 – Internship
- ERPE 397 – Thesis Research

All M.Sc. research/capstone experiences (either research or internship) require a written document/thesis and oral defense. Students must submit a final copy of the document to the program director at least two weeks prior to the oral defense date. Students are required to comply with the university formatting guidelines provided by the library. A pass is achieved when the committee agrees with no more than one dissenting vote, otherwise it is a fail.

The defense committee will be formed by the academic advisor, the program director, and at least one more ERPE faculty.

Graduate Seminar

All students are required to register and receive a satisfactory grade in the graduate seminar (non-credit) for every semester of the program they attend.

Winter Enrichment Program (WEP)

Students are required to satisfactorily complete at least one full Winter Enrichment Program (WEP).

Ph.D. Program

The Doctor of Philosophy (Ph.D.) degree is designed to prepare students for research careers in academia and industry.

There is a minimum residency requirement at KAUST of three and a half years for students entering with a bachelor's degree and two and a half years for students entering with a master's degree. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit.

The Ph.D. degree includes the following steps:

- Securing an academic advisor
- Successful completion of program coursework
- Passing the qualifying examination
- Passing the dissertation proposal defense to obtain candidacy status
- Preparing, submitting and successfully defending a doctoral dissertation

Designation of an Academic Advisor

*The selected a*cademic *advisor must be a full*-time program-affiliated *professor at KAUST. S*tudents may also select an *a*cademic *a*dvisor from another program at KAUST. The *a*cademic *a*dvisor can only become project affiliated for the specific dissertation project with program level approval. Project affiliation approval must be completed prior to commencing research.

View a list of faculty and their affiliations here.

Ph.D. Course Requirements

The required coursework varies for students entering the Ph.D. with a bachelor's degree or relevant master's degree. Students holding a bachelor's degree must complete all program core courses and elective courses outlined in the master's degree section and are also required to complete the Ph.D. courses below. Students entering with a bachelor's degree may also qualify to earn a master's degree by satisfying the master's degree requirements; however, it is students' responsibility to declare their intentions to obtain the master's degree.

Students entering the Ph.D. with a relevant master's degree must complete the minimum requirements below (note: additional courses may be required by the academic advisor):

- Students with an ERPE master's degree: at least two 300-level courses.
- Students with a KAUST master's degree but not in ERPE or with a master's degree from another university must take a minimum of four ERPE courses: two must be core courses and two must be 300-level courses.

- Transfer students: students transferring from another university's Ph.D. program may receive coursework credit on a case-by-case basis, upon the recommendation of the academic advisor and the approval of the dean. Transfer students must still take a minimum of four ERPE courses and satisfy the qualifying exam and dissertation proposal defense requirements at KAUST.
- Graduate seminar 398 (non-credit): all students are required to register and receive a Satisfactory grade for every semester of the program they attend.
- Winter Enrichment Program: students are required to satisfactorily complete at least one full Winter Enrichment Program (WEP) as part of the degree requirements. Students who completed WEP requirements while earning the M master's degree are not required to enroll in a full WEP for a second time in the Ph.D. degree.

Ph.D. Qualifying Examination

The purpose of the subject-based qualifying exam is to test students' knowledge of the subject matter within the field of study. All students entering the Ph.D. program with a bachelor's degree must take this examination within two years of their admission. Students with a master's degree must take the qualifying exam within one year of arriving at KAUST. Students who fail with no retake or fail the retake will be dismissed from the University.

The subject-based qualifying exam is built on the courses completed by Ph.D students during *their* studies at KAUST in the current program *they are* enrolled in. The exam has a written and an oral component, based on three ERPE courses, taught by three different faculty members, taken by students at KAUST. Student must select the courses in communication with the *a*cademic *a*dvisor, with at least one being a 300 level course. A relevant course from another program may be substituted for an ERPE course, but only upon approval by the *p*rogram *d*irector. Both the written and oral components of the exam have to be completed within a time frame of six weeks (in total). The oral examination in all three subjects will be held on the same day.

The qualifying exam is scheduled twice per year in January and June. A call for registration will be sent via email to eligible Ph.D. students. The email will include the exam date and instructions to register for the exam.

Ph.D. Dissertation Proposal

Students must successfully complete a Ph.D proposal defense. The purpose of the dissertation proposal defense is to demonstrate that students have the ability and are adequately prepared to undertake Ph.D.-level research in the proposed area. This preparation includes necessary knowledge of the chosen subject, a review of the literature and preparatory theory or experiment as applicable.

The dissertation proposal defense is the second part of the qualification milestone that must be completed to become a Ph.D. candidate. Ph.D. students are required to complete the dissertation proposal defense within one year after passing the qualifying examination. The dissertation proposal defense includes two aspects: a written research proposal and an oral research proposal defense. Ph.D. students must request to present the dissertation proposal defense to the proposal dissertation committee at the beginning of the semester they will defend their proposal. Students must submit the written research proposal to the committee at least two weeks prior to the defense date.

The Ph.D. dissertation proposal defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than six members. The chair, plus one additional faculty member must be affiliated with the program.

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty	Outside program
4	Approved research scientist	Inside KAUST

Notes:

- Members 1-3 are required, member 4 is optional
- Co-chairs may serve as members 2 or 3
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2 or 3 depending upon their affiliation with the program, they may also serve as co-chairs

Once constituted, the composition of the proposal committee can only be changed with the approval of both the academic advisor and the dean.

View a list of faculty and their affiliations here.

There are four possible outcomes from the dissertation proposal defense:

- Pass
- Pass with conditions
- Fail with retake
- Fail without retake

A pass is achieved when the committee agrees with no more than one dissenting vote, otherwise it is a fail. In the instance of a pass with conditions, the entire committee must agree on the required conditions and if they cannot, the dean decides. The deadline to complete the conditions is one month after the proposal defense date, unless the committee unanimously agrees to change it. In the instance of a fail with retake, the retake will take place within six months after the original defense date. The decision fail without retake must be unanimous and students will be dismissed from the University.

Students who successfully pass the dissertation proposal defense are deemed Ph.D. candidates.

Ph.D. Dissertation Defense Committee

To graduate, Ph.D. candidates must form a Ph.D. dissertation defense committee, finalize the Ph.D. dissertation, successfully defend the Ph.D. dissertation and submit the dissertation.

The Ph.D. dissertation defense committee, which must be approved by the dean, must consist of at least four members and typically includes no more than six members. At least three of the required members must be KAUST faculty and one must be an external examiner who is external to KAUST. The chair, plus one additional faculty member must be affiliated with the student's program. The external examiner is not required to attend the defense, but must write a report on the dissertation and may attend the dissertation defense at the discretion of the program.

Member Role Program Status

Member	Role	Program Status
1	Chair	Within Program
2	Faculty	Within Program
3	Faculty	Outside Program
4	External Examiner	Outside KAUST
5	Approved Research Scientist	Inside KAUST
6	Additional Faculty	Inside or outside KAUST

Notes:

- Members 1-4 are required. Members 5 and 6 are optional.
- Co-chairs may serve as members either 2, 3 or 6.
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees.
- Professors of practice and research professors may serve as members 2, 3 or 6 depending upon their affiliation with the program. They may also serve as co-chairs.
- Visiting professors may serve as member 6, but not as the external examiner.

The only requirement with commonality with the proposal committee is the academic advisor, although it is expected that other members will carry forward to this committee.

If students have a co-academic advisor, this person can be considered one of the above four members required, provided they come under the categories listed (i.e. meets the requirements of the position).

Ph.D. Dissertation Defense

The Ph.D. requires the passing of the defense and acceptance of the dissertation. The final defense is a public presentation that consists of an oral defense followed by questions and may last a maximum of three hours.

Students must determine the defense date with agreement of all the members of the dissertation committee, meet deadlines for submitting graduation forms and inform the committee of their progress. It is students responsibility to submit the required documents to the GPC at the beginning of the semester they intend to defend. Students must submit the written dissertation to the committee at least one month prior to the defense date in order to receive feedback.

There are four possible outcomes from the dissertation final defense:

- Pass
- Pass with conditions
- Fail with retake
- Fail without retake

A pass is achieved when the committee agrees with no more than one dissenting vote, otherwise it is a fail. In the instance of a pass with conditions, the entire committee must agree on the required conditions and if they cannot, the dean decides. The deadline to complete the conditions is one month after the proposal defense date, unless the committee unanimously agrees to change it. In the instance of a fail with retake the retake will take place within six months after the original defense date. The decision fail without retake must be unanimous and students will be dismissed from the University.

Evaluation of the Ph.D. dissertation defense is recorded by submitting the result of Ph.D. dissertation defense examination form within three days after the defense to the Office of the Registrar.

Ph.D. Dissertation Submission

The submitted written dissertation must comply with the University formatting guidelines which are available on the KAUST Library website.

Material Science and Engineering (MSE)

Aims and Scope

The Materials Science and Engineering (MSE) program is designed to equip students with fundamental and applied knowledge of materials. The program goal is to prepare students to tackle grand challenges in sustainability and alternative energy, nanotechnology and nano electronics, biomaterials, materials characterization and low-power computing. The program also aims to support KAUST existing research centers, such as the solar, membrane, catalysis, combustion and desalination centers.

M.Sc. Program

The Master of Science (M.S.) degree is awarded upon successful completion of a minimum of 36 credit hours with a minimum of 3.0 cumulative GPA. Individual courses require a minimum of a B- for course credit. Students are expected to complete the M.Sc. degree in three semesters. Satisfactory participation in every KAUST summer session is mandatory.

It is the responsibility of students to plan their graduate program in consultation with their academic advisor. Students should be aware that most core courses are offered only once per year.

Before students start creating their study plan, students will be required to take the program assessment test.

Assessment Test

Students are admitted to KAUST from a wide variety of programs and backgrounds. In order to facilitate the design of an appropriate study plan for each individual student, all M.Sc. and M.Sc./Ph.D. incoming students will be required to take an assessment during orientation week. There is no grade for the assessment. The purpose of the assessment is to determine whether students have mastered the prerequisites for undertaking graduate level courses taught in the program. The academic advisor uses the results of the assessments to design a study plan with a list of courses aimed at addressing content areas that may impede students from successful completion of the degree requirements. More information regarding the assessment test is available on MSE Academics webpage.

M.Sc. Degree Requirements

The M.Sc. degree has the following components:

- Core courses (12.0 credits)
- Elective courses (12.0 credits)
- Graduate seminar (MSE 398) (non-credit)
- Completion of one Winter Enrichment Program (WEP)
- Research/capstone experience (12.0 credits)

Core Courses (12.0 credits)

The MSE core courses are designed to provide students with the background needed to establish a solid foundation in the program area. M.Sc. students are required to complete 12.0 credits (4 courses) to fulfill the core requirements. Students must select 9.0 credits (3 courses) from the following list of MSE core courses. The remaining 3.0 credits must be a 200 or 300 level AMCS course.

MSE Core Courses

- MSE 221 - Crystallography and Diffraction
- MSE 225 - Electronic Properties of Materials
- MSE 226 - Thermodynamics and Equilibrium Processes
- MSE 227 - Applied Quantum Mechanics

Elective Courses (12.0 credits)

The elective courses are designed to allow students to tailor their educational experience to meet individual research and educational objectives. M.S. Students are required successfully complete 12.0 credits (4 courses). With the consent of the academic advisor, MSE courses and courses from other academic programs will count toward elective requirements. Research credits, internship credits, and IED courses will not count toward electives.

Graduate Seminar (MSE 398)

M.Sc. students are required to register three MSE graduate seminars and receive a satisfactory grade to fulfill the seminar requirements for M.Sc. degree.

Winter Enrichment Program

Students are required to satisfactorily complete at least one full Winter Enrichment Program (WEP).

Research/Capstone Experience (12.0 credits)

The research/capstone experience requirements varies depending on the master's degree option M.Sc. students choose to pursue, master's non-thesis or master's thesis.

M.Sc. Thesis

Designation of Thesis Advisor

The first step for students planning to apply for thesis is to identify an M.Sc. academic (thesis) advisor. Students are required to select an affiliated faculty members with the program to supervise the thesis research. The list of affiliated faculty members with MSE program is available on the Material Science and Engineering program main page, click here.

Students may choose to do thesis research with a non-affiliated faculty member. The potential non-affiliated academic (thesis) advisor must request for the program's approval to become a project-affiliated advisor for this specific thesis project before commencing the research work.

Apply for M.Sc. Thesis

Students wishing to do thesis research must submit the M.Sc. thesis application to change to M.Sc. thesis track. Students can apply to change track as early as their second semester. A minimum of 3.2 cumulative GPA is required to apply.

Thesis Credits Registration

Thesis students are required to complete a minimum of 12.0 credits of thesis research (MSE 297). Students are permitted to register for more than 12.0 credits of M.Sc. thesis research as necessary and with the permission of the academic (thesis) advisor.

M.Sc. Thesis Timeline and Extension

M.Sc. thesis students and their academic advisors need to define the thesis timeline at the time the thesis application is submitted. Students are expected to complete the M.Sc. thesis degree requirements by the end of their second fall semester (third semester).

M.Sc. thesis students may apply to extend into the spring semester (fourth semester) by submitting the request for time extension to complete M.Sc. thesis.

Thesis Defense and Submission

M.Sc. thesis students are expected to form a thesis examination committee, defend their thesis, and submit a written thesis document to complete the thesis research requirements.

M.Sc. Thesis Committee Formation

Once the thesis is ready to be examined/defended, students have to form the thesis examination committee and set the date for the oral defense.

Student are required to submit the thesis formation committee form at the beginning of the semester in which they intend to defend the thesis.

Thesis Committee Members Selection Criteria

The thesis defense committee must consist of at least three members and typically includes no more than four members as:

Member	Role	Program Status
1	Committee Chair	Affiliated faculty member
2	KAUST faculty	Affiliated faculty member
3	KAUST faculty	Non-affiliated faculty member
4	Additional faculty or research scientist	Inside or outside KAUST

Notes:

- Members 1-3 are required, member 4 is optional
- Member 1: committee chair must be MSE faculty member or KAUST faculty member affiliated with MSE program
- Member 2: must be MSE faculty member
- Member 3: KAUST faculty member not affiliated with the program
- Co-chairs may serve as member 2, 3, or 4, but may not be a research scientist
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 4 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 4

Thesis Defense

An oral defense of the M.Sc. thesis is required, although it may be waived by the dean's office under exceptional circumstances. Public presentation and all other details related to the format of the oral defense are left to the discretion of the thesis committee.

The oral thesis defense must be completed two weeks before the last day of classes of the graduating semester. Students must set the date of the thesis defense with the committee members by the time students submit their thesis committee formation form.

Thesis Document

Students must follow the KAUST Thesis and Dissertation Guidelines available on KAUST Library website when they write their thesis.

The division recommends students to submit the thesis to the examining committee no later than two weeks prior to the defense. However, the committee chair sets the final requirement for the submission timeline.

Thesis Defense Evaluation

Students defending their thesis will receive one of these two outcomes, pass or fail. A pass is achieved when the committee agrees with no more than one dissenting vote, otherwise the outcome is a fail.

In case of a pass, students are required to send a copy of the M.Sc. thesis approval form within two days after the thesis defense to the GPC.

In the case of a fail, the thesis supervisor must inform the GPC immediately to take the necessary action.

M.Sc. Non-Thesis

Students wishing to pursue this option must first seek the approval of the MSE curriculum committee. The non-thesis option students must complete a total of 12.0 research/capstone credits. A minimum of 6.0 credits of directed research (299) is required. Summer internship credits may be used to fulfill the research requirements.

Students must complete the remaining credits through one or a combination of the options listed below:

- Broadening experience courses: courses that broaden a student's M.Sc. experience
- Internship: research-based summer internship (295) – students are only allowed to take one internship
- Ph.D. courses: courses numbered at the 300 level

M.Sc. non-thesis students are required to take 200 or 300 level courses to complete the remaining 6.0 credits (two courses). Any course offered by the university, including IED courses, will count toward the requirements. Replacing the courses with research or summer internship credits is not permitted.

Ph.D. Program

The Doctor of Philosophy (Ph.D.) degree is designed to prepare students for research careers in academia and industry.

There is a minimum residency requirement at KAUST of three and a half years for students entering with a bachelor's degree and two and a half years for students entering with a master's degree. A minimum GPA of 3.0 must be achieved to graduate.

The Ph.D. degree includes the following steps:

- Securing an academic advisor
- Successful completion of program coursework
- Passing the qualifying examination
- Passing the dissertation proposal defense to obtain candidacy status
- Preparing, submitting and successfully defending a doctoral dissertation

Designation of Academic Advisor

The academic advisor must be a full-time program-affiliated assistant, associate or full professor at KAUST. The list of faculty members affiliated with MSE program is available on the program website.

Students may also select a non-affiliated advisor from another program at KAUST. The academic advisor may request to become a project-affiliated advisor for the specific dissertation project with program level approval. Project affiliation approval must be completed prior to commencing research.

Ph.D. Course Requirements

The required coursework varies for students entering the Ph.D. degree with a bachelor's degree or a relevant master's degree. Students holding a bachelor's degree must complete all program core/mandatory courses and elective courses outlined in the master's degree section and are also required to complete the Ph.D. courses below. Students entering with a bachelor's degree will qualify to earn a master's degree by satisfying the master's degree requirements.

Students entering the Ph.D. degree with a relevant M.Sc. degree must complete the requirements below, though additional courses may be required by the academic advisor.

Ph.D. Courses

- Students entering KAUST with a relevant master's degree must complete at least four courses, two of which must be 300-level courses. Students entering KAUST with a bachelor's degree are required to take two 300-level courses in addition to the M.Sc. degree coursework requirements. Individual courses require a minimum of a B- for course credit.
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for four semesters of the program's graduate seminar.
- Winter Enrichment Program (WEP) – students are required to satisfactorily complete at least one full Winter Enrichment Program (WEP). Students who completed WEP while earning the M.Sc. are not required to enroll in a full WEP for a second time during the Ph.D.

Ph.D. Candidacy

In addition to the coursework requirements, students must successfully complete the required Ph.D. qualification milestones to progress towards Ph.D. candidacy status. These milestones consist of the subject-based qualifying examination and Ph.D. proposal defense.

Ph.D. Qualifying Examination

The purpose of the subject-based qualifying exam is to test students' knowledge of the subject matter within the field of study.

All students entering the Ph.D. program with a bachelor's degree must take this examination within two years of their admission. Students admitted to the program with a master's degree must take this exam within one year.

The requirements to complete the MSE qualifying exam are available on MSE academics webpage.

Ph.D. Dissertation Proposal

The dissertation proposal defense is the second part of the qualification milestones that must be completed to become a Ph.D. candidate. The purpose of the dissertation proposal defense is to demonstrate that students have the ability and are adequately prepared to undertake Ph.D. level research in the proposed area. This preparation includes necessary knowledge of the chosen subject, a review of the literature and preparatory theory or experiment as applicable.

Ph.D. students are required to complete the dissertation proposal defense within one year after passing the qualifying exam. The proposal defense date will be determined by students and their academic advisor.

Ph.D. students are expected to form the Ph.D. dissertation proposal defense committee, and present the dissertation proposal.

Formation of Ph.D. Proposal Defense Committee

Ph.D. students must submit the request to form dissertation committee and present a Ph.D. proposal two weeks prior to the Ph.D. proposal defense date.

The Ph.D. dissertation proposal defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than five members. The criteria to select the committee members are as follows:

Member	Role	Program Status
1	Chair	Affiliated faculty member
2	Faculty	Affiliated faculty member
3	Faculty	Non-affiliated faculty member
4	Faculty or approved research scientist	Inside KAUST (optional)
5	Faculty	Inside or outside KAUST (optional)

Notes:

- Members 1-3 are required, member 4 and 5 are optional
- Co-chairs may serve as members 2 or 3
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2 or 3 depending upon their affiliation with the student's program, they may also serve as co-chairs

Once constituted, the composition of the proposal committee can only be changed with the approval of both the academic advisor and the dean.

Ph.D. Dissertation Proposal Defense

The dissertation proposal defense includes two aspects: a written research proposal and an oral research proposal defense.

There are four possible outcomes of the dissertation proposal defense:

- Pass
- Pas with conditions
- Fail with retake
- Fail without retake

A pass is achieved when the committee agrees with no more than one dissenting vote, otherwise the outcome is a fail. Students who successfully pass the dissertation proposal defense are deemed Ph.D. candidates.

In the instance of a pass with conditions, the entire committee must agree on the required conditions and if they cannot, the dean decides. The deadline to complete the conditions is one month after the defense date, unless the committee unanimously agrees to change it.

The deadline to complete the retake is six months after the defense date, unless the committee unanimously agrees to reduce it. Students who fail the retake will be dismissed from the University.

In the instance of a fail without retake, the decision of the committee must be unanimous. Students who fail the proposal will be dismissed from the University.

The outcome of the Ph.D. dissertation proposal defense is recorded by submitting the Ph.D. dissertation proposal evaluation form within three days after the proposal defense date.

Ph.D. Dissertation Final Defense

The Ph.D. dissertation defense is the final milestone of the degree. Ph.D. students are required to complete the following to earn the degree:

- Form Ph.D. dissertation committee and petition to defend Ph.D. dissertation
- Defend Ph.D. dissertation
- Submit Ph.D. dissertation

Petition to Defend Ph.D. Dissertation and Formation of Dissertation Committee

Students must determine the defense date with agreement of all the members of the dissertation committee, meet deadlines for submitting graduation forms and inform the committee of their progress. It is the responsibility of students to submit the required documents at the beginning of the semester they intend to defend, or two months before the date of the final defense. It is also expected that students submit their written dissertation to the committee about the same time as submitting the petition form.

Formation of Ph.D. Final Defense Committee

The Ph.D. dissertation defense committee, which must be approved by the dean, must consist of at least four members, one of which must be an external to KAUST, and typically includes no more than six members. The external examiner is not required to attend the defense, the attendance of the external examiner is left to the discretion of the Ph.D. academic advisor.

The external examiner is expected to review the dissertation and send a report that includes recommendations and questions prior to the final defense.

The criteria to select the committee members are as follows:

Member	Role	Program Status
1	Chair	Affiliated faculty member
2	Faculty	Affiliated faculty member
3	Faculty	Non-Affiliated faculty member
4	External examiner	Outside KAUST
5	Approved research scientist	Inside KAUST (optional)
6	Additional faculty	Inside or outside KAUST (optional)

Notes:

- Members 1-4 are required, members 5 and 6 are optional
- Co-chairs may serve as either members 2, 3 or 6
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 6 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 6, but not as the external examiner

The only requirement with commonality with the proposal committee is the academic advisor, although it is expected that other members will carry forward to this committee.

Co-supervisors can be considered one of the above four members required, provided they come under the categories listed (i.e. meets the requirements of the position).

View a list of faculty and their affiliations here.

Ph.D. Dissertation Defense

The Ph.D. dissertation final defense is a public presentation that consists of an oral defense followed by Q&A and committee examination. The defense may last a maximum of three hours.

There are four possible outcomes of the dissertation final defense:

- Pass
- Pas with conditions
- Fail with retake
- Fail without retake

A pass is achieved when the committee agrees with no more than one dissenting vote, otherwise the outcome is a fail.

In the instance of a pass with conditions, the entire committee must agree on the required conditions and if they cannot, the dean decides. The deadline to complete the conditions is one month after the defense date, unless the committee unanimously agrees to change it.

The deadline to complete the retake is six months after the defense date, unless the committee unanimously agrees to reduce it. Students who fail the retake will be dismissed from the University.

In the instance of a fail without retake, the decision of the committee must be unanimous. Students who fail the defense will be dismissed from the University.

The evaluation of the Ph.D. dissertation final defense is recorded by submitting the result of Ph.D. dissertation defense examination form within three days after the defense date.

Ph.D. Dissertation Submission

Students are required to follow the KAUST Thesis and Dissertation Guidelines available on KAUST Library website when they write their dissertation.

Student may seek the help of the Writing Center for editorial assistance while writing their dissertation. Students can book a time by sending an email to Skills Lab, skillslab@kaust.edu.sa.

Once the post-examination corrections required by the dissertation committee and the format of the dissertation have been checked and finalized, Ph.D. students must submit the final draft of the dissertation to the program to conclude the submission process.

MSE Courses

Core Courses

MSE 221 - Crystallography and Diffraction
MSE 225 - Electronic Properties of Materials
MSE 226 - Thermodynamics and Equilibrium Processes
MSE 227 - Applied Quantum Mechanics

Elective Courses

MSE 200 - Engineering Mathematics
MSE 201 - Fundamentals of Materials Science and Engineering

MSE 228 - Biomaterials
MSE 229 - Polymeric Materials
MSE 305 - Kinetics and Phase Transformations
MSE 310 - Materials and Energy
MSE 307 - Materials Characterization
MSE 311 - Soft Materials
MSE 313 - Functional Oxides
MSE 314 - Ab-initio Computational Methods
MSE 315 - Thin Film Science and Engineering
MSE 316 - Magnetic Materials
MSE 318 - Nanomaterials
MSE 320 - Solar Cell Materials and Devices
MSE 321 - Optical Properties of Materials
MSE 322 - Semiconductor Materials
MSE 394 - Advanced Topics in Materials Science III

Research/Seminar Courses
MSE 295 - Internship
MSE 297 - Thesis Research
MSE 299 - Directed Research
MSE 395 - Internship
MSE 397 - Dissertation Research
MSE 398 - Graduate Seminar
MSE 399 - Directed Research

Mechanical Engineering (ME)

Aims and Scope

The Mechanical Engineering (ME) program at KAUST aspires to become a world leading ME program by focusing on cutting-edge basic and applied research in the following areas: structures and mechanics of solids, composite materials, fluid dynamics, thermal sciences, combustion, energy, control and dynamics. Furthermore, within each of these research areas, the emphasis is on interdisciplinary research and collaborative research with top-tier institutions around the globe. The ME program also engages with the various research centers at KAUST, particularly the Clean Combustion Research Center.

The ME program course curriculum is modern and rigorous and courses in the program provide a solid foundation in each area, covering subjects such as mechanical behavior of engineering materials, continuum mechanics, thermodynamics, experimental and numerical combustion, computational fluid dynamics and control theory. Our graduates are technically well trained to be productive members of the modern world society at large and specifically suited for research careers in academia, industry and government research laboratories.

M.Sc. Program

It is the responsibility of students to plan their graduate program in consultation with their academic advisor. Students are required to meet all deadlines. Students should be aware that most core courses are offered only once per year.

The Master of Science (M.Sc.) degree is awarded upon successful completion of a minimum of 36 credit hours. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit. Students are expected to complete the M.Sc. degree in three semesters. Satisfactory participation in every KAUST summer session is mandatory.

The M.Sc. Requirements:

- Core courses (12.0 credits)
- Mathematical requirement (6.0 credits)
- Elective courses (6.0 credits)
- Research/capstone experience (12.0 credits)
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for every semester of the program they attend
- Completion of one Winter Enrichment Program (WEP)

Core Courses (12.0 credits)

The core courses are designed to provide students with the background needed to establish a solid foundation in the program area. To complete these 12.0 credit hours in mechanical engineering, students should register for four core courses from the following list:

ME 200 A, B – Fluid Mechanics
ME 211 A, B – Mechanics of Structures and Solids
ME 212 A, B – Continuum Mechanics
ME 221 A, B – Control Theory
ME 222 A, B – Mechatronics and Intelligent Systems
ME 232 A, B – Advanced Dynamics
ME 234 A, B – Introduction to Kinematics and Robotics
ME 241 – Thermodynamics
ME 242 – Heat and Mass Transfer

Mathematics Requirement (6.0 credits)

At least two graduate-level courses (i.e. courses numbered 200 and higher) in applied mathematics are required. It is recommended that students take Applied Mathematics I and II (AMCS 201 and 202), as these courses provide a strong foundation in applied mathematics which is essential for a research career in ME.

To complete these six credits, students should register for two AMCS or STAT courses among those listed in AMCS and STATS master's courses.

Elective Courses (6.0 credits)

Two graduate-level courses (i.e., courses numbered 200 and higher) must be chosen with the approval of the academic advisor. To complete these 6.0 credits, students should register for two elective courses from any academic program, though the students are encouraged to take these elective courses from the ME course list, as listed below.

ME 214 – Experimental Methods
ME 224 – System Identification and Estimation
ME 243 – Statistical Mechanics
ME 244 – Combustion
ME 250 – Energy
ME 252 – Sustainable Energy Engineering
ME 261 – Application of Atmospheric Pressure Plasma
ME 300 – Advanced Fluid Mechanics
ME 302 – Multi-Phase Flows
ME 304 – Experimental Methods in Fluid Mechanics
ME 305 A, B – Computational Fluid Dynamics
ME 306 – Hydrodynamic Stability
ME 307 – Turbulence
ME 308 – Introduction to Plasma Physics and Magneto-hydrodynamics
ME 310 – Mechanics and Materials Aspects of Fracture
ME 313 A, B – Theory of Structures
ME 314 – Plasticity
ME 316 – Micromechanics
ME 317 A, B – Mechanics of Composite Materials and Structures
ME 319 A, B – Computational Solid Mechanics

ME 320 – Geometry of Nonlinear Systems
ME 324 – Advanced Control Systems
ME 326 – Robust Control
ME 340 – Advanced Combustion Theory
ME 342 – Combustion Kinetics
ME 344 – Gas Dynamics
ME 346 – Turbulent Combustion
ME 348 – Introduction to Spectroscopy and Laser Diagnostics
ME 394A – Contemporary Topics in Fluid Mechanics
ME 394B – Contemporary Topics in Solid Mechanics
ME 394C – Contemporary Topics in Control Theory and Practice
ME 394D – Contemporary Topics in Dynamics
ME 394E – Contemporary Topics in Thermal Science and Engineering

The elective courses (which exclude research, internship credits, and IED courses) are designed to allow students to tailor their educational experience to meet individual research and educational objectives, with the permission of the academic advisor. Innovation and Economic Development (IED) courses are meant as a broadening experience and are not technical electives. Students should consult with their program to ensure credits can be applied toward their degree.

M.Sc. Thesis

Students wishing to pursue thesis option must secure the approval of an academic advisor who will supervise the thesis work. Student should register for a minimum of 12.0 credits of ME 297 (thesis research).

An oral defense of the M.Sc. thesis is required. Public presentation and all other details related to the format of the oral defense are left to the discretion of the thesis committee. The thesis defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than four members. At least two of the required members must be KAUST faculty. The chair plus one additional faculty member must be affiliated with the student's program. This membership can be summarized as:

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty or approved research scientist	Outside program
4	Additional faculty or research scientist	Inside or outside KAUST

Notes:
- Academic advisors may serve as the chair
- Members 1-3 are required, member 4 is optional
- Co-chairs may serve as member 2, 3, or 4, but may not be a research scientist
- Members 2 and 3 must use primary affiliation only
- Adjunct professors and professor emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 4 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 4

View a list of faculty and their affiliations here.

M.Sc. Non-Thesis

Students wishing to pursue the non-thesis option must complete a total of 12.0 capstone credits, with a minimum of 6.0 credits of directed research (299).

Students must complete the remaining 6.0 credits through one or a combination of the options listed below:
- Broadening experience courses: courses that broaden a student's M.Sc. experience. These include any graduate-level (i.e., courses numbered 200 or higher) courses offered at the university and the IED courses.
- Internship: research-based summer internship (295) – students are only allowed to take one internship. The internship must be pre-approved by the academic advisor. The academic advisor may require an internship report from the student at the completion of the internship. The report must demonstrate the research carried out during the internship.
- Ph.D. courses: courses numbered at the 300 level

Ph.D. Program

The Doctor of Philosophy (Ph.D.) degree is designed to prepare students for research careers in academia and industry.

There is a minimum residency requirement at KAUST of three and a half years for students entering with a bachelor's degree and two and a half years for students entering with a master's degree. The ME program expects that Ph.D. and M.Sc./Ph.D. students will complete their degrees within four or five years, respectively. A minimum GPA of 3.0 must be achieved to graduate. Individual courses require a minimum of a B- for course credit.

The Ph.D. degree includes the following steps:
- Securing an academic advisor
- Successful completion of program coursework
- Passing the qualifying examination
- Passing the dissertation proposal defense to obtain candidacy status

- Preparing, submitting and successfully defending a doctoral dissertation

Securing an Academic Advisor

Students are responsible for finding an academic advisor, and in consultation with this advisor, identifying research topics that are appropriate and adequate for a doctoral dissertation in mechanical engineering. Students will be admitted to Ph.D. or M.Sc./Ph.D. programs only after a faculty member has agreed to be the academic advisor. Students currently enrolled in a master's program at KAUST and wish to continue with Ph.D. studies must obtain the consent of a faculty member to supervise their Ph.D. work, and, thereafter, submit an application to the University Admission Office for admission to the Ph.D. program.

Ph.D. Course Requirements

The required coursework varies for students entering the Ph.D. degree with a bachelor's degree or a relevant master's degree. Students holding a bachelor's degree must complete all program core courses and elective courses, outlined in the master's degree section, and are also required to complete the Ph.D. courses below. Students entering with a bachelor's degree will qualify to earn a master's degree by satisfying the master's degree requirements.

Students entering the Ph.D. degree with a relevant M.Sc. degree must complete the requirements below, though additional courses may be required by the academic advisor.

Ph.D. Courses

- Four courses are required: two ME 300 level courses, one 200 level or higher course in AMCS or STATS, one 200 level or higher elective course.
- Graduate seminar 398 (non-credit) – all students are required to register and receive a satisfactory grade for every semester of the program they attend. Failure to do so may result in academic probation and/or dismissal.
- Winter Enrichment Program (WEP) – students who completed WEP while earning the M.Sc. are not required to enroll in a full WEP for a second time during the Ph.D.

Ph.D. Candidacy

In addition to the coursework requirements, students must successfully complete the required Ph.D. candidacy milestones to progress towards Ph.D. candidate status. These milestones consist of the subject-based qualifying examination and Ph.D. proposal defense. Once students have advanced to candidacy, students are designated as Ph.D. or doctoral candidates.

Ph.D. Qualifying Examination

All ME Ph.D. students must pass an oral comprehensive subject examination (also known as the PhD. qualifying examination) within the stipulated time frame.

Schedule

This qualifying examination will be given twice a year during a single time window. This window is approximately a week in length: the beginning of spring semester and fall semester.

Timeline

1. Ph.D. students (who already have an M.Sc. degree) must pass the exam within 18 months of the start of their Ph.D. studies in the ME program at KAUST. These students should, therefore, plan on making their first attempt within the first year of their Ph.D. studies.
2. MS/PhD students (who have a bachelor's degree) must pass the exam within 24 months of the start of their studies in the ME program at KAUST. These students should, therefore, plan on making their first attempt within the first year and a half of their studies.

Subjects

The exam will comprise of one oral examination in mathematics and two oral examinations in any of the following areas: (a) fluid mechanics, (b) solid mechanics, (c) control and dynamics, and (d) heat transfer and thermodynamics. The exam in each area will include common questions to be asked of all students who have selected that area. In addition, the examination will extend beyond the common questions to test students' ability in their major area of interest. Students may petition the ME program to replace one of the specified areas (other than mathematics) with an area that is not on the list and is not a subspecialty of one of the listed areas. Examples of "other areas" that might be appropriate are biomechanics and scientific computation, to mention only two.

Multiple Attempts

At the first attempt, students must attempt the exams in all three subjects simultaneously. In the event students fail the qualifying examination in one or more subjects, then at most one additional attempt (in the failed subject) will be allowed at the discretion of the ME faculty.

Format

All examinations will be closed book and closed notes. The exam in applied mathematics and other subject areas is forty-five minutes in length, preceded by a fifteen-minute period during which students will be allowed to review the written questions for that exam. The fifteen minute period is for students to collect their thoughts and there will be no consultation of reference material. Students may write some notes during this time to bring into the exam. The examiners will probe more deeply into the issues raised in the questions.

Notification by Ph.D. Students

At least one month prior to the examination, students must notify the GPC in writing of their choice of the two subject areas (other than mathematics) for the exam.

Subject Contents

While the exam in each subject area need not be limited to the content of any particular course, the nominal level of preparation for the exam is suggested by the courses appearing opposite each area listed in Table 1. ME Appendix A contains subject area descriptions which indicate the topics from which exam questions may be drawn.

Table 1: Subject Areas for the Candidacy Examination

Mathematics – compulsory	AMCS 201, 202
Fluid Mechanics	ME 200A, ME 200B
Solid Mechanics	ME 211A, ME 212A
Thermodynamics and Heat Transfer	ME 241, ME 242
Control and Dynamics	ME 221A, ME 232A

More information is available on the ME website here.

Ph.D. Proposal Defense

In addition to the subject component of the qualifying examination, Ph.D. students must also pass the research component examination (Ph.D. proposal defense). This exam should take place within six months of students passing the subject component of the qualifying examination. Failure to complete the exam in the stipulated time frame may result in academic probation and/or dismissal. The exam essentially consists of two items (with more details given below):

- Presentation: a presentation on the dissertation topic is required by the examining committee
- Proposal: submission of a 10-page proposal to the examining committee at least 10 days prior to the scheduled presentation

Scope of the Examination

The scope of this examination is to demonstrate that students have the ability and are adequately prepared to undertake Ph.D. level research in the proposed area. This preparation includes necessary knowledge of the chosen subject, a review of the literature and preparatory theory or experiment as applicable. It is not necessary to have final results, a working computer program, a functioning piece of equipment or fully analyzed data. It is also not necessary to present a definitive dissertation outline.

Scheduling

Students should schedule the examination at a time acceptable to the committee within six months of passing the subject component of the qualifying examination. Extensions must be approved by the program director at least one month prior to the six-month deadline.

Examination Committee

The Ph.D. dissertation proposal defense committee, which must be approved by the dean, must consist of at least three members and typically includes no more than six members. The chair, plus one additional faculty member must be affiliated with the student's program. Students should propose the committee, in consultation with the advisor, in writing to the GPC. Students are advised to seek the consent of the members before proposing them. The relevant form must be submitted at least two weeks prior to the scheduled proposal defense.

Member	Role	Program Status
1	Chair	Within Program
2	Faculty	Within Program
3	Faculty	Outside Program
4	Approved Research Scientist	Inside KAUST

Notes:

- Members 1-3 are required, member 4 is optional
- Academic advisor may serve as chair
- Adjunct professors and professor emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2 or 3 depending upon their affiliation with the student's program, they may also serve as co-chairs

Once constituted, the composition of the proposal committee can only be changed with the approval of both the academic advisor and the dean.

View a list of faculty and their affiliations here.

Examination

Students should submit a 10-page proposal document (note: the number of pages is a recommendation and not a strict requirement) to the three members of the committee at least 10 days before the examination. The proposal should describe the proposed topic of research, relevant survey of the literature and any preliminary results or laboratory preparation.

Students should make a *half-hour* oral presentation of the research proposal, followed by questions from the committee consistent with the scope of the examination. The examination is expected to last for approximately one hour. The exam is not open to the public.

Results

The examination committee can make one of four recommendations. These must be recorded on the Ph.D. Proposal Evaluation form.

1. Pass. This recommendation is made if students satisfy the criterion that forms the scope of this examination.
2. Pass subject to remedial action. This recommendation is made if students satisfy the criterion that forms the scope of this examination except for an isolated deficiency. No further examination is required. The examination committee will propose the remedial action, specify criteria to demonstrate that students have taken this action and a time-table to complete this action. Examples include but are not limited to (a) taking an additional course or (b) conducting additional literature survey in a specified area.
3. Fail with an option for re-examination. This recommendation is made if students fail to satisfy the criterion that form the scope of this examination, but the committee judges that students may be able to do so in the future with additional study. The examination committee will propose when the re-examination is offered; this date cannot be later than six months from the time of the examination.
4. Fail. This recommendation is made if students fail to satisfy the criterion that form the scope of this examination, and if the examination committee judges the deficiencies are so serious that students are unlikely to be able to do so in a re-examination.

The chair of the examination committee will notify the GPC of the recommendation. The final decision will be made by the associate dean. If the decision of the committee is

1. Pass, then students will be accepted to Ph.D. candidacy on fulfillment of the remaining requirements.
2. Pass subject to remedial action, then students will be accepted to candidacy on fulfillment of remaining requirements and the remedial action.
3. Fail with an option for re-examination, then the committee will specify the time table for the re-examination; this cannot be later than six months from the time of the examination. Further, the associate dean will suggest a faculty member (chair of the examination committee, academic advisor or another faculty member, as appropriate) to provide feedback to students regarding the examination and also to counsel students regarding the reexamination. The result of any re-examination can only be a pass or fail (with no second reexamination).
4. Fail, students will not be allowed to continue in the Ph.D. program.

Ph.D. Dissertation Progress

After passing the subject- and research-components of the qualifying exam, students become Ph.D. candidates. It is the responsibility of students to keep making steady and timely progress towards the goals set forth for Ph.D. dissertation work. The progress is overseen on a regular basis by the academic advisor. It is recommended (not required) that students update, typically every semester, the Ph.D. Proposal Committee members with regards to their progress. If students are having serious problems with dissertation work and the issues are not resolved by the academic advisor, students must inform the GPC and seek help from other members of the Proposal Committee and/or the associate dean.

Ph.D. Dissertation Defense

This is final and most important stage of students' Ph.D. journey. In consultation with the academic advisor, students will target a specific semester for dissertation submission and defense.

Ph.D. Dissertation

The Ph.D. dissertation must contain original results demonstrating students' scholarly activities during the course of the PhD. The dissertation must conform to the University library guidelines for Ph.D. dissertation. The student must be fully aware of what is considered plagiarism and must avoid all forms of plagiarism. The Ph.D. dissertation must be written in fluent high-quality English using proper language, style, and appropriate methods of scientific reasoning. Parts of the dissertation research should have been presented at international conferences. The dissertation research must lead to high quality scientific publications in international peer-reviewed journals, ideally leading journals of the field. The ME program expects that at least one such journal publication has appeared in print before the scheduling of the Ph.D. dissertation defense. In the introductory part of the dissertation, students must list all scientific publications coming out of their work. For each publication, students must indicate the contributions made by the key co-authors.

Petition to Defend

Students must submit the following to the GPC at least two months prior to the scheduled defense date or by the second week of the semester (whichever is earlier):

- Petition form signed by all committee members
- Draft of the Ph.D. dissertation
- Current transcript
- Current CV
- A list of publications

Dissertation Submission to the Committee

Students must send the final draft of the dissertation to all committee members and GPC at least four weeks prior to the scheduled defense. If the dissertation is not sent by this deadline, the defense will have to be rescheduled with a new petition form.

Ph.D. Dissertation Committee

The Ph.D. dissertation defense committee, which must be approved by the dean, must consist of at least four members and typically includes no more than six members. At least three of the required members must be KAUST faculty and one must be an external examiner who is external to KAUST. The chair, plus one additional faculty member must be affiliated with the student's program. It is expected that the Ph.D. proposal committee members will be part of the Ph.D. dissertation committee due to their familiarity with the dissertation work.

Member	Role	Program Status
1	Chair	Within program
2	Faculty	Within program
3	Faculty	Outside program
4	External examiner	Outside KAUST
5	Approved research scientist	Inside KAUST
6	Additional faculty	Inside or outside KAUST

Notes:

- Members 1-4 are required, members 5 and 6 are optional
- Academic advisor **cannot** serve as the chair
- Adjunct professors and professors emeriti may retain their roles on current committees, but may not serve as chair on any new committees
- Professors of practice and research professors may serve as members 2, 3 or 6 depending upon their affiliation with the student's program, they may also serve as co-chairs
- Visiting professors may serve as member 6, but not as the external examiner

Co-supervisors can be considered one of the above four members required, provided they come under the categories listed (i.e., meets the requirements of the position).

View a list of faculty and their affiliations here.

External Examiner

The academic advisor is responsible for nominating a well-qualified, objective, and experienced individual who is not a permanent faculty at KAUST. The specific qualifications of an external examiner are:

- Holds a Ph.D.
- Has previous experience with supervision and examination of doctoral students
- Has an established reputation in the area of the dissertation research and is able to judge whether a dissertation is acceptable
- Should be of either full or associate professor rank at a university, or have comparable expertise and standing if not at a university. If not presently associated with a university, nominees should have some previous university affiliation. Please attach a bio/web link and include a statement outlining the relevant qualifications of the nominee. In particular, please describe how the nominees meet the other criteria for appointment as noted above
- Attachment of a bio/web link for the associate dean to approve

Proposed external examiners must not be closely associated with Ph.D. candidates as research collaborator, co-author, previous supervisor, through family ties, or the like. External examiners must evaluate the Ph.D. dissertation and inform the chair if the thesis is not ready for defense. In such a case, the defense will be cancelled and rescheduled at a later date. The external examiner must submit their report to the GPC *at least two days* before the scheduled defense. The coordinator will pass this report on to the chair of the dissertation defense committee. The attendance of the external examiner at the oral defense is encouraged but not required. If the external examiner cannot be present, skype video conferencing is required. If the external examiner chooses to attend the Ph.D. defense in KAUST, then travel and lodging costs will be taken care of by KAUST.

Chair of the Dissertation Defense Committee

The chair of the dissertation defense committee must be from the ME program but not the Ph.D. academic advisor. The responsibilities of the chair are:

- Introduce the Ph.D. candidate and the committee members
- Outline the process followed for the dissertation defense
- Moderate the Q&A session with the general audience during the open session
- Organize the Q&A session with the committee members during the closed session
- Take votes and recommendations of the committee members for the final decision
- Write a short report (1 page) about the Ph.D. dissertation and defense for review by the associate dean within **three days** of the defense

Examination

The examination is divided into an open session and closed session. During the open session, the Ph.D. candidate will describe the dissertation work during a 45-minute (maximum) presentation which may be attended by other students, faculty, staff and student family members. No questions are allowed during the presentation. The student should clearly outline the big picture of the work, state the goals, illustrate the technical work and contributions, and finally conclude with key achievements and future work. Thereafter, the chair of dissertation committee will invite the audience (excluding committee members) to ask questions. This Q&A session is expected to last for no more than 15 minutes. At the conclusion of audience questions, the chair will request the audience to leave the room. The closed session of the exam will then begin where the committee members will ask questions to the Ph.D. candidate. Chairs may organize this session as they deem fit. The closed session of the exam is expected to last anywhere from one to three hours. At the conclusion of committee questions, the Ph.D. candidate will be asked to leave the room. The committee will then discuss their findings and reach a decision either by consensus or by voting. The Ph.D. candidate will then be asked to return to the room where the chair will inform students of the final decision of the committee.

Results

The Ph.D. dissertation committee can make one of four recommendations. These must be recorded on the Ph.D. Dissertation Defense form.

1. Pass. This recommendation is made if the committee agrees that the dissertation is already of high quality and no further changes are needed.
2. Pass with conditions. This recommendation is made if the committee is satisfied by the overall quality of the work but deems certain changes are necessary to be made to the dissertation. The Committee specifies the time period, typically four weeks or less, for students to submit a revised copy of the dissertation to all committee members and GPC. The chair will collect feedback from the committee members and accordingly inform the GPC that the revised dissertation is accepted.
3. Fail with an option for re-examination. This recommendation is made if the committee judges that the dissertation needs major modification with, for example, additional experiments or simulations. The committee will propose when the re-examination is offered, typically within one year.
4. Fail. This recommendation is made if the committee judges that the dissertation has major holes and the deficiencies are so serious that the student is unlikely to overcome those in a reasonable time frame.

The chair of the dissertation committee will notify the GPC of the recommendation. The final decision will be made by the associate dean.

Courses of Instruction

This section presents the descriptions of all courses offered at KAUST. Courses are listed in alphabetical order by course abbreviation and then course number. Please note that not all courses listed are necessarily offered every year. Students should consult their program for an official listing of courses offered in a given year.

Students should ensure they are familiar with their program requirements and restrictions before registering for courses.

Each course is listed prefaced with its unique number and post fixed with (L-C-R) where:

L	= the lecture hours to count towards fulfilling the workload during the semester/session
C	= the recitation or laboratory hours
R	= the credit hours towards fulfilling a degree course requirement

E.g. CS220 Data Analytics (3-0-3) has a total of three hours of lectures per week, has no labs and earns 3.0 credits for the semester.

100-level courses are preparatory in nature and do not count towards the M.Sc. or Ph.D. degrees.

Courses by Division

Biological and Environmental Science and Engineering (BESE)

BioE Bioengineering
B Bioscience
EnSE Environmental Science and Engineering
MarS Marine Science
PS Plant Science

Computer, Electrical and Mathematical Science and Engineering (CEMSE)

AMCS Applied Mathematical and Computational Science
CS Computer Science
EE Electrical Engineering
STAT Statistics

Physical Science and Engineering (PSE)

AP Applied Physics
CE Chemical Engineering
ChemS Chemical Science
ERPE Energy Resources and Petroleum Engineering
ErSE Earth Science and Engineering
ME Mechanical Engineering
MSE Material Science and Engineering

University Wide Courses

ESL English as a Second Language

These courses are designed to provide English language training for students who do not fully meet the University's English language entrance requirements. Students will be assigned courses based on their level of English proficiency.

IED Innovation and Economic Development

Innovation and economic development (IED) courses are meant as a broadening experience and are not technical electives. Students should consult with their program to ensure credits can be applied toward their degree.

WE Winter Enrichment Program

The Winter Enrichment Program (WEP) takes place in January each year and is designed to broaden students' horizon. WEP is an essential and core requirement of the degree programs at KAUST. Satisfactory completion of at least one WEP is required of all M.Sc. students as part of the completion of the degree requirements. Ph.D. students who did not receive their M.Sc. degree at KAUST are also required to satisfactorily complete at least one WEP. To satisfy this mandatory requirement, full participation must occur within a single WEP period.

Courses by Subject Area

AMCS

Applied Mathematics and Computational Science
Division of Computer, Electrical and Mathematical Science and Engineering (CEMSE)

AMCS 101 – Engineering Mathematics (3-0-0)

Coordinates, Lines, Circles, Functions and their graphs, Polynomials, trigonometric functions, limits, derivatives, numerical approximation of derivatives, indefinite integrals, the definite integral, the fundamental theorem of calculus, applications of the integral: areas, volumes, numerical integration, transcendental functions, techniques of integration: integration by parts; partial fraction decomposition, substitutions, differential equations of first order, separable equations, numerical integration of differential equations, Euler method, solution of linear differential equations of second order with constant coefficients, Infinite sequences and series, geometric series, convergence tests for series, power series and radius of convergence, Taylor series, approximation of functions by polynomials, exponential, cosine and sine expansions, error bounds. The plane and three-dimensional space, vectors, parametric equations for curves, lines, planes, dot and cross product, functions of several variables, partial derivatives, tangent planes and normals, linear approximation, gradient and the differential

AMCS 102 – Vector Calculus (3-0-0)

This course covers differential, integral and vector calculus for functions of more than one variable. These mathematical tools and methods are used extensively in the physical sciences, engineering, economics and computer graphics. The course covers triple integrals, cylindrical and spherical polar coordinates. Line and surface integrals. Divergence and curl applications, conservative vector fields. Green's, Gauss' and Stokes' theorems applications.

AMCS 107 – Introduction to Programming with Matlab and Mathematica (3-0-0)

This course gives an introduction to MATLAB® and Mathematica. It is designed to give students fluency in these two mathematical software. The course consists of interactive lectures with students doing sample programming problems in real time.

AMCS 131 – Vector Calculus and Ordinary Differential Equations (3-0-0)

The course is concentrated mostly on Multivariate Calculus and basic ODEs and contains some necessary preliminaries from Single Variable Calculus and Complex Analysis.

AMCS 143 – Introduction to Probability and Statistics (3-0-0)

This course provides an elementary introduction to probability and statistics with applications. Topics include: basic probability models; combinatorics; random variables; discrete and continuous probability distributions; statistical estimation and testing; confidence intervals and an introduction to linear regression.

AMCS 151 – Linear Algebra (3-0-0)

This is a basic subject on matrix theory and linear algebra. Emphasis is given to topics that will be useful in other disciplines, including systems of equations, introduction to vector spaces, basis and dimension, rank of a matrix, determinants, eigenvalues and diagonalization, similarity, and positive definite matrices. Applications. Orthogonal and unitary matrices and transformations. Orthogonal projections, Gram-Schmidt procedure.

AMCS 162 – Discrete Mathematics (3-0-0)

This course covers elementary discrete mathematics for computer science and engineering. It emphasizes mathematical definitions and proofs as well as applicable methods. Topics include formal logic notation, proof methods; induction, well-ordering; sets, relations; elementary graph theory; integer congruence's; asymptotic notation and growth of functions; permutations and combinations, and counting principles.

AMCS 199 – Directed Study in Applied Mathematics (variable contact hours, non-credit)

A course of self-study in a particular topic as directed by faculty and approved by the division.

AMCS 201 – Applied Mathematics I (3-0-3)

Prerequisites: Advanced and multivariate calculus and elementary complex variables. AMCS 201 and 202 may be taken separately or in either order. No degree credit for AMCS majors.
Part of a fast-paced two-course sequence in graduate applied mathematics for engineers and scientists, with an emphasis on analytical technique. A review of practical aspects of linear operators (superposition, Green's functions and Eigen analysis) in the context of ordinary differential equations, followed by extension to linear partial differential equations (PDEs) of parabolic, hyperbolic and elliptic type through separation of variables and special functions. Integral transforms of Laplace and Fourier type. Self-similarity. Method of characteristics for first-order PDEs. Introduction to perturbation methods for nonlinear PDEs, asymptotic analysis, and singular perturbations.

AMCS 202 – Applied Mathematics II (3-0-3)

Prerequisites: Advanced and multivariate calculus and elementary complex variables. AMCS 201 and 202 may be taken separately or in either order. No degree credit for AMCS majors.
Part of a fast-paced two-course sequence in graduate applied mathematics for engineers and scientists, with an emphasis on analytical technique. A review of linear spaces (basis, independence, null space and rank,

condition number, inner product, norm and Gram-Schmidt orthogonalization) in the context of direct and iterative methods for the solution of linear systems of equations arising in engineering applications. Projections and least squares. Eigen analysis, diagonalization and functions of matrices. Complex analysis, Cauchy-Riemann conditions, Cauchy integral theorem, residue theorem, Taylor and Laurent series, contour integration and conformal mapping.

AMCS 206 – Applied Numerical Methods (3-0-3)

Prerequisites: Advanced and multivariate calculus. No degree credit for AMCS majors.
A fast-paced one-semester survey of numerical methods for engineers and scientists, with an emphasis on technique and software. Computer representation of numbers and floating point errors. Numerical solution of systems of linear and nonlinear algebraic equations, interpolation, least squares, quadrature, optimization, nonlinear equations, approximation of solutions of ordinary and partial differential equations. Truncation error, numerical stability, stiffness, and operation and storage complexity of numerical algorithms.

AMCS 211 – Numerical Optimization (3-0-3)

Prerequisites: Advanced and multivariate calculus and elementary real analysis.
Solution of nonlinear equations. Optimality conditions for smooth optimization problems. Theory and algorithms to solve unconstrained optimization; linear programming; quadratic programming; global optimization; general linearly and non-linearly constrained optimization problems.

AMCS 212 – Linear and Nonlinear Optimization (3-0-3)

Prerequisites: Advanced and multivariate calculus.
The role of duality, optimality conditions and algorithms in finding and recognizing solutions. Perspectives: problem formulation, analytical theory, computational methods and recent applications in engineering, finance and economics. Theories: finite dimensional derivatives, convexity, optimality, duality and sensitivity. Methods: simplex and interior-point, gradient, Newton and barrier.

AMCS 231 – Applied Partial Differential Equations I (3-0-3)

Prerequisites: Advanced and multivariate calculus and elementary complex variables.
First part of a sequence of courses on partial differential equations (PDE) emphasizing theory and solution techniques for linear equations. Origin of PDE in science and engineering. Equations of diffusion, heat conduction and wave propagation. The method of characteristics. Classification of PDE. Separation of variables, theory of the Fourier series and Fourier transform. The method of Green's functions. Sturm-Liouville problem, special functions, Eigen function expansions. Higher dimensional PDE and their solution by separation of variables, transform methods and Green's functions. Introduction to quasi-linear PDE and shock waves.

AMCS 232 – Weak Solutions of Partial Differential Equations (3-0-3)

Prerequisite: AMCS 231 or 201.
This is a first course on weak solutions of partial differential equations. The course begins with a brief introduction to distributions and weak derivatives. Next we consider Sobolev spaces and fundamental results: extension and trace theorems, Sobolev and Morrey theorem, Poincare's inequality and Rellich-Kondrachov theorem. Then we examine weak solutions of elliptic equations through Lax-Milgram theorem. The course ends with a discussions of weak solutions of linear evolution equations - second-order linear parabolic equations, linear hyperbolic systems and semigroup methods.

AMCS 235 – Real Analysis (3-0-3)

Prerequisite: Advanced and multi-variable calculus.
This course is an introduction to measure and integration, the theory of metric spaces and their applications to the approximation of real valued functions. It starts with notions of convergence from sequences of continuous functions, the Ascoli- Arzela compactness theorem and the Weierstrass approximation theorem. The main body of the course deals with the theory of measure and integration and limiting processes for the Lebesgue integral. The last part covers the topics of differentiation, functions of bounded variation and Fourier series. The course provides the main background needed in modern Advanced Mathematics related to Real Analysis.

AMCS 241 – Stochastic Processes (3-0-3) (Equivalent to STAT 250)

Prerequisites: Advanced and multivariate calculus.
Introduction to probability and random processes. Topics include probability axioms, sigma algebras, random vectors, expectation, probability distributions and densities, Poisson and Wiener processes, stationary processes, autocorrelation, spectral density, effects of filtering, linear least-squares estimation and convergence of random sequences.

AMCS 251 – Numerical Linear Algebra (3-0-3)

Prerequisites: Programming skills (MATLAB preferred) and linear algebra.
Linear algebra from a numerical solution perspective. Singular Value Decomposition, matrix factorizations, linear least squares, Gram-Schmidt orthogonalization, conditioning and stability, Eigen analysis, Krylov subspace methods and preconditioning and optimization and conjugate gradient methods.

AMCS 252 – Numerical Analysis of Differential Equations (3-0-3)

Prerequisites: Familiarity with Taylor series, norms, orthogonal polynomials, matrix analysis, linear systems of equations, eigenvalues, differential equations, and programming in MATLAB or a similar language.
The course covers theory and algorithms for the numerical solution of ODEs and of PDEs of parabolic,

hyperbolic and elliptic type. Theoretical concepts include: accuracy, zero-stability, absolute stability, convergence, order of accuracy, stiffness, conservation and the CFL condition. Algorithms covered include: finite differences, steady and unsteady discretization in one and two dimensions, Newton methods, Runge-Kutta methods, linear multistep methods, multigrid, implicit methods for stiff problems, centered and upwind methods for wave equations, dimensional splitting and operator splitting.

AMCS 253 – Iterative Methods of Linear and Nonlinear Algebra (3-0-3)

Prerequisites: Programming skills (MATLAB preferred) and linear algebra.

Classical stationary iterative methods of linear algebra, Chebyshev, multilevel and Krylov subspace iterative methods, preconditioners from approximate factorizations, hierarchical solvers and domain decomposition; Classical nonlinear iterative methods, fixed-point, Newton and its variants, nonlinear Schwarz methods.

AMCS 255 – Advanced Computational Physics (3-0-3)

This course covers a selection of advanced topics related to computational physics. Based on prior knowledge in calculus and linear algebra, the following topics are considered: Lagrangian formalism, symmetries and conservation laws, stability and bifurcation, multi-body problems and rigid bodies, linear and nonlinear oscillations, Hamiltonian formalism, canonical transformations and invariances, Liouville's theorem, discrete Lagrangian and Hamiltonian formalisms, Hamilton Jacobi theory, transition to quantum mechanics and relativity fields.

AMCS 271 – Applied Geometry (3-0-3)

Differential Geometry: selected topics from the classical theory of curves and surfaces, geometric variational problems, robust computation of differential invariants, discrete differential geometry. Projective Geometry: computing with homogeneous coordinates, projective maps, quadrics and polarity. Algebraic Geometry: algebraic curves and surfaces, rational parameterizations, basic elimination theory. Kinematical Geometry: geometry of motions, kinematic mappings. The practical use of these topics is illustrated at hand of sample problems from Geometric Modelling, Computer Vision, Robotics and related areas of Geometric Computing.

AMCS 272 – Geometric Modelling (3-0-3)

Prerequisites: Advanced and multivariate calculus and linear algebra, computer graphics, and programming experience. Terminology, coordinate systems, and implicit forms. Parametric and spline representations of curves and surfaces and their uses. Basic differential geometry of curves and surfaces. Subdivision surfaces. Solid modelling paradigms and operations. Robustness and accuracy in geometric computations. Applications.

AMCS 290 – Special Topics in Applied Mathematics and Computational Science (3-0-3)

Master's-level lectures focusing on state of the art within the field.

AMCS 293 – Traveling Scholar (variable credit)

Master's level traveling scholar.

AMCS 294 – Contemporary Topics in Applied Mathematics and Computational Science (3-0-3)

A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

AMCS 295 – Internship (6-0-6 or variable credit)

Master's level internship.

AMCS 297 – Master's Thesis Research (variable credit)

Master's level research leading to a formal written thesis and oral defense.

AMCS 299 – Master's Directed Research (variable credit)

Prerequisite: Sponsorship of advisor and approved prospectus.

Master's level supervised research.

AMCS 303 – Numerical Methods of Geophysics (3-0-3)

Prerequisite: ErSE 203 or consent of instructor.

Built on the modelling and simulation foundation developed in ErSE203, this specialized course will discuss advanced ideas of multi-scale modelling, linear and non-linear finite element methods, investigate modern approaches to numerical simulations of hydrodynamic and geophysical turbulence, problems of theoretical glaciology and material science of ice for the prediction of ice sheet evolution and wave propagation in linear and non-linear media.

AMCS 308 – Stochastic Numerics with Application in Simulation and Data Science (3-0-3)

Prerequisites: Basic probability, numerical analysis, and programming.

Review of basic probability; Monte Carlo simulation; state space models and time series; parameter estimation, prediction and filtering; Markov chains and processes; stochastic control; Markov chain Monte Carlo. Examples from various engineering disciplines.

AMCS 312 – High Performance Computing (3-0-3)

Prerequisites: Experience with Linux and C/C++ and familiarity with basic discrete and numerical algorithms.

High performance computing algorithms and software technology, with an emphasis on using distributed memory systems for scientific computing. Theoretical and practically achievable performance for processors memory system, and network, for large-scale scientific applications. The state-of-the-art and promise of predictive computational science and engineering. Algorithmic kernels common to linear and nonlinear algebraic systems, partial differential equations, integral equations, particle methods, optimization and statistics. Computer architecture and the stresses put on scientific applications and their underlying mathematical algorithms by emerging architecture. State-of-the-art discretization techniques, solve libraries and execution frameworks.

AMCS 329 – Finite Element Methods (3-0-3)

An introduction to the mathematical theory of finite element methods and their applications to the solution of initial and boundary-value problems. A major component of the course will focus on the development of FE applications using the commercial software COMSOL Multiphysics to illustrate the fundamental features of the method. Topics of interest will cover classical problems in engineering and science.

AMCS 330 – Computational Science and Engineering (3-0-3)

Prerequisites: Programming experience and familiarity with basic discrete and numerical algorithms and experience with one or more computational applications.

Case studies of representative and prototype applications in partial differential equations and mesh-based methods, particle methods, ray-tracing methods and transactional methods.

AMCS 331 – Applied Partial Differential Equations II (3-0-3)

Prerequisites: Multivariate calculus, elementary complex variables, ordinary differential equations. Recommended: AMCS 231 or AMCS 201.

Second part of a sequence of courses on partial differential equations (PDE) emphasizing theory and solution techniques for nonlinear equations. Quasi-linear and nonlinear PDE in applications. Conservation laws, first-order equations, the method of characteristics. Burgers' equation and wave breaking. Weak solutions, shocks, jump conditions and entropy conditions. Hyperbolic systems of gas dynamics, shallow-water flow, traffic flow and bio-fluid flow. Variational principles, dispersive waves, solitons. Nonlinear diffusion and reaction-diffusion equations in combustion and biology. Traveling waves and their stability. Dimensional analysis and similarity solutions. Perturbation methods. Turing instability and pattern formation. Eigenvalue problems. Stability and bifurcation.

AMCS 332 – Introduction to Mathematical Modelling (3-0-3)

An introduction to mathematical modelling through a combination of practical problem-solving experience and applied mathematics techniques, including dimensional analysis, non-dimensionalization, asymptotic expansions, perturbation analysis, boundary layers, computing and other topics.

AMCS 333 – Hyperbolic Conservation Laws and Godunov-type Methods (3-0-3)

Prerequisites: Analysis of PDEs (AMCS 231) and Numerical analysis of PDEs (AMCS 252).

The course covers theory and algorithms for the numerical solution of linear and nonlinear hyperbolic PDEs, with applications including fluid dynamics, elasticity, acoustics, electromagnetics, shallow water waves and traffic flow. The main concepts include: characteristics; shock and rarefaction waves; weak solutions; entropy; the Riemann problem; finite volume methods; Godunov's method; TVD methods and high order methods; stability, accuracy and convergence of numerical solutions.

AMCS 334 – Mathematical Fluid Dynamics (3-0-3)

Prerequisites: AMCS 231 or AMCS 201. Recommended: AMCS 331.

Equations of fluid dynamics; inviscid flow and Euler equations; vorticity dynamics; viscous incompressible flow and Navier-Stokes equations; existence, uniqueness and regularity of solutions of Navier-Stokes equations; Stokes flow; free-surface flows; linear and nonlinear instability and transition to turbulence; rotating flows; compressible flow and shock dynamics; detonation waves.

AMCS 335 – Multiscale Modelling and Simulation for PDEs (3-0-3)

The course will cover some basic multiscale methods as well as some advanced methods for solving partial differential equations with multiple scales. The topics will include: Background, Problems with multiple scales; Difficulties in solving multiscale problems; Homogenization techniques for partial differential equations (PDEs) (with periodic micro-structure); Formal asymptotic analysis; Homogenized media properties. Applications to various PDEs: Effective medium theory (based on homogenization); Simplified theories; Bounds for homogenized coefficients: Numerical homogenization (upscaling) techniques; Slowly varying and non-periodic microstructures; Estimating errors of numerical homogenization: Homogenization for nonlinear operators; Numerical homogenization for nonlinear operators; Multiscale finite element methods; Differences from homogenization/numerical homogenization; Simplified multiscale basis functions.

AMCS 336 – Numerical Methods for Stochastic Differential Equations (3-0-3)

Prerequisites: knowledge of basic probability, numerical analysis, and programming.

Brownian motion, stochastic integrals and diffusions as solutions of stochastic differential equations. Functionals of diffusions and their connection with partial differential equations. Weak and strong approximation, efficient numerical methods and error estimates. Jump diffusions.

AMCS 338 – Functional Analysis (3-0-3)

This course covers topics in Real Analysis and Functional Analysis and their applications. It starts with a review of the theory of metric spaces, the Lp spaces, and the approximation of real functions. It proceeds to the theory of Hilbert spaces, Banach spaces and the main theorems of functional analysis, linear operators in Banach and Hilbert spaces, the spectral theory of compact, self-adjoint operators and its application to the theory of boundary value problems and linear elliptic partial differential equation. It concludes with approximation methods in Banach spaces.

AMCS 350 – Spectral Methods for Uncertainty Quantification (3-0-3)
This course is an advanced introduction to uncertainty propagation and quantification in model-based simulations. Examples are drawn from a variety of engineering and science applications, emphasizing systems governed by ordinary or partial differential equations. The course will emphasize a probabilitic framework and will survey classical and modern approaches, including sampling methods and techniques based on functional approximations.

AMCS 353 – Advanced Topics in Wave Propagation (3-0-3)
This course starts from the basic linearized theory of wave phenomena: examples are chosen from electromagnetics, acoustics, elastics and other subjects and exposes the recent developments in wave propagation. The topics include : basic concepts in wave propagation; waves in layered media; scattering, transmission and reflection; waves in random media, effective medium properties, resolution analysis; applications in wave functional materials and imaging and numerical techniques in techniques in solving wave equations in heterogeneous media. Basic knowledge on eigenvalue problem, fourier transform, linear algebra, vector analysis is desired.

AMCS 354 – Asymptotic Methods of Applied Mathematics (3-0-3)
Prerequisite: Basic courses in complex analysis, ODE, and PDE. Asymptotic approximations, regular and singular asymptotics, approximation of integrals (methods of stationary phase and steepest descents), asymptotic analysis of ODE at regular/irregular singular points, parameter asymptotics for initial/boundary value problems, matched asymptotic expansions, the method of multiple scales, WKB method, weakly nonlinear oscillations and waves, bifurcation and stability.

AMCS 355 – Advanced Topics in Numerical Integration (3-0-3)
Prerequisite: AMCS 252
Numerical methods for solving initial value ODEs, especially large problems arising from semi-discretization of PDEs. Review of Runge-Kutta and multistep methods: consistency, stability, convergence, accuracy. Error estimation and step size control. Stiffness, order reduction, stage order and stiff accuracy. Logarithmic norms and one-sided Lipschitz constants. Symplectic and energy-conserving methods. Monotonicity-, contractility- and positivity-preserving methods. Methods for Multiphysics problems: stabilized methods, exponential, and additive methods. Parallel time integration methods: Parallel, deferred corrections and PFASST, extrapolation.

AMCS 370 – Inverse Problems (3-0-3)
Prerequisites: Linear algebra, multi-variable calculus. The aim of the course is to introduce the basic notions and difficulties encountered with ill-posed inverse problems, to present methods for analyzing these problems and to give some tools that enable to solve such problems. The course will show what a regularization method is and introduce different kinds of regularization techniques and the basic properties of these methods for linear ill-posed problems. Non-linear inverse problems are also studied through some examples: inverse spectral problem, inverse problem of electrical impedance tomography and the inverse scattering problem. The course will introduce numerical tools for analyzing inverse problems, with a focus on the adjoint state method. The Bayesian estimation is also considered. Examples of inverse problems are provided especially in medical imaging.

AMCS 390 – Special Topics in Applied Mathematics and Computational Science (3-0-3)
Doctoral-level lectures focusing on state of the art within the field.

AMCS 393 – Traveling Scholar (variable credit)
Doctoral level traveling scholar.

AMCS 394 – Contemporary Topics in Applied Mathematics and Computational Science (3-0-3)
A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

AMCS 395 – Internship (variable credit)
Doctoral level internship.

AMCS 396 – Mathematical Modelling in Computer Vision (3-0-3)
Prerequisites: multivariable calculus and basic probability theory.
A research course that covers topics of interest in computer vision, including image denoising/debluring, image segmentation/ object detection and image registration / matching. The emphasis will be on creating mathematical models via the framework of Bayesian estimation theory, analyzing these models and constructing computational algorithms to realize these models. Techniques from calculus of variations, differential geometry and partial differential equations will be built up as the need arises.

AMCS 397 – Doctoral Dissertation Research (variable credit)
Doctoral level research leading to a formal written dissertation and oral defense.

AMCS 398 – Graduate Seminar (non-credit)
Graduate seminar focusing on special topics within the field.

AMCS 399 – Doctoral Directed Research (variable credit)
Prerequisite: Sponsorship of advisor.
Doctoral level supervised research.

AP
Applied Physics
Division of Physical Science and Engineering (PSE)

AP 199 – Directed Study in Applied Physics (variable contact hours, non-credit)
A course of self-study in a particular topic as directed by faculty and approved by the division.

AP 210 – Spectroscopy of Solids (3-0-3)
This course provides an introduction to the spectroscopy of solids. The first part covers fundamentals including, electromagnetic radiation, light sources, spectral analysis of light, and light detection. The second part will discuss light-matter interaction, covering dielectric responses of matter, transitions in the visible and near-visible spectral range, and selection rules. Finally, different spectroscopy techniques are reviewed and their application to different material classes including organic, hybrid, and inorganic materials are discussed.

AP 220 – Statistical Physics (3-0-3)
Prerequisite: MSE 200 and MSE 227 are beneficial but not mandatory
This course provides an introduction to statistical thermodynamics (physics) and then discusses more advanced problems by covering the following topics: macroscopic vs. microscopic systems, statistical weight, calculus of probabilities, Boltzmann distribution function, Lagrange multipliers, mean energy and internal energy of particles. Statistical ensembles: microcanonical and canonical ensembles, canonical and molecular partition functions, heat capacity, auxiliary functions. Further ensembles: Grand-canonical and others, fluctuations. Partition functions: translational, rotational, and vibrational partition functions, electronic and nuclear contributions, properties of the ideal gas, and equipartition principle. Monoatomic crystals: Einstein and Debye model of heat capacity. Classical statistics and quantum statistics: density of states, quantum statistics, bosons, fermions, and their microstates, distribution functions: Maxwell's velocity distribution, Fermi-Dirac statistics (electron gas), Bose-Einstein statistics (photon gas). Equilibria and dynamics: equilibrium constants and collision theory.

AP 228 – Advanced Quantum Mechanics (3-0-3)
Prerequisite: MSE 227
This class builds on basic concepts introduced in the Applied Quantum Mechanics course (MSE227) and expands towards more advanced topics. It covers angular momentum, spin angular momentum, including Clebsch-Gordan coefficients and Kramers theorem. Approximation methods are also addressed, such as perturbation theory, variational method, and time-dependent perturbation within the interaction picture, as well as adiabatic theorem and Berry's phase and quantum theory of scattering. Finally, relativistic quantum mechanics and Dirac equation will be introduced.

AP 230 – Condensed Matter Physics (3-0-3)
Prerequisite: MSE 225
This course aims at establishing solid foundations in condensed matter physics. Prior to take this class, students should be familiar with basic electronic properties of materials (such as MSE225) and standard applied mechanics (such as MSE227). Starting with the band theory of solids and tight-binding model, it covers the semiclassical theory of metals, and addresses the concepts and Bloch states, Fermi surface and quantum oscillations, as well as scattering rates, beyond the relaxation time approximation. Then, electron liquid theory is addressed and basics concepts related to electron-electron interactions are covered, including the Stoner criterion, the Ha rtree-Fock approximation, Fermi and Luttinger liquids, and charge/spin density waves. Finally, superconductors are considered, including London, Ginzburg-Landau and BCS theories.

AP 293 – Traveling Scholar (variable credit)
Master's level traveling scholar.

AP 294 – Contemporary Topics in Applied Physics (3-0-3)
A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

AP 295 – Internship (6-0-6 or variable credit)
Master's level internship.

AP 297 – Master's Thesis Research (variable credit)
Master's level research leading to a formal written thesis and oral defense.

AP 299 – Master's Directed Research (variable credit)
Master's level supervised research.

AP 320 – Introduction to Nanoelectronics (3-0-3)
This class explores quantum transport in mesoscopic devices. It addresses quantum transport in clean systems, including quantum conductance interference effects in nanodevices such as Aharonov-Bohm effects, and quantum oscillations. Properties of two-dimensional electron gases and nanowire will be discussed. The effect of disorder is discussed from Knudsen regime, including size effects, to drift-diffusion model and

quantum corrections to conductance including weak and strong localization, universal conductance fluctuation. Finally, single electron transistor, Coulomb and Pauli spin blockade regimes will be presented.

AP 330 – Many-Body Theory in Condensed Matter (3-0-3)

Prerequisite: AP 228
This course introduces techniques and concepts in many-body quantum physics in condensed matter. Fundamental theoretical tools such as second quantization, Green's function formalism, as well as Feynmann diagrams will be introduced and applied to selected topics such as weak localization, interacting electron systems, superconductivity.

AP 393 – Traveling Scholar (variable credit)

Doctoral level traveling scholar.

AP 394 – Contemporary Topics in Applied Physics (3-0-3)

A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

AP 395 – Internship (variable credit)

Doctoral level internship.

AP 397 – Doctoral Dissertation Research (variable credit)

Doctoral level research leading to a formal written dissertation and oral defense.

AP 398 – Graduate Seminar (non-credit)

Graduate seminar focusing on special topics within the field.

AP 399 – Doctoral Directed Research (variable credit)

Doctoral level supervised research.

B

Bioscience
Division of Biological and Environmental Science and Engineering (BESE)

B 100 – Basic Chemistry for Life Sciences (3-0-0)

This course will cover the essential foundations of general chemistry and organic chemistry relevant for all life science studies.

B 101 – Introductory Biochemistry (3-0-0)

This class targets at students with entry-level background in Biochemistry. It serves as refreshment as well as a boost course for those aiming to major in all disciplines in biology. The class starts with covering the chemistry principles that governs protein folding, mechanisms, kinetics and regulation. It then expands on these principles to introduce the structures and metabolisms of carbohydrates and lipids. The second half of the course focuses on introducing the foundation behind membrane functions, energy conversion pathways and the key metabolic pathways.

In addition to the upfront classroom teaching, the class will apply problem-based learning strategy to strengthen the critical thinking and quantitative skills of the students. This course will provide foundation that is necessary for many classes in BESE division with particular support to the advanced Cell Biology courses B 213 and B 224, Molecular and Cell Biology lab B 241, Bimolecular Structure and Function B 214 and Biochemistry and Metabolic Engineering B 305.

B 102 – Introductory Cell Biology (3-0-0)

This class targets students with entry-level background in cell biology. It serves as refreshment as well as a boost course for those aiming to major in all disciplines in biology. The class starts with defining the main terminology and fundamental principles of cell biology, it then recapitulates the different building blocks of cells from molecular to organelle level. Using a combination of upfront classroom teaching and problem-based learning, the principles of signaling, metabolism and energy homeostasis are discussed in the context of cellular organization.

Selected examples of different aspects of cell biology are examined to provide students with the central scientific concepts of this field that are essential for the advanced Cell Biology courses B 213 and B 224. These concepts are also important foundation to several other courses in BESE. A major aim of the class is to demonstrate students how deductive processes are applied in the life sciences for the gain of new knowledge.

B 103 – Introductory Microbiology (3-0-0)

This course aims at an audience with basic experience in microbiology. It will serve students intending to major in all disciplines in biology as opportunity to refresh existing knowledge as well as to broaden their horizon. The class starts with an overview over microbial cell structure and functions, metabolism and growth control as well as basic microbial genomics and genetics and their relevance for biotechnology. Microbial systematics and metabolic diversity will be introduced and illustrated by selected examples from different microbial taxa. Finally, the pivotal role of microorganisms in large scale ecological processes will be discussed and their interaction with other organisms, including humans, will be covered. Upfront-style teaching to classes will be combined with problem-based interactive approaches. Exemplary problems will be discussed to introduce students to essential topics that will be prerequisites for Fundamental of Microbiology B 211, Advanced Environmental Microbiology B 313 and Genomics B 204. It will also provide complementary foundation to the advanced Cell Biology courses B 213 and B 224 and Synthetic Biology and Biotechnology B 206. In addition, a central aim of the class is to help students realize how deductive processes are harnessed in biological research to gain new insight.

B 104 – Introductory Molecular Biology (3-0-0)

This course aims at an audience with basic competences in molecular biology and genetics. It will serve as a reminder as well as extension course for those intending to major in all disciplines in biology. The class starts with an overview over the features of DNA as the carrier of genetic information in cells and the mechanisms by which it is maintained over cell generations. Further, it addresses the fundamental mechanisms by which the information encoded in DNA is transcribed into RNA and then translated into proteins as functional units. Basic concepts of eukaryote genetics such as chromosome function and Mendelian heredity will be covered as well as aspects of bacterial genetics relevant for experimental molecular biology.

Upfront teaching will be combined with problem-based interactive approaches. Exemplary problems will be studied to further familiarize students with the essential concepts that are required for the advanced Cell Biology courses B 213 and B 224, Genomics B 204 and Synthetic Biology and Biotechnology B 206. A central goal of the course is to make students aware of how deductive processes are applied in biological research for the advancement to new insight.

B 199 – Directed Study in Bioscience (variable contact hours, non-credit)

A course of self-study in a particular topic as directed by faculty and approved by the division.

B 204 – Genomics (3-0-3)

Principles and technologies for generating genomic information for ecological, biomedical and biotechnological applications. Technologies will be introduced progressively, from DNA to RNA to protein to whole cell systems. The integration of biology, chemistry, engineering and computational sciences will be stressed. Topics include: Technology for the High-throughput Sequencing, Methods for annotating genomes, characterizing functional genes, Gene Expression, Comparative Genomics, Population Genomics, Proteomic Technologies and Systems Biology.

B 206/306 – Synthetic Biology and Biotechnology (3-0-3)

Introduction to genetic circuits in natural systems; engineering principles in biology; BioBricks and standardization of biological components; numerical methods for systems analysis and design; fabrication of genetic systems in theory and practice; transformation and characterization; examples of engineered systems.

B 209 – Molecular Genetics (3-0-3)

The course will begin by introducing classical genetics and transition to a comprehensive coverage of molecular genetics, with an emphasis on molecular tools used to engineer genetic change. The first part of the course will cover the basic principles of classical genetics such as heredity, mutations, pedigree analysis, genetic testing, and genetic mapping. These topics include an understanding of how genetics was used to discover the rules for genetic inheritance, chromosome organization, replication (DNA), transcription (RNA), and translation (proteins). These concepts will be used to describe gene regulation and mRNA processing in eukaryotes. The second part will discuss how technologies such as sequencing and proteomics have revolutionized the field of genetics, with a special focus on crop breeding and synthetic genetics in model organisms. We will discuss how these tools allow engineering plants, cells, and organisms for agricultural and health-related purposes.

B 211 – Fundamentals of Molecular Microbiology (3-0-3)

This course is designed to provide introductory concepts on fundamentals of microbiology. This course covers basic knowledge on molecular biology of microorganisms, microbial bio-diversity, and microbial diseases. In the end, a series of practical sessions will also be included to provide students with some basic skills in molecular microbiology.

B 213 – The Cell: Structure, Development and Physiology II (3-0-3)

Pre-requisite: B 244 – The Cell: Structure, Development and Physiology I

The scope of this course is to provide a comprehensive overview of eukaryotic cell structure and the fundamental functional aspects of membranes, organelles, nuclear architecture, genome and epigenome in the context of development, specialization, and integration with the environment.

B 214 – Biomolecule Structure and Function (3-0-3)

This course will start with an overview of the structural features of proteins and some other biological macromolecules, and discuss how these features have evolved to support specific functions. The course will then proceed to introduce the major methods used to determine 3D structures of proteins and other biomolecules, in particular X-ray crystallography, Nuclear Magnetic Resonance, cryo-Electron Microscopy, Small Angle X-ray Scattering and computational methods (Bioinformatics, 3D Homology Modelling). We will discuss the strengths and weaknesses of each method and to instruct students on how these methods are best used and combined.

B 224 – The Cell: Structure, Development and Physiology I (3-0-3)

The scope of this course is to provide a comprehensive overview of eukaryotic cell structure and the fundamental functional aspects of membranes, organelles, nuclear architecture, genome and epigenome in the context of development, specialization, and integration with the environment.

B 241 – Molecular and Cellular Biology Lab (3-0-3)

This course covers principles and practice of basic molecular and cellular biology techniques; Introduction to skills in a Molecular and Cellular Biology lab; Plasmids: transformation, isolation and restriction digestion; protein production, purification and functional assay; Small-interfering RNAs (siRNA) and gene expression; Isolation of RNA and Analysis of gene expression by Polymerase Chain Reaction (PCR) and RT-qPCR; Immunofluorescence: following cellular movement of a shuttling RNA-binding protein before and after stress.

B 290B – Special Topics: Biophysics (3-0-3)

This course is destined to provide biologists with the principals of biophysics, in particular concerning theoretical bases and their usage in modern molecular biology along with other biophysical techniques that are used for the characterization of macromolecules in the state-of-the-art laboratories. Thus the course aims at allowing biology students to understand advanced structural biology and biophysical methods well enough to critically evaluate research in these areas, plan own experiments, and fully profit from available resources (for example the PDB, BMRB, and other data bases and professional servers). For students in the field of bioscience, this course should also provide a solid basis for their own experimental research.

B 293 – Traveling Scholar (variable credit)

Master's level traveling scholar.

B 294 – Contemporary Topics in Bioscience (3-0-3)

A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

B 295 – Internship (6-0-6 or variable credit)

Master's level internship.

B 296 – Lab Rotation (3-0-3)

Master's students are expected to go through a lab rotation their first fall semester. The objective of this course is to help students in identifying their future research advisor by exposing them to different research areas. Master's students are expected to complete 3 rotations their first semester (5 weeks per rotation). The nature of the rotation may vary from one (1) lab to another depending on the advisor; thus some rotations can be research focused and others can involve more literature and background work

B 297 – Master's Thesis Research (variable credit)

Master's level research leading to a formal written thesis and oral defense.

B 299 – Master's Directed Research (variable credit)

Master's level supervised research.

B 316 – Foundations in Bioimaging (3-0-3)

This course provides a comprehensive overview of bioimaging techniques including fundamental concepts and applications, which allow biology students to design imaging experiments for their own research. The course covers basic optics and spectroscopy, advanced fluorescence microscopy, basics of electron microscopy, and single-molecule imaging techniques. The course also introduces label-free optical imaging methods including Raman and infrared microscopy, Second and Third harmonic microscopy and holographic microscopy. Introduction to advanced methods for manipulation of single cells and single molecules (optical and magnetic tweezers), Atomic Force Microscopy and some references to advanced applications of electron microscopy for imaging bio-samples will be also provided.

B 317 – Advanced Environmental Microbiology (3-0-3)

Pre-requisite: B 211, EnSE 203 or B 206. (Please note: prerequisites are for M.Sc. students only).
The course introduces the principles and applications of microbial biotechnology for the environment under the concepts of Microbial Resource Management. The course illustrates the biology, ecology, production and application of microorganisms for sustainable agriculture and environmental bioremediation and cleanup. The course is divided in four sections: 1) "Microbial diversity and soil fertility" illustrates prokaryote phylogeny and the microbial role in the soil/plant ecosystem. 2) "Microbial antagonism and biocontrol" deals with the biology, ecology and biotechnology of symbiotic and antagonistic microorganisms against phytopathogens and insects. 3) "Microbial technologies for environmental decontamination and bioremediation" introduces the metabolic pathways for pollutants' degradation and the technologies for their exploitation in aquatic and terrestrial ecosystems. 4) "The industrial production of microorganisms for environmental applications" illustrates the principles of industrial microbiology including strain selection, microbial growth, and the fermentative process.

B 318 – Tissue Engineering and Regenerative Medicine (3-0-3)

The course covers major topics in tissue engineering and regenerative medicine. The fast moving fields of tissue engineering and regenerative medicine are considered to have transformative implications for future biomedical applications and the future health care. This course should give an overview on the current state in tissue engineering and regenerative medicine, for example stem cell bioengineering and cell therapy, at the level of basic principles and of specific applications, with additional focus on clinical trials.

B 319 – Biomaterials and Biomedical Devices (3-0-3)

This course is about the biomedical implants, the materials used in biomedical devices and the operation and fabrication of electrical devices such as sensors or stimulators that are designed to communicate with human body. It will provide an overview of the research highlights in the field of biomedical engineering and design principles of the materials/devices currently employed in the clinic.

B 320 – Stem Cells and Molecular Medicine (3-0-3)

Prerequisite: B 224 (Please note: prerequisites are for M.Sc. students only.)
This course will provide a comprehensive overview of pluripotent stem cell biology, advanced techniques of cellular reprogramming, trans differentiation and genome editing and how these technologies can be applied to disease modeling studies.

B 321 – Epigenetics and Chromatin (3-0-3)

Prerequisites: B 241, B 224, 213 (Please note: prerequisites are for M.Sc. students only)
The major aim of the three-week summer block course is to train participants (min. 6, max. 12) in experimental Cell Biology on the example of Chromatin Biochemistry, Epigenome Structure and Nuclear Organization. To improve students' skills in designing, executing and analyzing experiments, the course combines two principles: theory and practice. Besides covering the fundamental background and theory of Epigenetics and Genome Regulation, participants will learn basal and cutting-edge experimental technologies that are currently used to answer key questions at the frontiers of Epigenetics research. The course is shaped according to international EMBL (European Molecular Biology Laboratories) and MPI (Max Planck Institutes) advanced method courses for M.Sc. and Ph.D. students. Profs. Orlando and Fischle (including their laboratories' staff) will introduce Applied Epigenetics on the basis of dissection of classical and recent experiments. Student participants will carry out several hands-on experiments with step-by-step instructions.

B 322 – Computational Bioscience and Machine Learning (3-0-3)

The Course provides a broad and practical overview of selected techniques and concepts in rapidly developing areas such as bioinformatics, computational biology, systems biology, systems medicine, network biology, synthetic biology, data analytics, predictive modelling, machine learning, and machine intelligence. Topics are selected to be of relevance for the computer scientist, working biologist, computational scientist, and applied investigator (Biotechnology and engineering).

B 345 – Advanced Topics: Bioscience (3-0-3)

The course reviews current topics in bioscience, particularly relying on scientific journal publications to provide case studies, illustrative examples, classic studies and controversial findings pertinent to specific fields within biosciences.
The course will feature an emphasis on primary literature searches, reading and assessment of primary literature. It is expected that the student reads no less than 5 scientific papers per week in the prescribed topic area and is capable of presenting and critically discussing the content of these publications. In this level 300 course, the student assessment is based on active participation in the lectures and tutorials.

B 390L – Special Topics: Advanced Bioimaging (3-0-3)

Prerequisite: B 316 Foundations in Bioimaging (Please note: prerequisites are for M.Sc. students only.)
This course provides a broad and in depth overview of cutting edge imaging techniques used in life science researches: advanced application of both Transmission and Scanning Electron Microscopy (TEM and SEM) to biological materials investigations; fluorescence imaging and related techniques, including selective-plane illumination microscopy, super-resolution fluorescence imaging, tissue clearing techniques, and advanced fluorescent protein technologies; Coherent Raman microscopy; Near-field optical microscopy and recent advances in endoscopy; digital holographic microscopy. Through hands-on learning, the students will also learn: basics of correlative light and electron microscopy (CLEM), cryo-methods for bio-samples preparation, EM-based methods for the 3d reconstruction of cells and tissues, basic and advanced fluorescence microscopy techniques including confocal microscopy and stimulated emissions depletion (STED) microscopy for cellular imaging.

B 390N – Special Topics in Genomics, Medicine, and Digital Health/Wellness Using Machine Learning (3-0-3)

Recent progress in machine learning and artificial intelligence is currently transforming genomics, translational medical research, healthcare, and wellness. Huge data-sets are produced at an increasing rate. This include recordings of smart living augmented by sensor devices, medical images, text data in healthcare and social media, and genomics profiling of a range of different biomolecular data. Concurrent with these developments there has over the last 5 years been a stunning production of open source machine learning tools and powerful computational platforms. These advances are currently advancing bioinformatics, computational biology, systems biology, where an area which could be referred to as Digital Medicine in a broad sense is emerging. We expect students with a background in computer science, mathematics, bioscience, and engineering to learn how to use, develop, and to think on how to use ML/AI techniques in what can broadly be referred to as Digital Technologies for Medicine and Health.

B 393 – Traveling Scholar (variable credit)

Doctoral level traveling scholar.

B 394 – Contemporary Topics in Bioscience (3-0-3)

A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

B 395 – Internship (variable credit)

Doctoral level internship.

B 397 – Doctoral Dissertation Research (variable credit)
Doctoral level research leading to a formal written dissertation and oral defense.

B 398 – Graduate Seminar (non-credit)
Graduate seminar focusing on special topics within the field.

B 399 – Doctoral Directed Research (variable credit)
Doctoral level supervised research.

BioE
Bioengineering
Division of Biological and Environmental Science and Engineering (BESE)

BioE 199 – Directed Study in Bioengineering (variable contact hours, non-credit)
A course of self-study in a particular topic as directed by faculty and approved by the division.

BioE 201– Foundations of Bioengineering (3-0-3)
This course contains elements of programing, statistics, electronics, materials and synthetic biology. It describes the fundamental principles and methods of different engineering fields to provide the necessary background for future specialization in the tracks of this program. The course aims to apply engineering principles to understand the physical, chemical, and mathematical basis of biological systems.
The students will learn the origin of electrical biosignals, fundamental operation principles of modern electronics (sensing and control instrumentation) used at the interface with biological systems including EEG, ECG, biochemical sensors. They will learn about the basics of fabrication of devices involving microfluidics and microarray device design principles.
The students will be then introduced to the different types of reactor configurations commonly used as bioreactors, operational parameters related to these reactors, and optimization of the reactors to maximize cell yield.

The course will then introduce the principles of material science interfacing with biology, in order to design artificial implants and matrices for biomedical applications. This will broaden the knowledge of the chemical, physical and biological properties of the materials, focusing on the materials recently used in the biomedical field. In particular, students will develop critical analysis of biomaterial development and methods of characterization. Furthermore, it will also introduce cutting-edge techniques associated with 3D bioprinting.
Finally, the students will be introduced to data-analytics and modeling with particular focus on R and MATLAB through hands-on exercises. Using R students will learn to plot data-distributions, calculate summary statistics, perform dimension reduction analysis (PCA, and other related techniques) and to run elementary bioinformatics scripts. In the modeling part students will work with simple mathematical models for synthetic biology (biological switch and oscillator) and basic predictive models (KNN, decision trees and SVM) using MATLAB.

BioE 202– Foundations of Synthetic Biology (3-0-3)
The course focuses on introducing bioengineers to the types of concepts, cellular hosts, devices, and engineering principles they need to apply to solve real-world problems. Key concepts are covered including the cell as a basic unit of life, central dogma, gene regulation, genetic modification, growth, development and evolution. The course covers the basic principles of cell structure and function of different prokaryotic and eukaryotic species used as hosts for bioengineering applications (bacteria, yeast, algae, plant, human). Students will learn the chemical structure of DNA, RNA, and protein, enzymatic catalysis, metabolism, and manipulations. How this structure information is used to evolve new functions in these molecules will be discussed. The course then highlights the use of these key concepts, devices, molecules, and engineering principles to solve real world problems by providing examples and grand challenges.

BioE 230– Foundations of Bioengineering Lab (3-0-3)
In this course, students will gain hands on experience in fundamental operation principles of modern electronics used at the interface with biological systems. They will learn about the basics of fabrication of devices involving microfluidics and microarray device design principles. Students will then gain hands on experience in operating a bioreactor using the knowledge acquired from the lectures. Students will vary the different operational parameters and observe changes to the biomass, resource recovery etc.
Next, we will provide students the principles of material science interfacing with biology, in order to design artificial implants and matrices for biomedical applications. The course aims to broaden the knowledge of the chemical, physical and biological properties of the materials, focusing on the materials recently used in the biomedical field. In particular, students will develop critical analysis of biomaterial development and methods of characterization. Furthermore, it will also introduce cutting-edge techniques associated with 3D bioprinting.
Finally, students are introduced to data-analytics and modeling. Students will learn to use R and MATLAB through hands-on exercises. Using R students will learn to plot data-distributions, calculate summary statistics, perform dimension reduction analysis (PCA, and other related techniques) and to run elementary bioinformatics scripts. In the modeling part students will work with simple mathematical models for synthetic biology (biological switch and oscillator) and basic predictive models (KNN, decision trees and SVM) using MATLAB.

BioE 293 – Traveling Scholar (variable credit)
Master's level traveling scholar.

BioE 294 – Contemporary Topics in Bioengineering (3-0-3)
A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

BioE 295 – Internship (6-0-6 or variable credit)
Master's level internship.

BioE 297 – Master's Thesis Research (variable credit)
Master's level research leading to a formal written thesis and oral defense.

BioE 299 – Master's Directed Research (variable credit)
Master's level supervised research.

BioE 393 – Traveling Scholar (variable credit)
Doctoral level traveling scholar.

BioE 394 – Contemporary Topics in Bioengineering (3-0-3)
A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

BioE 395 – Internship (variable credit)
Doctoral level internship.

BioE 397 – Doctoral Dissertation Research (variable credit)
Doctoral level research leading to a formal written dissertation and oral defense.

BioE 398 – Graduate Seminar (non-credit)
Graduate seminar focusing on special topics within the field.

BioE 399 – Doctoral Directed Research (variable credit)
Doctoral level supervised research.

CE
Chemical Engineering
Division of Physical Science and Engineering (PSE)

CE 199 – Directed Study in Chemical Engineering (variable contact hours, non-credit)
A course of self-study in a particular topic as directed by faculty and approved by the division.

CE 201 – Chemical Thermodynamics (3-0-3)
Prerequisites: Undergraduate thermodynamics course.
The primary goal of chemical thermodynamics is the physical explanation of the fundamental principles governing the variety of chemical phenomena taking place in the world around us. The goal of this course is to give students a conceptual understanding of the main principles of thermodynamics. Topics include: the concept of entropy; the Clausius, Gibbs, Boltzmann and Shannon definition of entropy; entropy and information; Maxwells demon; the Boltzmann distribution law; the Maxwell-Boltzmann speed distribution; Gibbs and Helmholtz free energy; the chemical potential; Gibbs-Duhem and Euler equation; the Gibbs phase rule; entropy of mixing and Gibbs paradox; phase diagrams, the Flory-Huggins phase diagram; spontaneous and non-spontaneous processes; thermodynamics of chemical reactions; thermodynamics of osmosis and reverse osmosis, entropy and irreversible phase transitions; introduction in thermodynamics of irreversible processes; introduction in statistical thermodynamics.

CE 202 – Advanced Transport Phenomena (3-0-3)
Prerequisites: Basic knowledge of fluid mechanics, heat & mass transfer, vector analysis, and differential equations.
The aim of this course is to enable students to i) derive appropriate differential balances for specific material properties, including momentum, thermal energy, and mass species, accounting appropriately for property flux by convective and diffusive (molecular-scale) processes, along with property generation or loss in the material continua; ii) write the Thermal Energy Equation, the Species Continuity Equation, and the Navier-Stokes Equations and pose (simplify) them appropriately for specific transport problems; iii) know appropriate boundary conditions that can be applied to specific transport problems; iv) conduct scale or dimensional analyses of transport problems, using the analyses to help simplify or enhance understanding of underlying transport processes; v) solve and physically interpret one (1)-dimensional steady state conduction and species diffusion problems in rectangular, cylindrical, and spherical geometries, with and without zero-order and first-order generation/ loss; vi) use separation of variables technique to solve and physically interpret two (2)-dimensional steady-state conduction and species diffusion problems; vii) use similarity methods to solve and physically interpret unsteady state conduction and diffusion problems in unbounded material regions; viii) use the finite Fourier transform method to solve and interpret unsteady state conduction and diffusion problems in bounded material regions; ix) solve and physically interpret unidirectional steady and unsteady viscous flows in unbounded regions and in bounded regions (i.e. flow conduits or ducts); and x) solve and physically interpret simultaneous convection and diffusion (conduction) problems involving the interaction of thermal or concentration boundary layers with developing or developed velocity profiles.

CE 203 – Advanced Reaction Engineering (3-0-3)
The objective of this course is to impart and to continue the rigorous study of reaction engineering. In this course, particular emphasis will be given to chemical kinetics and transport phenomena, review of elements

of reaction kinetics, rate processes in heterogeneous reacting systems, design of fluid-fluid and fluid-solid reactors, scale-up and stability of chemical reactors and residence time analysis of heterogeneous chemical reactors.

CE 210 – Materials Chemistry I (3-0-3)
A presentation of present fundamental concepts in materials chemistry. The main topics to be covered include structure and characterization, macroscopic properties and synthesis and processing

CE 225 – Materials Chemistry II (3-0-3)
An introduction to electron microscopy based techniques: Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Electron diffraction (ED), Scanning transmission electron microscopy (STEM), Energy-filtered TEM (EFTEM), Energy dispersive X-ray analysis (EDX), and Electron energy loss spectroscopy (EELS). On-site demonstration of the electron microscope will be given. Nano porous materials including zeolites and mesoporous materials will be another topic of this course.

CE 226 – Process Modeling and Control (3-0-3)
This course aims at building knowledge in process systems modeling/control. This unit will also enable you to develop a systematic approach to process modeling, control design and controller development and analysis. The course aims at: developing an appreciation for the importance of process models and process control in a chemical plant/process, to see the significance of these in real life and to relate the theory learnt to practice; developing an appreciation for the importance of process models in the development of control theory and practice.

CE 230/330 – Physical Chemistry of Macromolecules (3-0-3)
Conformation and configuration; Solution Thermodynamics; Phase separation (theory and experimental aspects), polymer fractionation; Mechanisms and kinetics of phase separation; Miscibility of polymer blends and compatibilization; Micro phase separation and self-assembly; Rheology of polymer solutions; Viscosity of diluted and concentrated solutions, polymer gels; Rheology of polymer melts and composites, relevance for polymer processing; Amorphous state, glass-rubber transition, plasticizers; Elasticity and Viscoelasticity; Thermal analysis, dynamic mechanical analysis; Crystalline state, liquid-crystalline state; Mechanical properties.

CE 293 – Traveling Scholar (variable credit)
Master's level traveling scholar.

CE 294 – Contemporary Topics in CE (3-0-3)
A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

CE 295 – Internship (6-0-6 or variable credit)
Master's level internship.

CE 297 – Master's Thesis Research (variable credit)
Master's level research leading to a formal written thesis and oral defense.

CE 299 – Master's Directed Research (variable credit)
Master's level supervised research.

CE 305 – Sustainable Engineering (3-0-3)
Engineers face growing pressure to incorporate sustainability objectives into their practice. In comparing two (2) products/ designs it is often not apparent which one (1) is more sustainable. The course introduces concepts and method for determining the net environmental, economic, and social impacts of an engineering technology or process. Specific topics include life cycle assessment, cost/benefits analysis, energy auditing, materials accounting, and environmental assessment. These methods are examined and applied to current engineering issues such as global climate change, alternative-fueled vehicles, water and wastewater treatment, urban development, renewable energy (solar, wind, and biomass), and waste mitigation. Each student will be required to apply tools learned to assess the sustainability of a specific engineering system. This is a research-based course and is suitable for students interested in researching in-depth a particular topic. By the end of the course, students will have an awareness of analytical tools/resources for evaluating sustainability employing a systems perspective.

CE 317 – Clean Fossil Fuels and Biofuels (3-0-3)
The different types of biofuels will be presented and discussed in this course. Topics include biomass feedstocks, first, second and third generation of biofuels, fuel from cellulose, catalytic conversion of biomass to liquid, energy balance of biofuels, biological production of hydrogen, biodiesel, microbial fuel cells. The Clean Fossil Fuel part of this course deals with gasification processes including ICCG power plants, Fischer Tropsch synthesis, clean coal technologies, desulfurization and carbon dioxide capture and storage.

CE 336 – Membrane Science and Membrane Separation Processes (3-0-3)
Formulation and solution of engineering problems involving design of membrane systems for gas separation, reverse osmosis, filtration, dialysis, pervaporation and gas absorption/stripping processes. Membrane selection, fabrication and preparation. Membrane transport: gas permeation and reverse osmosis. Polarization and fouling, membrane module design.

CE 390 – Special Topics: Chemical Kinetic Modelling and Simulation (3-0-3)

Prerequisite: Advanced Reaction Engineering (CE 203), Advanced Transport Process (CE 202), Chemical Thermodynamics (CE 201) or similar courses in other programs.
Understanding the oxidation and pyrolysis chemistry of hydrocarbons can aid in developing thermal conversion processes and in improving combustion applications. Optimization of engine performance requires an understanding of how a fuel's molecular structure affects important combustion properties. The course presents the current state-of-the-art in comprehensive chemical kinetic modeling for gas-phase and liquid-phase reacting flows. The course will cover the development of large databases of chemical reaction pathways with associated kinetic rate parameters, as well as thermochemical and transport properties for all reactant, intermediate, and product species. First, the mapping out of detailed reaction pathways at the temperatures and pressures relevant to chemical reactors and combustion applications will be discussed. Next the art of assigning rate constants using chemical intuition and quantum chemical modeling will be covered. The determination of thermochemical and transport properties is achieved using both molecular modeling tools and empirical methods. The comprehensive models are then validated against data from well-defined experimental configurations using zero-dimensional and one-dimensional reacting flows whose physics can be simulated exactly. These models are finally employed to determine the thermal degradation and oxidation pathways relevant to the prediction of combustion performance in practical applications.

CE 390A – Special Topics: Chemical Kinetic Modelling and Simulation (3-0-3)

Prerequisite: Advanced Reaction Engineering (CE203), Advanced Transport Process (CE202), Chemical Thermodynamics (CE 201) or similar courses in other programs. Understanding the oxidation and pyrolysis chemistry of hydrocarbons can aid in developing thermal conversion processes and in improving combustion applications. Optimization of engine performance requires an understanding of how a fuel's molecular structure affects important combustion properties.
The course presents the current state-of-the-art in comprehensive chemical kinetic modeling for gasphase and liquid- phase reacting flows. The course will cover the development of large databases of chemical reaction pathways with associated kinetic rate parameters, as well as thermochemical and transport properties for all reactant, intermediate and product species. First, the mapping out of detailed reaction pathways at the temperatures and pressures relevant to chemical reactors and combustion applications will be discussed. Next the art of assigning rate constants using chemical intuition and quantum chemical modeling will be covered. The determination of thermochemical and transport properties is achieved using both molecular modeling tools and empirical methods. The comprehensive models are then validated against data from well-defined experimental configurations using zerodimensional and one-dimensional reacting flows whose physics can be simulated exactly. These models are finally employed to determine the thermal degradation and oxidation pathways relevant to the prediction of combustion performance in practical applications.

CE 390B – Special Topics: Heterogeneous Catalysis (3-0-3)

Catalysis in itself is a multi-disciplinary subject. It is considered to be part of physical chemistry, organometallic chemistry, surface sciences, or chemical engineering. In the world of the chemical engineer, catalysis is an enabling technology that is crucial for the application of chemistry in a modern society. This applies to the design and operation of modern plants, but also to the reduction of the environmental impact of mankind. This work treats the subject of catalysis from the point of view of the chemical engineer. This course focuses on heterogeneous chemocatalysis.

CE 390C – Special Topics: Sustainable Process Design (3-0-3)

The Sustainable Process Development will equip the next generation of chemical engineers with a process intensification toolbox in order to stay ahead of the 21st century's sustainability challenge: manufacture more from less. In particular, existing design principles and methods will be discussed, challenged and adapted to the new challenges of sustainable development. Quantitative sustainability assessment will be introduced and employed for industrial case studies. The crucial role of recovery and recycling units as well as continuous operation will be discussed.

CE 393 – Traveling Scholar (variable credit)

Doctoral level traveling scholar.

CE 394 – Contemporary Topics in CE (3-0-3)

A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

CE 397 – Doctoral Dissertation Research (variable credit)

Doctoral level research leading to a formal written dissertation and oral defense.

CE 398 – Graduate Seminar (non-credit)

Graduate seminar focuses on special topics within the field.

CE 399 – Doctoral Directed Research (variable credit)

Doctoral level supervised research.

ChemS

Chemical Science
Division of Physical Science and Engineering (PSE)

ChemS 101 – Basic Principles of General Chemistry (3-0-0)

A course covering: basic concepts of Atomic numbers, masses, isotopes, stoichiometry, atomic orbitals. Bonding in molecules: Lewis structures, resonance structures, Types of bonding interactions, Bond polarity and dipole moments, Hydrogen bonds, VB theory, hybridization, MO theory, isoelectronic molecules, aromaticity, VSEPR model.

Acids, bases and solutions: Bronsted acids and bases, Lewis acid theory, Introduction to coordination complexes, stability of complexes. Reduction and oxidation: Standard reduction potentials E0, Concentration effects, complexation and precipitation vs. E0, Disproportionation. Basic spectroscopy techniques (UV/Vis, IR, NMR, X-Ray, MS).

ChemS 102 – Basic Principles of Inorganic & Organic Chemistry (3-0-0)

A course covering periodicity and molecular symmetry: Atomic/ ionic radii, Electron affinities and electrone gativity, Symmetry operations and elements, Point groups and character tables, Chirality. General groups' properties: Alkali metals: Group I, Earth alkali metals: Group 2, Earth metals: Group 13, d- block chemistry. Coordination and Organometallic Chemistry: Ligand field theory, Jahn-Teller effect, Common types of ligands, Carbonyl complexes, Isolobal principle. Functional groups and their transformations: Alcohols and alkyl halides, Aldehydes and ketones, Carboxylic acids and esters, Amines and amino acids, Lipids. Common Organic Reactions and their mechanism: Condensation reactions, Elimination reactions, Substitution reactions, Radical reactions.

ChemS 103 – Basic Principles of Physical Chemistry (3-0-0)

A course covering basic concepts of thermodynamics and kinetics. Ideal gas law and its application; First law of thermodynamics: heat, work, heat capacity, Born-Habor cycle and its application; Second (and third) law of thermodynamics: entropy and its application; Helmholtz and Gibbs energies, spontaneity of reaction, standard Gibbs energy and its application; Chemical potential and phase rule; Fundamental equation of chemical thermodynamics and phase boundary; Raoult's and Henry's law; Phase diagram and distillation; Equilibrium, exothermic and endothermic reactions; Rate law: First order and second order reactions and simple examples (catalysis); Isotherm (Langmuir) and its application; Example of rate equation; Basic spectroscopy techniques relevant to thermodynamics and kinetics.

ChemS 199 – Directed Study in Chemical Science (variable contact hours, non-credit)

A course of self-study in a particular topic as directed by faculty and approved by the division.

ChemS 210 – Material Chemistry I (3-0-3)

Prerequisite: An understanding of the material covered in basic inorganic and organic chemistry. Presents students with a descriptive overview of Materials Chemistry with particular emphasis on the correlation between materials structure and their properties. This course will cover the following topics: molecular symmetry; basic crystallography; band theory; porous materials; nano-structured materials and some material characterization techniques including powder X-ray diffraction and physical adsorption.

ChemS 212 – Spectroscopy Analysis (3-0-3)

An introduction to the theory, application, and interpretation of four (4) major types of spectroscopy: absorption, infrared, and nuclear magnetic resonance spectroscopy, and mass spectrometry. It will focus heavily on interpretation of spectra and application of these tools to address questions of structure and reactivity of organic, organometallic, and inorganic materials. A training session of two (2)-dimensional nuclear magnetic resonance (COSY, NOESY, HSQC, HMBC, etc) will be offered

ChemS 214 – Nano-Catalysis (3-0-3)

An introduction to basic concepts of nanochemistry including various synthesis methods (nanofabrication by scanning probe instruments, lithography, sol-gel, hydrothermal, self-assembly, crystal growth etc.), advance synthesis and modifications of nanomaterials (organic functionalization, metallic, bi-metallic, core-shell, shape and morphology controlled synthesis etc.), tools to characterize nanomaterials (scanning probe microscopy like AFM, STM, MRM and electron microscopy like SEM, TEM). This course will also cover green nanochemistry, nanotech & environment and finally applications in various fields with special emphasis on nano-catalysis. This course will empower the students to understand the scientific importance and technological potential of nanotechnology and students will be able to perform three (3) important activities related to Nanochemistry, i.e. synthesis, functionalization and application of nanomaterials.

ChemS 215 – Polymers and Polymerization Processes (3-0-3)

The preparation, reactions and properties of high-molecular-weight polymeric materials of both natural and synthetic origin. Physical and organic chemistry of polymers for persons with a basic training in chemistry, physics or engineering. The course is a survey of preparative methods of polymers; step growth polymerization, radical polymerization, ionic polymerization, ring-opening polymerization, polymerization by transition metal catalysts and methods of characterization (nuclear magnetic resonance, Raman, infrared, intrinsic viscosity, differential scanning, calorimetry, gel permeation chromatography) and scattering (light, x-rays).

ChemS 218 – Photo and Electro Catalysis (3-0-3)

Fundamentals of Photo and Electro catalysis presented with a novel approach for industrial applications

ChemS 220 – Organometallic Chemistry (3-0-3)
The course aims to cover current aspects of research in the field of organometallic chemistry. It is assumed that students taking this course are already familiar with general organometallic chemistry at the undergraduate level. The course materials can be divided into two (2) parts. We will cover topics relating to general organometallic chemistry to function as a refresher but with a practicing researcher's bent and some special topics with focuses on catalysis and its applications.

ChemS 240 – Supramolecular Chemistry (3-0-3)
Most of the crucial biological processes, such as antigen-antibody recognition and DNA replication, rely on non-covalent bonding and self-assembly. Taking lessons from Nature, chemists have crafted artificial systems capable of specific molecular recognition. Some of these fascinating molecules, such as crown ethers, cucurbiturils and calixarenes, are pervasive in contemporary chemical literature. This course will examine the topics of non-covalent bonding, molecular recognition and self-assembly.

ChemS 250 – Material Chemistry II (3-0-3)
Prerequisite: ChemS 210 or consent of instructor.
An introduction to electron microscopy based techniques: Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Electron diffraction (ED), Scanning transmission electron microscopy (STEM), Energy-filtered TEM (EFTEM), Energy dispersive X-ray analysis (EDX) and Electron energy loss spectroscopy (EELS). On-site demonstration of the electron microscope will be given.

ChemS 293 – Traveling Scholar (variable credit)
Master's level traveling scholar.

ChemS 294 – Contemporary Topics in Chemical Science (3-0-3)
A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

ChemS 296 – Lab Rotation (3-0-3)
Master's students are expected to go through a lab rotation their first fall semester. The objective of this course is to help students in identifying their future research advisor by exposing them to different research areas. Master's students are expected to complete 3 rotations their first semester (3 weeks per rotation). A student upon the approval of the advisor may choose to spend 3 rotations in one (1) lab; this advisor will be the chosen research advisor. Students will choose, at the end of their first semester, the possible advisor(s) that they would like to work with. A faculty committee will then meet and place students according to mutual advisor/ student agreement. The nature of the rotation may vary from one (1) lab to another depending on the advisor; thus some rotations can be research focused and others can involve more literature and background work

ChemS 297 – Master's Thesis Research (variable credit)
Master's level research leading to a formal written thesis and oral defense.

ChemS 299 – Master's Directed Research (variable credit)
Prerequisite: Approval of Advisor.
Master's level supervised research.

ChemS 301 – Crystallography and Diffraction (3-0-3)
The objective of this course is to present the basic concepts needed to understand the crystal structure of materials. Fundamental concepts including lattices, symmetries, point groups, and space groups will be discussed and the relationship between crystal symmetries and physical properties will be addressed. The theory of X-ray diffraction by crystalline matter along with the experimental X-ray methods used to determine the crystal structure of materials will be covered. Application of X-ray diffraction to proteins, electron diffraction and neutron diffraction will be briefly discussed.

ChemS 319 – Bioinorganic Chemistry (3-0-3)
Interdisciplinary research on the inorganic chemistry of life has developed into a major source of innovation for catalyst development, material chemistry and medicine. The course "Biological Inorganic Chemistry" details the numerous functions of inorganic materials and ions in biology. It provides a general overview of the fundamental tasks performed by inorganic elements in living organisms as well as the related methods and theories with particular emphasis on enzymatic conversions, inorganic biomaterials and medical applications. Nature's strategies are elucidated based on model systems and basic concepts are illustrated by examples relevant to technological or medical applications.
The course is designed for P.h.D students in chemistry, biochemistry and biotechnology, yet interested students on the M.S. level are welcome.

ChemS 320 – Advanced Organic Chemistry I (3-0-3)
A focus on a deeper understanding of the structure and reactivity of organic molecules with an emphasis on reaction mechanisms. It is a review of aspects of physical organic chemistry, covering structure and bonding, stereochemistry, and kinetics and thermodynamics, as well as molecular orbital theory with an introduction to the use of computational tools, such as Gaussian 09.

ChemS 326 – Biocatalysis (3-0-3)
Biocatalysis has become an integral part of modern industry technology enabling rapid developments in pharmacology, medicine, nutrition, analytics, environmental technology, fine chemical synthesis

biofuel production and related areas. Starting out from basic food-processing fermentations e.g. related to bread baking or cheese making, today the results emerging from this discipline influence all areas of our daily life.Enzymes as nature's catalysts set the benchmarks for artificial systems in terms of activity and selectivity. Correspondingly, biocatalysis is regarded a key-competence in biotechnology and chemical industry. The course "Biocatalysis" provides students with a detailed understanding of fundamental aspects of the area, while it focuses on current applications of biocatalytic systems. It is designed for P.h.D students in chemistry, biochemistry and biotechnology, yet interested students on the M.Sc. level are welcome.

ChemS 330 – Advanced Inorganic Chemistry I (3-0-3)
Prerequisite: Adequate Knowledge in general chemistry rules and concepts.
Generalizations of the periodic table and their relationship to classical and modern concepts of atomic and molecular structure. Inorganic stereochemistry including concepts of crystal chemistry, silicate chemistry, coordination theory, ligand field theory, catalysis, acid-base theory, reaction mechanisms, organometallic chemistry and a detailed consideration of selected groups of the periodic table.

ChemS 340 – Advanced Organic Chemistry II (3-0-3)
Prerequisite: Adequate Knowledge in general chemistry rules and concepts.
Reactivity and reactions of organic moieties including enolates, carbenes, radicals, carbonyl compounds and transition metal organometallics; mechanisms of named reactions; multistep total synthesis techniques and reactions; advanced NMR and mass spectrometric techniques as applied to research efforts in organic chemistry and related fields, such as pharmaceuticals, materials science, supramolecular synthesis and crystal engineering.

ChemS 350 – Advanced Inorganic Chemistry II (3-0-3)
Prerequisite: ChemS 330 or consent of instructor.
Emphasis on concepts and applications of homogenous and heterogeneous catalysis and the impact of such processes on the advancement of different industries.

ChemS 360 – Advanced Physical Chemistry I (3-0-3)
Thermodynamics and Kinetics (3-0-3). Review fundamental concepts and laws of thermodynamics and kinetics. Learn and describe concepts of chemical potential, internal energy and chemical equilibrium of the system. Essence of kinetics to describe changes of chemical system with time, i.e. rates of chemical reactions, dealing with molecules in motion, collisions and diffusion of gases and how to establish rate expression.

ChemS 370 – Advanced Physical Chemistry II (3-0-3)
Theoretical Chemistry (3-0-3) Prerequisite: Adequate knowledge in general chemistry rules and concepts.
Review of quantum mechanics from a postulational viewpoint; variational and matrix methods; time independent and time-dependent perturbation theory; applications to molecular systems including potential energy surfaces and reaction pathways.

ChemS 390 – Advanced Topics in Chemistry (3-0-3)
The advanced topics class will focus on current research topics that have a direct influence on various applications including catalysis, solar energy in addition to emerging synthetic and analytical techniques for producing new generations of materials.

ChemS 393 – Traveling Scholar (variable credit)
Doctoral level traveling scholar.

ChemS 394 – Contemporary Topics in Chemical Science (3-0-3)
A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

ChemS 397 – Doctoral dissertation Research (variable credit)
Doctoral level research leading to a formal written dissertation and oral defense.

ChemS 398 – Graduate Seminar (non-credit)
Graduate seminar focusing on special topics within the field.

CS
Computer Science
Division of Computer, Electrical and Mathematical Science and Engineering (CEMSE)

CS 161 – Theory of Computer Science (3-0-0)
The course will progress through finite automata, circuits and decision trees, Turing machines and computability, efficient algorithms, reducibility, the P versus NP problem, NP-completeness, the power of randomness, and computational learning theory. It examines the classes of problems that can and cannot be solved by various kinds of machines. It tries to explain the key differences between computational models that affect their power. No degree credits for CS majors.

CS 199 – Directed Study in Computer Science (variable contact hours, non-credit)
A course of self-study in a particular topic as directed by faculty and approved by the division.

CS 204 – Data Structures and Algorithms (3-0-3)
Prerequisites: instructor approval based on basic programing proficiency
This course teaches basic and advanced data structures such as linked lists, search trees, heaps, hash tables, etc … It also covers algorithm design techniques like divide and conquer, transform and conquer, dynamic

programming and greedy approaches. These techniques are applied to a variety of problems including sorting, graph problems, numerical problems, string processing. No degree credits for CS majors.

CS 205 – Systems Programming (3-0-3)

Prerequisites: instructor approval based on basic programing proficiency
This course provides a comprehensive and unified introduction to operating systems and concurrency control topics. It emphasizes both design issues and fundamental principles in contemporary systems and gives students a solid understanding of the key structures and mechanisms of operating systems. It also prepares the students to master concurrent and parallel programming by exposing the concepts of parallelism, synchronization and mutual exclusion. The course discusses design trade-offs and the practical decisions affecting design, performance and security. The course illustrates and reinforces design concepts and ties them to real-world design choices through the use of case studies. No degree credits for CS majors.

CS 207 – Programming Methodology and Abstractions (3-0-3)

Computer programming and the use of abstractions. Object-oriented programming, fundamental data structures (such as stacks, queues, sets) and data-directed design. Recursion and recursive data structures (linked lists, trees, graphs). Introduction to basic time and space complexity analysis. The course teaches the mechanics of the C, C++ or Java language as well as an example of media library. No degree credits for CS majors.

CS 213 – Knowledge Representation and Reasoning (3-0-3)

The course covers basic concepts in knowledge representation, reasoning and its application in the Semantic Web. The aims of the course are to introduce key concepts of knowledge representation and its role in artificial intelligence, enable students to design knowledge-based systems and understand limitations and complexity of algorithms for representing knowledge.

CS 220 – Data Analytics (3-0-3)

Prerequisites: familiarity with algorithm runtime analysis (e.g., big O notations), probability theory (e.g. Gaussian distribution and conditional probability) and programming language (e.g., MATLAB or C++).
The course covers basic concepts and algorithms for artificial intelligence, data mining and machine learning. The main contents are: artificial intelligence (task environment, performance measure and problem solving by searching), data mining (data and patterns, summary statistics and visualization, unsupervised feature selection and supervised feature selection) and machine learning (cross validation and supervised learning).

CS 229 – Machine Learning (3-0-3)

Prerequisites: linear algebra and basic probability and statistics. Familiarity with artificial intelligence recommended.
Topics: linear and non-linear regression, nonparametric methods, Bayesian methods, support vector machines, kernel methods, Artificial Neural Networks, model selection, learning theory, VC dimension, clustering, EM, dimensionality reduction, PCA, SVD and reinforcement learning.

CS 240 – Computing Systems and Concurrency (3-0-3)

Prerequisite: solid computer programming skills.
Operating systems design and implementation. Basic structure; synchronization and communication mechanisms; implementation of processes, process management, scheduling and protection; memory organization and management, including virtual memory; I/O device management, secondary storage and file systems. Concurrency at the hardware, programming language and operating system level.

CS 244 – Computer Networks (3-0-3)

Packet switching, Internet architecture, routing, router architecture, control algorithms, retransmission algorithms, congestion control, TCP/IP, detecting and recovering from errors, switching, Ethernet (wired and wireless) and local area networks, physical layers, clocking and synchronization. Assignments introduce network programming using NS-3, sockets, designing a router and implementing a transport layer. Also, advanced research papers on cloud computing, software define networking, and wireless sensor networks. The course consists of a final implementation project on a novel idea.

CS 245 – Databases (3-0-3)

Prerequisites: working knowledge of basic discrete mathematics (e.g., sets, functions and relations) and programming skills. Database design and use of database management systems for applications. The relational model, relational algebra and SQL, the standard language for creating, querying and modifying relational and object-relational databases. XML data including the query languages XPath and XQuery. UML database design and relational design principles based on functional dependencies and normal forms. Other topics include indexes, views, transactions, authorization, integrity constraints and triggers. Advanced topics from data warehousing, data mining, Web data management, Datalog, data integration, data streams and continuous queries and data-intensive Web services.

CS 247 – Scientific Visualization (3-0-3)

Recommended prerequisites: Linear algebra, basic calculus, C/C++ programming experience.
Recommended additional prerequisites: AMCS/CS 248 Computer Graphics, CS 380 GPU and GPGPU Programming, OpenGL programming experience.

This course covers the basics and applications of scientific visualization. It covers techniques for generating images and interactive visualizations of various types of experimentally measured, computer-generated (simulated) or gathered data. It covers grid structures, scalar field and volume visualization, vector field and flow visualization, and tensor field visualization. It covers applications in science, engineering and medicine.

CS 248 – Computer Graphics (3-0-3)

Prerequisites: solid programming skills and linear algebra.
Basic topics: linear algebra for computer graphics, 2D and 3D transformations, mesh data structures, viewing and camera models, local shading models, texturing, shader programming.
Advanced topics: color, radiometry, real-time rendering, bump mapping, environment mapping, bounding volumes, hierarchical data structures, collision detection, parametric curves, ray tracing, photon mapping, path tracing, anti-aliasing, reaction-diffusion, scanning, normal estimation, ransac, quaternions and displays.

CS 260 – Design and Analysis of Algorithms (3-0-3)

Prerequisites: computer programming skills, probability, basic data structures and algorithms, basic discrete mathematics.
The course covers main approaches to design and analysis of algorithms including important algorithms and data structures and results in complexity and computability. The main contents are: review of algorithm analysis (search in ordered array, binary insertion sort, merge sort, worst-case and average-case time complexity, minimum complexity of sorting n elements for small n, 2-3 trees, asymptotic notation); divide and conquer algorithms (master theorem, integer multiplication, matrix multiplication, fast Fourier transform); graphs (breadth-first search, connected components, topological ordering, depth-first search, way from planar graphs to Robertson-Seymour theorem);dynamic programming (chain matrix multiplication, shortest paths, edit distance, sequence alignment, extensions of dynamic programming); greedy algorithms (binary heaps, Dijkstra's algorithm, minimum spanning tree, Huffman codes, matroids); randomized algorithms (selection, quick sort, global minimum cut, hushing); P and NP (Cook's theorem, examples of NP-complete problems); approximate algorithms for NP- hard problems or polynomial algorithms for sub problems of NP-hard problems (set cover, vertex cover, maximum independent set, 2-SAT); partial recursive functions (theorem of Post, Diophantine equations); computations and undecidable problems (existence of complex problems, undecidability of halting problem, theorem of Rice, semantic and syntactical properties of programs).

CS 261 – Combinatorial Optimization (3-0-3)

Prerequisite: familiarity with discrete algorithms at the level of AMCS 260
Topics: Maximum flow, minimum cut. Polytopes, linear programming, LP-relaxation, rounding. Greedy algorithms, matroids. Approximation algorithms for NP-complete problems. Randomized algorithms. These techniques are applied to combinatorial optimization problems such as matching, scheduling, traveling salesman, set cover, maximum satisfiability.

CS 272 – Geometric Modeling (3-0-3)

Prerequisites: Advanced and multivariate calculus, and linear algebra, computer graphics and programming experience. Terminology, coordinate systems and implicit forms. Parametric and spline representations of curves and surfaces and their uses. Basic differential geometry of curves and surfaces. Subdivision surfaces. Solid modeling paradigms and operations. Robustness and accuracy in geometric computations. Applications.

CS 290 – Special Topics in Computer Science (3-0-3)

Master's-level lectures focusing on state of the art within the field.

CS 291 – Scientific Software Engineering (3-0-3)

Prerequisites: programming experience and familiarity with basic discrete and numerical algorithms.
Practical aspects of application development for high performance computing. Programming language choice; compilers; compiler usage. Build management using make and other tools. Library development and usage. Portability and the GNU auto-configure system. Correctness and performance debugging, performance analysis. Group development practices and version control. Use of third-party libraries and software licensing.

CS 292 – Parallel Programming Paradigms (3-0-3)

Prerequisites: programming experience and familiarity with basic discrete and numerical algorithms.
Distributed and shared memory programming models and frameworks. Thread programming and OpenMP. Message passing and MPI. Parallel Global Address Space (PGAS) languages. Emerging languages for many core programming. Elements to be covered will include syntax and semantics, performance issues, thread safety and hybrid programming paradigms.

CS 293 – Traveling Scholar (variable credit)

Master's level traveling scholar.

CS 294 – Contemporary Topics in Computer Science (3-0-3)

A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

CS 295 – Internship (6-0-6 or variable credit)

Master's level internship.

CS 297 – Master's Thesis Research (variable credit)
Master's level research leading to a formal written thesis and oral defense.

CS 299 – Master's Directed Research (variable credit)
Master's level supervised research.

CS 308 – Stochastic Methods in Engineering (3-0-3)
Prerequisite: CS 241.
Review of basic probability; Monte Carlo simulation; state space models and time series; parameter estimation, prediction and filtering; Markov chains and processes; stochastic control and stochastic differential equations. Examples from various engineering disciplines.

CS 320 – Probabilistic Graphical Models (3-0-3)
Prerequisite: Students are expected to be familiar with probability theory, algorithms, machine learning and programming language.
This is a research-oriented graduate-level course on PGMs. The course will cover two main types of PGMs, i.e., directed PGMs and undirected PGMs. For directed PGMs we will cover Bayesian networks with one of its most important variants, hidden Markov models. For undirected PGMs, we will cover Markov networks (or Markov random fields) with one of its most important variants, conditional random fields. Therefore, the course contains four (4) parts: Bayesian networks, hidden Markov models, Markov networks and conditional random fields.
In each part, motivations, ideas, definitions, examples, properties, representations, inference algorithms, and applications for the corresponding PGM will be introduced. This is done through lectures by the instructor. In the next two lectures, the students will present recommended research papers and lead in-class discussions. The last lecture of each part will be an in-class quiz, the purpose of which is not to judge their ability of calculation or memorization, but to push them to think more and deeper about the contents introduced in lectures. The course will finish by a final exam lecture and two project presentation lectures. The projects are expected to be a real application or a serious theoretical work of PGMs on real research problems.

CS 321 – Applications of AI in Bioinformatics (3-0-3)
Prerequisite: C/C++, HPC (parallel computing) programming experience
Recommended additional prerequisites: Course consists of selected projects. These projects cover application of AI to some of the relevant problems of analysis of large biological data and generally deal with complex information. Each year problems change. Students get assigned one project and they work either alone or in groups of 2. Students in the interactive discussions with the whole class and the instructor solve the project problems. Students regularly present their progress and defend their approach and results in front of the whole class. During one semester several types of topics are dealt with. Students get direct experience in research methodology, report writing, presentations and most importantly, different ways of approaching solving AI problems

CS 322 – Applied Ontology (3-0-3)
Prerequisite: CS 213.
The course covers advanced topics in conceptual modelling, data management, integration and analysis, all of which have applications in data-intensive disciplines such as biology, biomedicine and others. The aims of the course is to provide an in-depth understanding of the state of the art in formal ontologies, including their role in integrating and analyzing data. While Knowledge Representation and Reasoning (CS 213) introduced basic logic formalisms that can be used to express knowledge. Examples include the theories for mereological (parthood) relations, or theories of space and time and the consequences of selecting a particular theory in formalized knowledge bases. The Course is split in two parts, the first focusing on concrete applications with examples taken from the biomedical domain, the second focusing on the theoretical framework underlying formal ontologies and their role in information systems.

CS 337 – Information Networks (3-0-3)
Prerequisite: probability, stochastic systems, network architecture of the Internet and the systems performance
Modeling, experimental design, performance measurement, model development, analytic modeling, single queue facility, networks of queues, stochastic systems, deterministic systems, birth-death model analysis, closed network model, bottleneck, interactive networks, M/M/m queues, M/G/1 priority queues, Markovian queuing model, random numbers, discrete event simulation, verification and validation of simulation models, workload characterization and benchmarks. Also, advanced research papers on using queuing theory for networking systems. The course consists of a final modeling and simulation project on a novel idea that leads to publication

CS 340 – Computational Methods in Data Mining (3-0-3)
Prerequisites: Probability and Statistics, Linear Algebra, Artificial Intelligence.
Focus is on both classical and new emerging techniques in data mining. Topics include computational methods in supervised and unsupervised learning, association mining, collaborative filtering and graph mining. Individual or group applications-oriented programming project is required.

CS 341 – Advanced Topics in Data Management (3-0-3)
Prerequisites: CS 245.
Topics in Data Management will be analyzed and discussed. Students will engage in research and project presentations. Topics will vary by semester.

CS 343 – Advanced Distributed and Networked System (3-0-3)

Prerequisites: CS 240

This class is a graduate seminar that covers design and implementation concepts in distributed systems and networked systems by reviewing a selection of classical and contemporary papers. We will study efficient system design and evaluation as well as learn high-level system issues with a focus on exciting topics in distributed and networked systems. Research in these areas also tends to be scattered across disjoint sets of researchers and conferences and the course attempts to study commonalities. The syllabus for this course will vary from year to year so as to cover a mixture of older and more contemporary systems papers. Contemporary papers will be generally selected from the past 5 years, primarily drawn from high quality conferences such as SOSP, SIGCOMM, OSDI, NSDI and EuroSys. On completion of this module, students should have a broad understanding of some key papers and concepts in computer systems research as well as an appreciation of how to argue for or against any particular idea. There is no textbook for this course.

CS 344 – Advanced Topics in Computer Networks (3-0-3)

Prerequisites: solid computer networking background or CS 244 computer networks, excellent skills in programming using C/C++, using network simulators such as NS-3, working with Linux systems.

Topics in Computer Networks will be analyzed and discussed. Topics will vary by a semester

CS 345 – Advanced Topics in Distributed and Networked Systems (3-0-3)

This course is a graduate seminar that covers design and implementation concepts in distributed systems and networked systems by reviewing a selection of classical and contemporary papers. We will study efficient system design and evaluation as well as learn high-level system issues with a focus on exciting topics in distributed and networked systems. Research in these areas also tends to be scattered across disjoint sets of researchers and conferences and the course attempts to study commonalities.

The syllabus for this course will vary from year to years so as to cover a mixture of older and more contemporary systems papers. Contemporary papers will be generally selected from the past 5 years, primarily drawn from high quality conferences such as SOSP, SIGCOMM, OSDI, NSDI and EuroSys.

On completion of this module students should have a broad understanding of some key papers and concepts in computer systems research, as well as an appreciation of how to argue for or against any particular idea. There is no textbook for this course.

CS 346 – Advanced Topics in Operating Systems (3-0-3)

Prerequisites: Solid computer programming skills (at least at the level of CS 207) and solid background in at least one operating systems (CS 240) or computer architecture (at least at the level of CS 209 or CS 280), or permission of instructor.

Topics in Operating Systems will be analyzed and discussed. Topics will vary by semester.

CS 360 – Computational Complexity (3-0-3)

Prerequisites: CS 260.

This course covers the main complexity classes, as well as selected advanced topics in computational complexity. Topics: Hardness of Computational problems, models of computations including Turing machines (universal, probabilistic), Boolean Circuits. Complexity classes (P, NP, coNP, PSPACE, NL, P/poly, BPP) and their relations. Diagonalization, space complexity, randomized computation. Selection of topics such as interactive proofs, cryptography, quantum computation, hardness of approximation, decision trees, or algebraic computational models.

CS 361 – Combinatorial Machine Learning (3-0-3)

Prerequisites: CS 260 Design and Analysis of Algorithms, CS 220 Data Analytics.

The course covers tools for design and analysis of decision trees, decision rules and tests, their applications to supervised machine learning and related topics including current results of research. The main contents are: introduction (basic notions and examples from applications); tools (relationships among decision trees, rules and tests, bounds on complexity of tests, decision rules and trees, algorithms for construction of tests, decision rules and trees); applications (supervised machine learning); some of the additional topics (decision tables with many-valued decisions, approximate decision trees, rules and tests, global and local approaches to the study of problems over infinite sets of attributes, applications to combinatorial optimization, fault diagnosis, pattern recognition, analysis of acyclic programs, data mining and knowledge representation); current results of research.

CS 372 – Computational Geometry (3-0-3)

Prerequisites: CS 260. This course presents worst-case efficient algorithms for geometric problems.

The main topics are: Notions of discrete geometry (convex hulls, planar graphs, triangulations, Delaunay graphs, Voronoi diagrams, arrangements of lines, point-line duality).

Geometric algorithms design techniques (plane sweep, randomized incremental construction, bucketing, divide and conquer).

Geometric data structures (doubly-connected edge list, history graphs, range trees, segment trees, and interval trees)

Low-dimensional linear programming. Topological lower bounds. Implementation issues.

These theoretical results are presented in connection with applications to computer graphics, robotics, databases, and geographic information systems.

CS 380 – GPU and GPGPU Programming (3-0-3)

Prerequisites: Good C/C++ programming skills, or other strong programming background. Understanding of basic computer architecture.
Recommended optional prerequisites: CS 248, CS 280, and CS 292. The course covers the architecture and programming of GPUs (Graphics Processing Units). It covers both the traditional use of GPUs for graphics and visualization, as well as their use for general purpose computations (GPGPU, GPU Computing). The main contents are: GPU many-core hardware architecture, shading and GPU programming languages and APIs, programming vertex, geometry and fragment shaders, programming with CUDA, Brook, OpenCL, stream computing, approaches to massively parallel computations, memory subsystems and caches, rasterization, texture mapping, linear algebra computations, alternative and future architectures.

CS 390 – Special Topics in Computer Science (3-0-3)
Doctoral-level lectures focusing on state of the art within the field

CS 393 – Traveling Scholar (variable credit)
Doctoral level traveling scholar.

CS 394 – Contemporary Topics in Computer Science (3-0-3)
A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

CS 395 – Internship (variable credit)
Doctoral level internship.

CS 397 – Doctoral Dissertation Research (variable credit)
Doctoral level research leading to a formal written dissertation and oral defense.

CS 398 – Graduate Seminar (non-credit)
Graduate seminar focusing on special topics within the field.

CS 399 – Doctoral Directed Research (variable credit)
Doctoral level supervised research.

EE
Electrical Engineering
Division of Computer, Electrical and Mathematical Science and Engineering (CEMSE)

EE 101 – Circuits (3-0-0)
Prerequisites: familiarity with Resistance, Capacitance, Electric current, Kirchhoff's rules, DC circuits and AC circuits.
The course covers the fundamentals of the lumped circuit abstraction. The main contents are: independent and dependent sources; Resistive circuits RC, RL and RLC circuits in time domain and frequency domain; Impedance transformations; Two-port networks and parameters Operational amplifiers Filters, Diodes and Transistors. Small signal and large signal analysis. Includes a weekly laboratory.

EE 102 – Analog Electronics (3-0-0)
Prerequisite: EE 101.
This course covers the design, construction and debugging of analog electronic circuits.
The main contents are: the basic principles of operation, terminal characteristics and equivalent circuit models for diodes, transistors and op-amps. Design and analysis of multistage analog amplifiers. Study of differential amplifiers, current mirrors and gain stages. Frequency response of cascaded amplifiers and gain-bandwidth considerations. Concepts of feedback, stability and frequency compensation. Includes a weekly laboratory.

EE 103 – Solid State (3-0-0)
Prerequisites: EE 101 Co-Requisite EE 102.
This course covers the physics of microelectronic semiconductor devices for Silicon integrated circuit applications. The main contents are: semiconductor fundamentals, p-n junction, metal-oxide semiconductor structure, metal semiconductor junction, MOS field-effect transistor and bipolar junction transistor. The course emphasizes physical understanding of device operation through energy band diagrams and MOSFET device design. Issues in modern device scaling are also outlined. Includes a weekly laboratory.

EE 122 – Electromagnetic (3-0-0)
Prerequisites: familiarity with Resistance, Capacitance, Electric current and basic vector calculus.
The course covers quasistatic and dynamic solutions to Maxwell's equations; waves, radiation, and diffraction. The main contents are: vector analysis and vector calculus; The laws of Coulomb, Lorentz, Faraday, Gauss, Ampere, Biot-Savart and Lenz. Dielectric and magnetic materials; Poisson equation solutions; Forces, Power and Energy in electric and magnetic fields; Capacitance and Inductance; Maxwell's equations; Boundary conditions; Introduction to Wave equation; Poynting vector; Wave propagation and reflection. Includes weekly Simulations.

EE 151 – Signal and Systems I (3-0-0)
Introduction to analog and digital signal processing, a topic that forms an integral part of engineering systems in many diverse areas, including seismic data processing, communications, speech processing, image processing, defense electronics, consumer electronics and consumer products. The course presents and integrates the basic concepts for both continuous-time and discrete-time signals and systems. It addresses the following topics: classifications of signals and systems, basic signal operations, linear time-invariant (LTI) systems, time-domain analysis of LTI systems, signal representation using Fourier series, continuous-time Fourier transform, discrete-time Fourier transform and Laplace transform.

EE 152 – Signal and Systems II (3-0-0)

Pre-requisite: EE 151.

This course builds upon the material investigated in EE 151 and addresses the following topics: z-transform, continuous-time filters, digital filters, finite impulse response (FIR) filter design, infinite impulse response (IIR) filter design, sampling and quantization and applications of digital signal processing including spectral estimation, digital audio, audio filtering and digital audio compression.

EE 199 – Directed Study in Electrical Engineering (variable contact hours, non-credit)

A course of self-study in a particular topic as directed by faculty and approved by the division.

EE 201 – Introduction to CMOS VLSI Circuits (3-0-3)

Design techniques for rapid implementations of very large-scale integrated (VLSI) circuits, MOS technology and combinational and sequential logic; Structured design; Design rules; layout design techniques; Computer Aided Design (CAD) layout; design rule checking; logic and circuit simulation; timing and power analysis.

EE 202 – Analog Integrated Circuits (3-0-3)

This course covers principles of designing and optimizing analog and mixed-signal circuits in CMOS technologies, including an overview of device physics of the MOS transistor; small and large signal models; Analysis and design of CMOS multi-transistor amplifiers; feedback theory and application to feedback amplifiers; Stability considerations; pole-zero cancellation; root locus techniques in feedback amplifiers and noise analysis.

EE 203 – Solid-State Devices Fabrication (2-1-3)

Semiconductor material and device fabrication and evaluation: capacitors and field-effect transistors. Semiconductor processing techniques: oxidation, diffusion, deposition, etching, photolithography. Lecture and laboratory.

EE 204 – Integrated Microsystems Laboratory (1-2-3)

Device physics and technology of advanced transistors and the process and device interplay that is critical for sub-100 nm metal oxide semiconductor (MOS) capacitors and field-effect transistors (MOSFETs) based microsystems design. Design of MOS interface circuits: relationships between processing choices and device performance characteristics. Long-channel device I-V review, short-channel MOSFET I-V characteristics including velocity saturation, mobility degradation, hot carriers, gate depletion. MOS device scaling strategies, silicon-on-insulator, lightly doped drain structures, on-chip interconnect parasitics and performance. Major CMOS scaling challenges. Process and circuit simulation.

EE 205 – Introduction to MEMS (1-2-3)

(Same as ME 323) Micro electro mechanical systems (MEMS), devices and technologies. Micro-machining and microfabrication techniques, including planar thin-film processing, silicon etching, wafer bonding, photolithography, deposition and etching. Transduction mechanisms and modeling in different energy domains. Analysis of micro machined capacitive, piezo resistive and thermal sensors/actuators and applications. Computer-aided design for MEMS layout, fabrication and analysis.

EE 206 – Device Physics (3-0-3)

Structural properties of materials. Basic quantum mechanics of electrons in solids. Band theory and trap states. Charge transport, band conduction and hopping conduction. Optical properties of materials. Piezoelectric and ferro-electric phenomena. Magnetic effects in materials. Physical phenomena will be related transistors, light emitters, sensor and memory devices.

EE 208 – Semiconductor Optoelectronic Devices (3-0-3)

Materials for optoelectronics, optical processes in semiconductors, absorption and radiation, transition rates and carrier lifetime. Principles of LEDs, lasers, photo detectors and solar cells. Designs, demonstrations and projects related to optoelectronic device phenomena.

EE 221 – Electromagnetic Theory (3-0-3)

Prerequisites: EE 122 or equivalent undergraduate-level course on Electromagnetics Fundamental concepts of electromagnetics: Maxwell equations, Lorentz force relation, electric and magnetic polarizations, constitutive relations, boundary conditions, Poynting theorem in real and complex forms, energy relations. Solution of Helmholtz equation: plane, cylindrical and spherical waves, dispersion, phase and group velocities, attenuation, wave propagation in anisotropic media. Electromagnetic theorems: uniqueness, duality, reciprocity, equivalence and induction theorems, Huygen and Babinet principles. Guided wave propagation: mode expansions, metallic and dielectric waveguides, resonant cavities. Antennas: potentials, radiation, elementary antennas

EE 222 – Antenna Theory and Design (3-0-3)

Pre-requisites: EE 122 or equivalent undergraduate-level course on Electromagnetics. Desirable: Undergraduate-level course on Antenna Theory and Design Fundamental antenna system parameters: gain, directivity, efficiency, input impedance, radiation pattern. Theory of transmitting and receiving antennas: reciprocity, equivalence and induction theorems. Elementary antennas: dipole, monopole, loop, traveling-wave antennas. Antenna arrays: linear and phased arrays, mutual impedance. Antenna design: log-periodic, reflector, and (corrugated) horn antennas and micro strip, integrated and on-chip antennas. Computer aided design: student projects using antenna simulation tools.

EE 223 – Microwave Circuits (3-0-3)

Pre-requisite: Undergraduate electromagnetics course.
Desirable: Undergraduate Microwave course
Fundamental microwave concepts: Transmission-line theory and practical transmission line design, Smith Chart, impedance matching (L and stub matching networks), guided wave propagation and rectangular wave guide design, Z and Y parameters, S-parameters, ABCD matrix, Microwave Filters, Microwave system level concepts (Noise figure, Dynamic Range, Non-linearity), diode detectors, microwave transistors, microwave amplifier design concepts, Low Noise and Power Amplifier Design, Introduction to Microwave CAD tools, Microwave Design Simulation project

EE 231 – Principles of Optics (3-0-3)

Prerequisites: basic knowledge of electromagnetic, signals and systems, and linear algebra.
Basic principles of optics. Topics include classical theory of diffraction, interference of waves, study of simple dielectric elements such as gratings and lenses, analysis of Gaussian beams, elements of geometrical optics, Waveguides, interferometers and optical resonators. The course aims at equipping the student with a set of general tools to understand basic optical phenomena and model simple optical devices.

EE 232 – Applied Quantum Mechanics (3-0-3) (Equivalent to MSE 232)

Introduction to nonrelativistic quantum mechanics. Summary of classical mechanics, postulates of quantum mechanics and operator formalism, stationary state problems (including quantum wells, harmonic oscillator, angular momentum theory and spin, atoms and molecules, band theory in solids), time evolution, approximation methods for time independent and time-dependent interactions including electromagnetic interactions, scattering.

EE 233 – Photonics (3-0-3)

Prerequisites: principle of optics EE 231.
Introduction to Photonics and integrated optics. Topics include the study of anisotropic media and anisotropic optical elements such as half/quarter-wave retarders, interaction of light and sound, elements of plasmonics, dielectric waveguides and optical fibers, bragg gratings, directional couplers and integrated optical filters. The course introduces the student to a variety of different integrated devices for the manipulation of optical signals, discussing also design and modeling principles.

EE 242 – Digital Communication and Coding (3-0-3)

Digital transmission of information across discrete and analog channels. Sampling; quantization; noiseless source codes for data compression: Huffman's algorithm and entropy; block and convolutional channel codes for error correction; channel capacity; digital modulation methods: PSK, MSK, FSK, QAM; matched filter receivers. Performance analysis: power, bandwidth, data rate and error probability.

EE 244 – Wireless Communications (3-0-3)

Prerequisite: preceded or accompanied by AMCS 241, EE 242.
This course introduces fundamental technologies for wireless communications. It addresses the following topics: review of modulation techniques, wireless channel modeling, multiple access schemes, cellular communications, diversity techniques, equalization, channel coding, selected advanced topics such as CDMA, OFDM, Multiuser detection, space time coding, smart antenna, software radio.

EE 251 – Digital Signal Processing and Analysis (3-0-3)

Prerequisite: adequate background in linear algebra, multivariate optimization, signals and systems, Fourier series and Fourier transform.
It addresses the following topics: sampling and quantization, multirate digital systems, discrete Fourier transform (DFT), windowed DFT, fast Fourier transform (FFT), digital filter design, decimation and interpolation filters, linear predictive coding, and an introduction to adaptive filtering.

EE 253 – Wavelets and Time-Frequency Distribution (3-0-3)

Prerequisite: EE 251.
Review of DTFT and digital filtering. Multirate filtering. Filter banks and subband decomposition of signals. Multiresolution subspaces. Wavelet scaling and basis functions and their design: Haar, Littlewood-Paley, Daubechies, Battle-Lemarie. Denoising and compression applications. Spectrogram, Wigner-Ville, Cohen's class of time-frequency distributions and their applications.

EE 262 – Communication Networks (3-0-3)

Prerequisite: preceded or accompanied by AMCS 241.
System architectures. Data link control: error correction, protocol analysis, and framing. Message delay: Markov processes, queuing, delays in statistical multiplexing, multiple users with reservations, limited service, priorities. Network delay: Kleinrock independence, reversibility, traffic flows, throughput analysis, Jackson networks, Multiple access networks: ALOHA and splitting protocols, carrier sensing, multi-access reservations. (Previously EE 243)

EE 271A and EE 271B – Control Theory (2-1-3).

First and Second Terms. (Same as ME 221A and ME 221B)
Prerequisites: Linear Algebra (AMCS 151), Differential Equations (AMCS 131), Signals and Systems (EE 151 & EE 152).
Content: Core material in linear systems and optimal control.
Topics in 271A: review of vector spaces, systems of linear equations, internal stability, controllability, observability, Lyapunov equations, input-output stability, linear matrix inequalities, stabilization, and state observers.

Topics in 271B: The aim of this course is to introduce the student to the area of nonlinear control systems with a focus on systems' analysis and control design. Nonlinear phenomena including multiple equilibria, limit cycles and bifurcations will be presented. Lyaponuv and input/output stability will be discussed. Examples of control design will be studied such as feedback linearization and sliding mode control.

EE 272A - Mechatronics and Intelligent Systems I (2-1-3)

(Same as ME 222A)
Principles, modeling, interfacing and signal conditioning of motion sensors and actuators; acquire and analyze data and interact with operators. Basic electronic devices, embedded microprocessor systems and control, power transfer components and mechanism design. Hardware-in-the-loop simulation and rapid prototyping of real-time closed-loop computer control of electromechanical systems; modeling, analysis and identification of discrete-time or samples-data dynamic systems; commonly used digital controller design methods; introduction to nonlinear effects and their compensation in mechatronic systems; robotic manipulation and sensing; obstacle avoidance and motion planning algorithms; mobile robots, use of vision in navigation systems. The lectures will be divided between a review of the appropriate analytical techniques and a survey of the current research literature. Course work will focus on an independent research project chosen by the student.

EE 272B – Mechatronics and Intelligent Systems II (2-1-3)

(Same as ME 222B)
Principles, modeling, interfacing and signal conditioning of motion sensors and actuators; acquire and analyze data and interact with operators. Basic electronic devices, embedded microprocessor systems and control, power transfer components and mechanism design. Hardware-in-the-loop simulation and rapid prototyping of real-time closed-loop computer control of electromechanical systems; modeling, analysis and identification of discrete-time or samples-data dynamic systems; commonly used digital controller design methods; introduction to nonlinear effects and their compensation in mechatronic systems; robotic manipulation and sensing; obstacle avoidance and motion planning algorithms; mobile robots, use of vision in navigation systems. The lectures will be divided between a review of the appropriate analytical techniques and a survey of the current research literature. Course work will focus on an independent research project chosen by the student.

EE 273A and EE 273B – Advanced Dynamics (3-0-3)

First and Second Terms (Same as ME 232A and ME 232B). Prerequisites: AMCS 201 and AMCS 202 or equivalents (may be taken concurrently)
Content Analysis of models described by nonlinear differential equations. Topics: equilibria, stability, Lyapunov functions, periodic solutions, Poincaré Bendixon theory, Poincaré maps, attractors and structural stability, the Euler-Lagrange equations, mechanical systems, small oscillations, dissipation, energy as a Lyapunov function, conservation laws, introduction to simple bifurcations and eigenvalue crossing conditions, Discussion of bifurcations in applications, invariant manifolds, the method of averaging, Melnikov's method and the Smale horseshoe.

EE 274 – System Identification and Estimation (3-0-3)

(Same as ME 224) Prerequisite: EE 271A and EE 271B (EE 271B can be taken concurrently).
Content: Building mathematical models and estimates of unknown quantities in dynamic settings based on measured data.
Topics: Deterministic state estimation, recursive observers, estimation for uncertain process dynamics; SISO and MIMO least-squares parameter estimation, linear system subspace identification, random variables and random processes, linear systems forced by random processes, power-spectral density, Bayesian filtering including Kalman filter, jump-Markov estimation and fault diagnosis, nonlinear estimation, particle filters, unscented Kalman filter, introduction to estimation for hybrid systems.

EE 293 – Traveling Scholar (variable credit)

Master's level traveling scholar.

EE 294 – Contemporary Topics in Electrical Engineering (3-0-3)

A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

EE 295 – Internship (6-0-6 or variable credit)

Master's level internship.

EE 297 – Master's Thesis Research (variable credit)

Master's level research leading to a formal written thesis and oral defense.

EE 299 – Master's Directed Research (variable credit)

Master's level supervised research.

EE 301 – Advanced VLSI Systems (3-0-3)

Prerequisite: EE 201.
This course offers a system level approach toward VLSI design and covers a wide range of topics, including digital IC flow, synthesis and placement and routing, FPGA design and Verilog implementation, complex arithmetic units, clock distribution, timing considerations and skew tolerant design, VLSI functional testing and verification.

EE 302 – Integrated Analog/Digital Interface Circuits (3-0-3)

Prerequisite: EE 202.
This course covers most of the well-known digital-to-analog and analog-to-digital conversion schemes.

These include the flash, folding, multi-step and pipeline Nyquist rate, architectures. Oversampling converters are also discussed. Practical design work is a significant part of this course. Students design and model complete converters.

EE 303 – Integrated Circuits (3-0-3)
Alternate device architectures, materials and physics for integrated circuits based on alternate channel materials like SiGe, Ge, III-V, two (2) dimensional materials such as graphene, dichalcogenides, one (1) dimensional nanowire and nanotube architecture devices, tunneling FET, spin logic, ferroelectric devices, nanoelectromechanical (NEM) switches and such for logic computation and ultra-mobile communication devices.

EE 304 – Integrated Microsystems (3-0-3)
Prerequisites: EE 203 and EE 205.
Integrated systems including MOS circuits, energy harvesting, MEMS sensors and actuators to understand the design rule, process integration, physical and electrical characterization of fabricated systems.

EE 305 – Advanced MEMS Devices and Technologies (3-0-3)
Prerequisite: EE 205.
Advanced micro electro mechanical systems (MEMS) devices and technologies. Transduction techniques, including piezoelectric, electro thermal and resonant techniques. Chemical, gas and biological sensors; microfluidic and biomedical devices. Micromachining technologies such as laser machining and micro drilling, EDM, materials such as SiC and diamond. Sensor and actuator analysis and design through CAD.

EE 306 – Electronic and Optical Properties of Semiconductors (3-0-3)
The course discusses in detail the theory behind important semiconductor based experiments such as Hall Effect and Hall mobility measurement, velocity-field measurement, photoluminescence, gain, pump-probe studies, pressure and strain dependent studies. Theory will cover: Band structure in quantum wells; effect of strain on band structure; transport theory; excitons, optical absorption, luminescence and gain.

EE 307 – High-Speed Transistors (3-0-3)
Prerequisite: EE 204.
Detailed theory of high-speed digital and high-frequency analog transistors. Carrier injection and control mechanisms. Limits to miniaturization of conventional transistor concepts. Novel submicron transistors including MESFET, heterojunction and quasi-ballistic transistor concepts.

EE 308 – Semiconductor Lasers and LEDs (3-0-3)
Prerequisite: EE 208.
Optical processes in semiconductors, spontaneous emission, absorption gain, stimulated emission. Principles of light-emitting diodes, including transient effects, spectral and spatial radiation fields. Principles of semiconducting lasers, gain-current relationships, radiation fields, optical confinement and transient effects.

EE 309 – Flexible and Stretchable Electronics (3-0-3)
Prerequisite: College level knowledge on Physics, Chemistry, Mathematics and Biology.
In this course we will study physics and mechanics, materials and chemistry, devices and circuits and finally system level integration aspects of flexible, stretchable and reconfigurable electronics.

EE 310 – Integrated Sensors (3-0-3)
The design and implementation of monolithic and hybrid sensors using integrated circuits, particularly in CMOS is presented. Performance metrics of sensors will be defined. The advantages and shortcomings of sensors built in silicon-based fabrication processes will be analyzed. A comprehensive study of the design and analysis of CMOS integrated image sensors, integrated biosensors and electronic backbone of MEMS hybrid sensors including silicon photodetectors; CCD and CMOS sensor architectures and circuits; affinity-based detection and biochemical transduction, integrated microarrays, biochips and sensor SoCs will be studied.

EE 321 – Numerical Methods in Electromagnetics (3-0-3)
Prerequisites: EE 221 or equivalent Master-level course on Electromagnetics
Introduction to computational electromagnetics. Finite difference time domain method: fundamentals, absorbing boundary conditions, perfectly matched layers. Integral equations: fundamentals, method of moments, Galerkin schemes, fast solvers. Finite element method: fundamentals, vector and higher-order basis functions, hybridization of finite and boundary element methods. Applications of these methods in problems of electromagnetics, optics and photonics.

EE 323 – Microwave Measurements Laboratory (1-2-3)
Prerequisites: EE 221 or EE 222, EE 223.
Advanced topics in microwave measurements: introduction to state-of-the-art microwave test equipment (Vector Network analyzer, spectrum analyzer), power spectrum and noise measurements, calibration, S-parameter and impedance measurements, methods for measuring the dielectric constant of materials, Low Noise and Power amplifier measurements, Non-linearity measurements, near-field and far-field antenna pattern measurements, Printed Circuit Board (PCB) design and fabrication, Introduction to Microwave and Antenna CAD tools. Followed by a project that includes design, analysis, fabrication and testing of a microwave subsystem.

EE 331 – Classical Optics (3-0-3)
Prerequisite: EE 231.
Theory of electromagnetic, physical and geometrical optics. Classical theory of dispersion. Linear response,

Kramers-Kronig relations and pulse propagation. Light scattering. Geometrical optics and propagation in inhomogeneous media. Dielectric waveguides. Interferometry and theory of coherence. Diffraction, Fresnel and Fraunhofer. Gaussian beams and the ABCD law.

EE 332 – Optical Waves in Crystals (3-0-3)

Prerequisite: EE 233.

Propagation of laser beams: Gaussian wave optics and the ABCD law. Manipulation of light by electrical, acoustical waves; crystal properties and the dielectric tensor; electro-optic, acousto-optic effects and devices. Introduction to nonlinear optics; harmonic generation, optical rectification, four-wave mixing, self-focusing and self-phase modulation.

EE 333 – Lasers (3-0-3)

Prerequisites: EE 331, EE 333.

Complete study of laser operation: the atom-field interaction; homogeneous and inhomogeneous broadening mechanisms; atomic rate equations; gain and saturation; laser oscillation; laser resonators, modes and cavity equations; cavity modes; laser dynamics, Q-switching and mode-locking. Special topics such as femto-seconds lasers and ultra-high-power lasers.

EE 334 – Nonlinear Optics (3-0-3)

Prerequisites: EE 331, EE 333.

Formalism of wave propagation in nonlinear media, susceptibility tensor, second harmonic generation and three (3)-wave mixing, phase matching, third-order nonlinearities and fourwave mixing processes, stimulated Raman and Brillouin scattering. Special topics: nonlinear optics in fibers, including solitons and self-phase modulation.

EE 341 – Information Theory (3-0-3)

Prerequisite: AMCS 241.

The concepts of source, channel, rate of transmission of information. Entropy and mutual information. The noiseless coding theorem. Noisy channels, the coding theorem for finite state zero memory channels. Channel capacity. Error bounds. Parity check codes. Source encoding.

EE 343 – Digital Communication Theory (3-0-3)

Prerequisite: AMCS 241, EE 242, a strong background in linear algebra, detection and estimation and a working knowledge of optimization and discrete Fourier transform (DFT).

It addresses the following topics: review of digital modulation techniques and maximum likelihood detectors, fading channels, diversity techniques, multiple-input/ multiple-output (MIMO) systems, space-time coding and orthogonal frequency-division multiplexing (OFDM).

EE 351 – Advanced Signal Processing (3-0-3)

Prerequisites: AMCS 241, EE 251.

Estimators of second-order properties of random processes: nonparametric and model-based techniques of spectral estimation, characterization of output statistics for nonlinear systems, time-frequency representations. Performance evaluation using asymptotic techniques and Monte Carlo simulation. Applications include speech processing, signal extrapolation, multidimensional spectral estimation and beam forming.

EE 352 – Image Processing (3-0-3)

Prerequisites: EE 251, multi-variable calculus and linear algebra.

This course gives an overview of the theoretical and practical foundations of digital image processing, including random field models of images, sampling, quantization, image compression, enhancement, restoration, segmentation, shape description, reconstruction of pictures from their projections, pattern recognition. Applications include biomedical images, time-varying imagery, robotics and optics.

EE 353 – Adaptive Signal Processing (3-0-3)

Prerequisites: AMCS 241, EE 251.

Theory and applications of adaptive filtering in systems and signal processing. Iterative methods of optimization and their convergence properties: transversal filters; LMS (gradient) algorithms. Adaptive Kalman filtering and least-squares algorithms. Specialized structures for implementation (e.g., least-squares lattice filters, systolic arrays). Applications to detection, noise canceling, speech processing and beam forming.

EE 354 – Introduction to Computer Vision (3-0-3)

Prerequisites: Multi-variable calculus and linear algebra.

This course gives an introductory overview of concepts (e.g. photometric and multi-view stereoscopy, epipolar geometry, interest point detection and description), problems (e.g. image-to-image matching and alignment, image classification, clustering/ segmentation, face recognition) and methodology (e.g. linear/nonlinear image filtering, RANSAC for robust fitting, discriminative and generative models) in the field of computer vision. It is intended to provide a solid background for students, who are planning to do research in visual computing.

EE 355 – Estimation, Filtering and Detection (3-0-3)

Prerequisite: AMCS 241.

Principles of estimation, linear filtering and detection. Estimation: linear and nonlinear minimum mean squared error estimation and other strategies. Linear filtering: Wiener and Kalman filtering. Detection: simple, composite, binary and multiple hypotheses. Neyman-Pearson and Bayesian approaches.

EE 372 – Dynamic programming and Optimal Control (3-0-3)

Prerequisites: Familiarity with basic probability, optimization and differential equations.

Dynamic programming is a framework for deriving optimal decision strategies in evolving and uncertain environments. Topics include the principle of optimality in deterministic and stochastic settings, value and policy iteration, connections to Pontryagin maximum principle, imperfect state measurement problems and simulation-based methods such as online reinforcement learning.

EE 374 – Advanced Control Systems (3-0-3)

(Same as ME 324) Prerequisites: AMCS 201 and AMCS 202 or equivalent; EE 271A and EE 271B or equivalent. Introduction to modern control systems with emphasis on the role of control in overall system analysis and design. Input-output directions in multivariable systems: eigenvalues and singular value decomposition. System norms and introduction to MIMO robustness. Controller design for multivariable plants: linear quadratic regulator, linear quadratic Gaussian optimal control, H-infinity and H-2 control, sampled-data, model predictive control. Convex design methods: Youla parameterization, linear matrix inequalities; adaptive control, neural networks, fuzzy logic systems; introduction to neurofuzzy systems and soft computing. Multivariable control design examples drawn from throughout engineering and science in the field of aerospace, automotive, chemical- and energy-efficient buildings.

EE 376 – Robust Control (3-0-3) (Equivalent to ME 326)

Prerequisites: AMCS 201 and AMCS 202 or equivalents; EE 271A and EE 271B or equivalent.
Contents: Advanced methods for control design of multivariable linear systems subject to modeling errors. Topics: Signal and system norms and performance measures, robust stability and performance, linear fractional transformations, uncertainty modeling, optimal disturbance rejection, structured uncertainty analysis and synthesis, model reduction.

EE 390 – Special Topics in Circuits (3-0-3)

Doctoral-level lectures focusing on state of the art within the field.

EE 393 – Traveling Scholar (variable credit)

Doctoral level traveling scholar.

EE 394 – Contemporary Topics in Electrical Engineering (3-0-3)

A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

EE 395 – Internship (variable credit)

Doctoral level internship.

EE 397 – Doctoral Dissertation Research (variable credit)

Doctoral level research leading to a formal written dissertation and oral defense.

EE 398 – Graduate Seminar (non-credit)

Graduate seminar focusing on special topics within the field.

EE 399 – Doctoral Directed Research (variable credit)

Doctoral level supervised research.

EnSE

Environmental Science
Division of Biological and Environmental Science and Engineering (BESE)

EnSE 199 – Directed Study in Environmental Science (variable contact hours, non-credit)

A course of self-study in a particular topic as directed by faculty and approved by the division

EnSE 201 – Water Quality and Environmental Analysis (3-0-3)

The course covers introduction to water quality parameters (with a focus on toxic pollutants), pollutants properties, measurement techniques, and control technologies. Fate and transport of pollutants in relation with their physicochemical properties, risk assessment in relationship to water quality. Environmental analytical techniques, drinking water and domestic wastewater treatment are included.

EnSE 202 – Aquatic Chemistry (3-0-3)

The course covers chemistry of processes in aquatic systems, natural water composition, characteristics and analysis (inorganic and organic composition, ionic balance, pH, conductivity, turbidity), acids and bases, carbonate system, chemistry of metals, precipitation, and redox chemistry.

EnSE 203 – Fundamentals of Environmental Microbiology (3-0-3)

This course is designed to provide introductory concepts on fundamentals of environmental microbiology to students from different engineering and science disciplines. Concepts related to the different molecular biology tools used in microbial ecology will also be introduced. The course will equip students with knowledge to apply these tools to unravel scientific questions relevant to natural and engineered biological processes.

EnSE 205 – Principles of Environmental Sustainability (3-0-3)

Fundamental aspects of sustainability, water and energy cycles and accounting. Climate change, water-food nexus, carbon cycle, emissions and sequestration. Concepts of green design. Life-cycle analysis. Assignments (each report is over 3 to 4 weeks).

EnSE 214 – Microbiological Aspects of Water Sources, Treatment and Distribution (3-0-3)

This course addresses microbiological aspects of water sources, drinking water production and distribution. The topics to be covered include: microbiology basics, pathogens, drinking water production, biological stable water, distribution of drinking water (e.g. effect of material types), biofilms, biofouling, biofouling of membranes, biofilm modelling, etc. There will be student seminars, guest lecturers and a research center visit.

EnSE 222 – Surface Hydrology (3-0-3)
Fundamentals of surface hydrology, the hydrologic cycle, hydrologic processes, and water management with an emphasis on arid lands

EnSE 223 – Groundwater Hydrology (3-0-3)
Groundwater hydrology, subsurface flow, geological considerations, aquifers and wells.

EnSE 293 – Traveling Scholar (variable credit)
Master's level traveling scholar.

EnSE 294 – Contemporary Topics in Environmental Science (3-0-3)
A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

EnSE 295 – Internship (6-0-6 or variable credit)
Master's level internship.

EnSE 297 – Master's Thesis Research (variable credit)
Master's level research leading to a formal written thesis and oral defense.

EnSE 299 – Master's Directed Research (variable credit)
Master's level supervised research.

EnSE 310 – Colloids, Interfaces, and Surfaces (3-0-3)
The course covers a variety of topics in surface science, including surface tension and surface free energy (theory and measurement methods), surface films on liquid substrates (surface potential, monomolecular films, Langmuir-Blodgett layers), capillarity, gecko effect, electrical aspects of surface chemistry (electrical double layer, zeta potential, DLVO theory), surface of solids, solid-liquid interface, stability of dispersions, stabilization of suspensions, contact angle (theory and measurement methods), emulsions, foams and aerosols, wetting of surfaces by liquids, lotus effect, flotation, aggregation and flocculation, detergency, surfactants, self-assembly, micelles and vesicles, friction, lubrication and adhesion, adsorption, characterization of colloidal particles, etc. Applications of colloid and surface science in petroleum recovery, coating and painting, food, pharmaceutical and cosmetic industry will also be covered. Surface characterization methods will be introduced.

EnSE 314 – Public Health Microbiology (3-0-3)
An introduction to the diversity of microbial agents that can impact the public health and environmental systems. The course is structured to detail the microbial hazards found in waters, soils and air. Molecular biology techniques and the current regulatory methods for investigating pathogens and the surrogate indicators will be discussed. Treatment and engineering strategies are discussed. The latter part of the course serves to provide an introduction to Quantitative Microbial Risk Assessment (QMRA). The concepts related to exposure assessment and risk characterization will be included. Practical lab classes will be incorporated as soon as student laboratories are available. This course also includes practical lab component where some of the fundamental principles taught during lectures will be recapped.

EnSE 316 – Advanced Topics in Environmental Science and Engineering (3-0-3)
The course reviews current topics in environmental science and engineering, particularly relying on scientific journal publications to provide case studies, illustrative examples, classic studies and controversial findings pertinent to specific fields within environmental science and engineering. The course will feature an emphasis on primary literature searches, reading and assessment of primary literature. It is expected that the student reads no less than 5 scientific papers per week in the prescribed topic area and is capable of presenting and critically discussing the content of these publications. In this level 300 course, the student assessment is based on active participation in the lectures and tutorials.

EnSE 325 –Water Desalination (3-0-3)
Theoretical and practical aspects of seawater/brackish water desalination technologies, including thermal-based (MSF, MED, VC) and membrane-based (RO, NF, ED/EDR), and emerging (FO, MD, AD) desalination processes; process design and system performance; fouling, scaling (including bio-fouling) and cleaning; product water quality and post-treatment.

EnSE 341 – Processes in Environmental Biotechnology (3-0-3)
Prerequisite: EnSE 203. (Please note: prerequisites are for M.Sc. students only.)
A course that introduces students from different engineering and science disciplines to the fundamental principles of microbiology and engineering (quantitative tools) and discusses example applications (traditional and emerging) of microbiological processes for wastewater treatment and resource recovery. This course also includes a lab practical where students apply the basic principles taught in the course in the design of microbiological processes.

EnSE 342 – Physical/Chemical Treatment Processes (3-0-3)
Prerequisite: EnSE 202 (please note: prerequisites are for M.Sc. students only)
Water-treatment processes, membranes, advanced oxidation, principles and techniques of water desalination.

EnSE 390 – Special Topics in Environmental Science and Engineering (3-0-3)
Doctoral-level lectures focusing on special topics in environmental science and engineering.

EnSE 393 – Traveling Scholar (variable credit)
Doctoral level traveling scholar.

EnSE 394 – Contemporary Topics in Environmental Science (3-0-3)
A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

EnSE 395 – Internship (variable credit)
Doctoral level internship.

EnSE 397 – Doctoral Dissertation Research (variable credit)
Doctoral level research leading to a formal written dissertation and oral defense.

EnSE 398 – Graduate Seminar (non-credit)
Graduate seminar focusing on special topics within the field.

EnSE 399 – Doctoral Directed Research (variable credit)
Doctoral level supervised research.

ERPE
Energy Resources and Petroleum Engineering
Division of Physical Science and Engineering (PSE)

ERPE 200 – Energy and the Environment (3-0-3)
Prerequisites: Introductory calculus, physics, chemistry, thermodynamics.
Possible futures of humanity based on current trends. Analyses based on laws of mass and energy conservation and thermodynamics to evaluate overall efficiencies of major human energy supply schemes: fossil, solar, wind, and biomass. Irreversible linear processes, and sustainable/unsustainable cycles. Relationship between ecosystems (ancient and new), their energy storage and throughput, and energy production and its side effects. Analysis of inadequate economic theories that hamper understanding of the relationship between human economy and the Earth's economy (ecology). Most course assignments will be done in MATLAB

ERPE 210 – Fundamentals of Carbonate Geology (3-0-3)
Prerequisite: Basic knowledge of Geology
Historical development of carbonate fields. Carbonates mineralogy. Depositional environments. Classification systems. Evolution from sediments to rocks. Diagenesis: driving forces and physical environments. Dolomitization. Generation of rock sequences: facies, facies belts, facies stacking and stratigraphy. The role of porosity, its creation, alteration and classification. Carbonate rock systems for the oil industry. Lab Work: core description, petrography, microscopy, petrographic and geochemical tools.

ERPE 220 – Sediments: Properties and Processes (3-0-3)
Prerequisite: Introductory calculus, physics, chemistry, thermodynamics.
Fundamental concepts (Geological history. Governing laws. Biological considerations. Water. Sediment formation and diagenesis). Particulate media (Interparticle forces and effective stress. Fabric. Classification). GeoMechanics (Effective stress. Numerical micromechanics. Strain regimes. Deformation and failure. Biot, Terzaghi, Skempton. Repetitive loading). Coupled Bio-Thermo-Hydro-Chemo-Mechanical Processes (Mixed fluids. Conduction phenomena. Diffusion Phenomena. Thermal properties. Couplings). Localizations, scales and spatial variability. Implications in energy geo-engineering, infrastructure and environmental solutions.

ERPE 230 – Rock Mechanics for Energy Geo-Engineering (3-0-3)
Prerequisites: Introductory calculus, physics, mechanics
Rock formation; tectonism; geological structures and reservoirs. Fractured rock mass (Fracture characterization, description of fracture sets); intact rock versus fractured rock. Initial conditions: stress field in the earth crust, fluid composition and pressure. Hydraulics: matrix and fractures; mixed fluids and reactive fluids; evolution of fluid pressure during production. Mechanics: strain hardening and softening, strain localization, tensile and shear failure, creep, constitutive models and yield-envelope. Thermal properties and heat transfer. Classical hydro-mechanical coupling (effective stress, reservoir compaction, deformation, fault reactivation), and multi-HTCM couplings. Well and reservoir engineering: drilling and stimulation in various formations. Challenges: shale instability, sand production and creep. Laboratory and field rock and rock mass characterization.

ERPE 240 – Fractals, Percolation and Pore-scale Flow (3-0-3)
Prerequisites: Introductory calculus, physics, chemistry, thermodynamics, and MATLAB programming.
Fractals, their construction and dimensions, bond and site percolation, and cluster analysis. Equations of capillarity, contact angles, thermodynamics of interfaces. Creeping flow of two and three immiscible fluids in porous media. Pore-level characterization of sediments; pore networks; invasion percolation in drainage and imbibition; description of capillary pressures and relative permeabilities in two- and three-phase flow in mixed-wet rocks. Applications to geology, petroleum, environmental, geotechnical, mechanical, and chemical engineering. Most course assignments will use MATLAB.

ERPE 241 – Multiphase Flow in Porous Media (3-0-3)
Prerequisite: Introductory calculus, physics, chemistry,

thermodynamics.
Basic physical laws that govern flow and transport in porous media. Rock and fluid properties. Derivation of mathematical models for multiphase flow in subsurface porous media. Finite difference methods. Mass-conservative block-centered finite difference scheme. Pressure, saturation and species transport equations. Finite volume and finite element numerical models.

ERPE 250 – Reservoir Engineering Fundamentals and Applications (3-0-3)

Prerequisites: Basic knowledge of multiphase flow in porous media, thermodynamics, and MATLAB programming.
Basic concepts: hydrocarbon PVT/thermodynamics, material balance, uncertainty analysis, drive mechanisms, vertical equilibrium, capillarity and J-functions. Primary depletion: recovery mechanism and performance evaluation. Secondary depletion: displacement efficiency, Buckley-Leverett theory, mobility ratio, sweep efficiency, well placement, water flood evaluation and tracer concept. Reservoir simulation: governing equations, linear/nonlinear solvers, IMPES/FI/AIM formulations, well model/control, numerical error, history-match concept and prediction uncertainties. Enhanced oil recovery (EOR): hydrocarbon trapping mechanisms, concepts of miscible/immiscible gas flood, chemical EOR, thermal EOR and EOR screening. Field management: workflow, economics, decision analysis. Reservoir Simulation project. Course programming assignments will use MATLAB and Excel-VBA. Reservoir simulations will use CMG and/or Eclipse.

ERPE 290 – Special Topic in Energy Resources and Petroleum Engineering

Special Topics Specialized courses that cover subjects of particular interest, augment 200-level courses with in-depth coverage of the foundations, or provide computational applications and extended projects. Special Topics may also introduce new scientific fields and research areas, or broaden and challenge the students experience and expertise in other ways.

ERPE 293 – Traveling Scholar (variable credit)

Master's level traveling scholar.

ERPE 295 – Internship (6-0-6 or variable credit)

Master's level internship.

ERPE 297 – Master's Thesis Research (variable credit)

Master's level research leading to a formal written thesis and oral defense.

ERPE 299 – Master's Directed Research (variable credit)

Master's level supervised research.

ERPE 310 – Stratigraphy (3-0-3)

Prerequisite: Fundamentals of Carbonate Geology
Carbonate factories, Characteristics of carbonate sequences and systems tracts, Depositional topography in carbonate systems, Carbonate cyclicity and stratigraphic hierarchies, Milankovitch patterns as seen in carbonate sequence development. The icehouse stratigraphic record of Pleistocene sequences of the Bahamas and learnings for ancient carbonate cycles and sequences. The Cretaceous of the eastern Arabian Plate as a model for Greenhouse carbonates. Seismic imaging issues in carbonates. Carbonate diagenesis within a sequence stratigraphic context. Applications of concepts to reservoir-scale problems in carbonates. Applications of concepts to exploration-scale problems in carbonates. Non-eustatic drivers of carbonate sequences, biotic crisees, climatic input.

ERPE 350 – Thermodynamics of Subsurface Reservoirs (3-0-3)

Prerequisite: Introductory calculus, physics, chemistry, thermodynamics.
Fundamental laws of thermodynamics and their applications to subsurface reservoirs especially to hydrocarbon reservoirs. Bulk-phase equilibrium thermodynamics with cubic equations of state, in particular, the Peng-Robinson equation of state. Detailed calculation procedures to predict volumetric properties, gas and liquid phase compositions, thermal properties and sonic velocities of reservoir fluids. Algorithms for flash calculation and stability analyses. Interfacial thermodynamics and irreversible thermodynamics with applications to subsurface reservoirs.

ERPE 351 – Modeling Naturally Fractured Reservoirs (3-0-3)

Prerequisite: ERPE 250 - Reservoir Engineering Fundamentals and Applications.
Overview of naturally fractured reservoirs (NFR) and modeling methods. (1) Introduction to NFR: definitions, importance, detection methods, characterization. (2) Single porosity model: multiphase flow, matrix-fracture interaction (diffusion, imbibition, infiltration), gridding, limitations. (3) Dual porosity/dual permeability models: derivations, shape factor, transfer functions and limitations. (4) Discrete fractured models; 2D/3D gridding simplifications. (5) Advanced methods; Finite Element FE, Control-Volume FE, Mixed FE. (6) DFN upscaling: static/dynamic upscaling, single-phase/multi-phase upscaling. (7) Class project. Course programming assignments will require MATLAB, Fortran or C/C++.

ERPE 360 – Field Development Planning (3-0-3)

Prerequisites: Two ERPE courses
Work flow to develop a hydrocarbon reservoir field development plan. Value chain, work plan setting, project timing and typical duration. Contributions and significance of complementary disciplines (geology, geophysics, petrophysics, reservoir engineering, drilling & concept engineering). Inherent uncertainties in data and models; consequences, impact and engineering under uncertainty.

ERPE 361 – Advanced Well Testing (3-0-3)

Oil and gas production rates from a well often undergo a declining behavior over time. Well productivity is a complex process that is a function of the hydrocarbon reservoir subsurface properties related to the fluids in places and the hosting environment. It is also related to the wellbore flow conditions from the reservoir to the surface. Well testing is an important technology that is frequently used in the industry. This technology consists of flow diagnostics (rates and pressure) to evaluate a well productivity or injectivity performance such as skin factor, non-Darcy effect, and storativity. It is also used to acquire insights about the reservoir properties such as connectivity, heterogeneity including fractures, flow regime, and drainage area. This course covers the fundamentals of well testing and discusses real field applications. The course includes : 1) fundamentals of flow in porous media; 2) introduction to decline-curve analysis; 3) Buildup-test analysis of slightly compressible fluids; 4) Analysis of oil and gas well flow and buildups tests; 5)Well-test in hydraulically fractured wells; 6) Well-test in naturally fractured reservoirs; 7) Interference and pulse testing; 8) well testing in unconventional reservoirs.
Note: students are expected to have at least basic familiarity with: Multi-phase flow in porous media, reservoir
engineering, and programming in Matlab or Python.

ERPE 370 – Experimental Methods in Research - DSP (2-2-3)

Prerequisite: Introductory calculus, physics, chemistry, thermodynamics.
(1) The experimentalist: guiding principles and cognitive issues. (2) Theoretical concepts in experimental design: measurement theory. (3) Preliminary design of experiments: statistics, dimensional analysis and models. (4) Devices: cells and instrumentation, boundary conditions, sensing concepts, instruments, transducer, electronics. (5) Conducting the tests. (6) Complimentary analytical and numerical tools: signal processing, regression and inversion. (7) Advanced testing technologies. (8) Reporting and presentation.

ERPE 390 – Special Topics (3-0-3)

Specialized Ph.D. level courses that cover subjects of particular interest, augment 200- or 300-level courses with in-depth coverage of the foundations, or provide computational applications and extended projects. Special Topics may also introduce new scientific fields and research areas, or broaden and challenge the student's experience and expertise in other ways.

ERPE 393 – Traveling Scholar (variable credit)

Doctoral level traveling scholar.

ERPE 395 – Internship (variable credit)

Doctoral level internship.

ERPE 397 – Doctoral Dissertation Research (variable credit)

Doctoral level research leading to a formal written dissertation and oral defense.

ERPE 398 – Graduate Seminar (non-credit)

Graduate seminar focusing on special topics within the field.

ERPE 399 – Doctoral Directed Research (variable credit)

Doctoral level supervised research.

ErSE

Earth Science and Engineering
Division of Physical Science and Engineering (PSE)

ErSE 199 – Directed Study in Earth Science (variable contact hours, non-credit)

A course of self-study in a particular topic as directed by faculty and approved by the division.

ErSE 201 – Geophysical Fluid Dynamics I (3-0-3)

Prerequisite: Basic knowledge of general principles of fluid dynamics and thermodynamics.
Introductory description of the Earth's climate system, governing equations of mass and momentum conservation, equation of state, thermodynamic equation, wave kinematics, dispersion, group velocity, sound waves, gravity waves, effect of rotation, equations of motion in spherical coordinates, primitive equations, Boussinesq approximation, changing vertical coordinate, asymptotic analysis and scaling, geostrophic balance, thermal wind, static instability, boundary layers in atmosphere and ocean.

ErSE 202 – Computational Groundwater Hydrology (3-0-3)

Prerequisite: Basic programming skill in MATLAB or consent of instructor.
Derivation of mathematical models for porous media flow. Development and application of mass conservative simulator models of single phase, miscible fluids in porous media. Solution of the pressure equation. Numerical methods for convection diffusion equations. The course covers derivation of mathematical models for porous media flow, and the development and application of mass-conservative simulator models of single phase, miscible fluids in porous media. Solutions of the pressure equation, and numerical methods for convection and diffusion equations are presented as well.

ErSE 204 – Geophysical Continuum Mechanics (3-0-3)

Prerequisite: AMCS 231 or consent of Instructor.
The course provides physical background foundation and overview of mathematical continuum models of geophysics. The goal of the course is to allow students to learn modelling ideas and utilize them in simulation. Topics discussed include: brief introduction to Cartesian tensors, their calculus and algebra; deformations and strain measures; balance laws and equations of motion; thermo-dynamical relations and constraints; mixture theory and phase change.

ErSE 209 – Thermodynamics of Subsurface Reservoirs (3-0-3)

Prerequisite: None.
This course covers the fundamental laws of thermodynamics and their applications to subsurface reservoirs especially to hydrocarbon reservoirs. Bulk phase equilibrium thermodynamics is a focus of this course, which prepares students the required thermodynamic skill for compositional petroleum reservoir simulation. Cubic equations of state and their strengths are discussed for pure components and mixtures. In particular, Peng-Robinson equation of state and its modelling parameters are addressed. Detailed calculation procedures are given to predict volumetric properties, gas and liquid phase compositions, thermal properties and sonic velocities of reservoir fluids. Algorithms on flash calculation and stability analysis are considered. We study bisection and successive substitution techniques based on the Rachford-Rice equation as well as Newton's method. Optional advanced topicsin this course include 1) statistical thermodynamics and molecular simulation for phase behaviors of fluids, 2) nonequilibrium and irreversible thermodynamics, especially as applied to reservoir grading, and 3) interfacial thermodynamics and its application to micro-pores and nano- particles for oil reservoirs.

ErSE 210 – Seismology I (3-0-3)

Prerequisite: Basic knowledge of elastic processes in continuous media or consent of instructor.
Introductory and advanced concepts of seismic wave propagation. Vectors and tensors, Hooke's law, elastic coefficient tensors, Christoffel equation, group and phase velocities, and Green's theorem. The following concepts will also be covered: reflection and transmission coefficient formulas for a layered medium, attenuation, Snell's law, Hooke's law, Fermat's principles, Fresnel zone, finite-difference solutions to the wave equation and eikonal equation, transport equation, and traveltime tomography.

ErSE 211 – Global Geophysics (3-0-3)

Prerequisite: Basic knowledge of fluid/elastic processes in continuous media or consent of instructor.
The course provides introductory descriptions of the Earth solid and fluid natural systems and their interaction. It discusses Earth early geological history, plate motions, magnetism and sea floor spreading, earthquakes and earth structure, gravity, geochronology, heat flow, mantle convection and earth's magnetic field; history of earth climate, formation of oceans and atmosphere, biological history, energy balance climate model, general circulation of ocean and atmosphere, climate change, coupled ocean-atmosphere-biosphere climate models. The course introduces descriptions of solid and fluid Earth systems and their interaction, and is divided in two (2) parts. Part I covers the history of Earth climate, formation of oceans and atmosphere, biological history, energy balance in climate model, general circulation of ocean and atmosphere, climate change, and coupled ocean-atmosphere-biosphere climate models. Part II discusses Earth early geological history, plate motions, sea floor spreading, earthquakes and Earth structure, gravity, geochronology, heat flow, mantle convection and Earth's magnetic field.

ErSE 212 – Geophysical Geodesy and Geodynamics (3-0-3)

Prerequisite: ErSE 211 or consent of instructor.
Satellite geodesy, gravimetry, GPS, Interferometric Synthetic Aperture Radar (InSAR), radar altimetry. Plate tectonics and paleomagnetism, plate motions, plate-boundary deformation, seismic cycle, heat flow, basin subsidence, plate-flexure, post-glacial rebound, geoid determination, gravity anomalies, sea-level measurements, tides, earth rotational variations, volcano geodesy. This course provides an introduction to commonly used geodetic methods in geophysics, such as triangulation, leveling, borehole strain monitoring, GPS, Interferometric Synthetic Aperture Radar (InSAR), radar altimetry, optical image correlation and gravimetry. Several applications of these methods are discussed, e.g. for studying plate motions, plate-boundary deformation, seismic cycle processes, basin subsidence, plate-flexure, post-glacial rebound, geoid variations, gravity anomalies, sea-level changes, tides, earth rotational variations, and volcanic processes.

ErSE 213 – Inverse Problems (3-0-3)

Prerequisite: Linear algebra, multivariable calculus, probability theory, MATLAB programming.
This course will introduce the principles of Inverse theory and data assimilation with applications to geophysics and other sciences. Both deterministic and stochastic viewpoints will be covered. Subjects studied will include topics such as least squares, generalized inverses, regularization, Kalman filter, adjoint method, etc. Techniques for solving nonlinear inverse and data assimilation problems will be also covered (200- level for Master students, 300-level for Ph.D. students with more home- and project work).

ErSE 214 – Seismic Exploration (2-1-3)

Prerequisite: None.
An introductory course on Seismic exploration covering the basics of seismic waves, seismic data, seismic acquisition, data processing, filters, seismic velocities, and stacking. The course includes an introduction to seismic imaging.

ErSE 215 – Geomechanics I (3-0-3)

Prerequisite: None.
Concepts of linear elastic fracture mechanics as applied to the classification, origin and evolution of all types of rock fractures; continuum theory in rock mechanics; rock strength and failure criteria; rock mechanics testing; stress tensors; elastic theory; poroelasticity and thermoelasticity; inelastic behaviour; stress regimes; geological applications.

ErSE 217 – Seismotectonics (3-0-3)

Prerequisite: Basic knowledge of elastic processes in continuous media or consent of instructor.
Stress and strain, tensor analysis, rheology, brittle vs. ductile deformation, fracture, fault mechanics, friction, stable and unstable sliding, double-couple representation of earthquake sources, moment tensors, coulomb failure stress changes, earthquake triggering, stress drop, Kostrov's summation, comparative seismotectonics.

ErSE 218 – Geophysical Field Methods (3-0-3)

Prerequisite: ErSE 201 or ErSE 221 or ErSE 214.
Theory and practice of seismic refraction, gravity, electromagnetic, and resistivity surveys will be presented. Lectures will cover both geophysical theory and field method procedures, accompanied by either a geophysical field exercise or data processing lab. The final grade is based on homework grades, a project report and the related presentation. Field projects cover applications in environmental engineering, exploration, and earthquake hazards. Instruments to be used include the 64-node Syscal multi-node resisitvity system, the Geonics EM-34 frequency domain loop antennae system, the Geonics microgravimeter, and the Geometrics 624-channel seismic recording system. Commercial codes will be used for processing the data.

ErSE 225 – Physical Field Methods in Geophysics I (2-1-3)

Prerequisite: AMCS 231 (or similar) and ErSE 2111 or consent of instructor.
Measurement and theory of gravity and magnetic fields of the earth; small to large- scale gravity and magnetic anomalies in exploration and global geophysics; reduction of gravity and magnetic data and forward modelling; applications to exploration, tectonics, and environmental problems. Thermal properties, temperatures, and heat transfer within the context of global geological and geophysical processes, such as plate tectonics and sedimentary basin evolution.

ErSE 253 – Data Analysis in Geosciences (3-0-3)

Prerequisite: Background in linear algebra, probability theory, statistics; programming in MATLAB.
Time series (filtering, correlation, deconvolution, spectral analysis, regression), processing of multidimensional data, spatial statistics including variogram, covariance analysis and modelling, multipoint estimation, spatial interpolation including statistical methods (kriging) and dynamical methods (Kalman filter), uncertainty assessment, cross validation, multivariate analysis including principal component analysis and canonical analysis.

ErSE 260 – Seismic Imaging (3-0-3)

Prerequisite: ErSE 210 or ErSE 213 or consent of instructor.
Seismic migration methods are developed. Green's theorem is used to derive the Lippmann-Schwinger equation and the following migration methods: phase-shift migration, split-step and PSPI migrations, Fourier Finite Difference migration, phaseencoded multi-source migration, Kirchhoff migration, beam migration, diffraction stacK migration, reverse time migration, and migration velocity analysis. This course is devoted to studying the concept of seismic imaging for exploration purposes. We introduce seismic imaging in the framework of Green's functions and wavefield extrapolation and discuss the various imaging conditions. We look at the various migration methods including Kirchhoff, phase-shift migration, Downward continuation methods, reverse time migration, and others. We discuss the role that velocity plays in the seismic imaging process.

ErSE 290 – Special Topics (3-0-3)

Special Topics Specialized courses that cover subjects of particular interest, augment 200-level courses with in-depth coverage of the foundations, or provide computational applications and extended projects. Special Topics may also introduce new scientific fields and research areas, or broaden and challenge the students experience and expertise in other ways.

ErSE 290A – Reservoir Engineering Fundamentals and Applications (3-0-3)

This course presents key fundamentals of reservoir engineering and reservoir simulation, considering realistic hydrocarbon field cases. Students will be exposed to industry adopted workflows in reservoir modeling and management and will be familiarized with a commercial reservoir simulator. Topics include: 1) Basic concepts: hydrocarbon PVT/thermodynamics, material balance, uncertainty analysis, drive mechanisms, vertical equilibrium, capillarity and J-functions; 2) Primary depletion: recovery mechanism, performance evaluation; 3) Secondary depletion: displacement efficiency, Buckly-Leverett theory, mobility ratio, sweep efficiency, well placement, water flood evaluation, tracer concept; 4) Reservoir simulation governing equations, linear/nonlinear solvers, IMPES/FI/AIM formulations, well model/control, numerical error, history-match concept, prediction uncertainties; 5) Enhanced oil recovery (EOR): hydrocarbon trapping mechanisms, concepts of miscible/immiscible gas flood, chemical EOR, thermal EOR, EOR screening; 6) Field management workflow, economics and decision analysis.

ErSE 290B – Fundamentals of Carbonate Geology (3-0-3)

The course addresses key fundamentals of carbonate geology. An overview is given covering all aspects of carbonate geology from historical development of the field, to the mineralogy of carbonates, the individual components, depositional environments and classification systems. The evolution from sediments to rocks is covered by the introduction of diagenesis and the driving forces and physical environments behind diagenesis. The generation of rock sequences is elaborated through the introduction of the concepts of facies, facies belts, facies stacking and stratigraphy.

Finally, the role of porosity, its creation, alteration and classification is developed with the aim to provide an understanding of the carbonate rock system for the oil industry. The course is based on lectures, lab work, field excursions and assignments.

ErSE 290C – Special Topics: Machine Learning Methods in Geosciences (3-0-3)

Prerequisite: knowledge of calculus, statistics, and linear algebra
The course covers a number of Machine Learning methods and their applications in solving geoscience problems. The main focus is on using supervised learning methods to solve geoscience problems, with an emphasis on the practical use of convolutional neural networks. At the end of the course, the diligent student will know how to design the architecture of a convolutional network and employ it in solving a particular geoscience problem. Students are expected to have experience in programming a high-level language such as MATLAB and have a background in partial differential equations and linear algebra.

ErSE 293 – Traveling Scholar (variable credit)

Master's level traveling scholar.

ErSE 294 – Contemporary Topics in Earth Science (3-0-3)

A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

ErSE 295 – Internship (6-0-6 or variable credit)

Master's level internship.

ErSE 297 – Master's Thesis Research (variable credit)

Master's level research leading to a formal written thesis and oral defense.

ErSE 299 – Master's Directed Research (variable credit)

Prerequisite: Approval of Academic Advisor.
Master's level supervised research.

ErSE 301 – Geophysical Fluid Dynamics II (3-0-3)

Prerequisite: ErSE 201 or consent of instructor.
Climate and climate change, large-scale atmospheric and oceanic motions, fine-scale processes, shallow water equations, conservation properties of shallow water equations, geostrophic adjustment, vorticity and circulation, circulation theorems, potential vorticity conservation, quasi-geostrophic equations, energetics of quasi-geostrophic equations, Rossby waves, barotropic and baroclinic instabilities.

ErSE 303 – Numerical Methods of Geophysics (3-0-3)

Prerequisite: Basic knowledge of fluid/elastic processes in continuous media.
Built on the modeling and simulation foundation developed in ErSE203, this specialized course will discuss advanced ideas of multi-scale modeling, linear and non-linear finite element methods, and investigate modern approaches to numerical simulations of hydrodynamic and geophysical turbulence, problems of theoretical glaciology and material science of ice for the prediction of ice sheet evolution, and wave propagation in linear and non-linear media.

ErSE 304 – Geophysical Continuum Mechanics (3-0-3)

Prerequisite: AMCS 231 or consent of Instructor.
The course provides physical background foundation and overview of mathematical continuum models of geophysics. The goal of the course is to allow students to learn modelling ideas and utilize them in simulation. Topics discussed include: brief introduction to Cartesian tensors, their calculus and algebra; deformations and strain measures; balance laws and equations of motion; thermo-dynamical relations and constraints; mixture theory and phase change.

ErSE 305 – Multiphase Flows in Porous Media (3-0-3)

Prerequisite: One (1) of AMCS 206 or 231 or consent of instructor.
Thermodynamics of pressure, volume, temperature and composition relationships in water, oil or nonaqueous phase liquids and gas mixtures. Modeling compositional and thermal fluids, including streamline flow, fractional flow and both immiscible and miscible flow. This course covers the thermodynamics of pressure, volume, temperature and composition relationships in water, oil or non-aqueous phase liquids and gas mixtures. In addition, modelling compositional and thermal fluids, including streamline flow, fractional flow and both immiscible and miscible flow will be taught.

ErSE 306 – Ocean Modelling (3-0-3)

Prerequisites: ErSE 201 or consent of instructor.
This course introduces the theory and numerical modelling of ocean circulation. This includes the theory of steady and time-dependent large-scale circulation, effects of earth's curvature, wind-driven Sverdrup circulation, western boundary currents, eastern boundary upwelling, effects of buoyancy forcing, wind- and buoyancy-forced circulation in the thermocline. The course also reviews theoretical models of ocean circulation, including shallow water, barotropic, quasigeostrophic, and primitive equation models; adjustment times, internal length and time scales; the role of advection, bathymetry and coastlines; global models, basin models, regional models.

ErSE 307 – Atmospheric Chemistry and Transport (3-0-3)

Prerequisite: ErSE 201 or consent of instructor.
The course provides an introduction in atmospheric chemical processes and their role in climate system. It covers fundamentals of reactions kinetics, photochemical processes, chemistry of troposphere and stratosphere, tropospheric ozone and air-pollution, stratospheric ozone and ozone hole, atmospheric aerosols, chemistry of clouds, atmospheric transport, chemistry transport models, chemistry climate models.

ErSE 308 – Atmospheric Physics (3-0-3)

Prerequisite: ErSE 201, AMCS 252 or consent of instructor.
The course discusses main physical processes in the Earth's atmosphere and their role in the formation of weather and climate including atmospheric dynamics and general circulation, sub-grid fine-scale processes and their parameterizations, atmospheric convection, cloud and precipitation formation, atmospheric turbulence and the planetary boundary layer, air-sea interaction, energy balance, radiative-convective equilibrium, general circulation models, coupled ocean-atmosphere models.

ErSE 309 – Thermodynamics of Subsurface Reservoirs (3-0-3)

This course covers the fundamental laws of thermodynamics and their applications to subsurface reservoirs especially to hydrocarbon reservoirs. Bulk phase equilibrium thermodynamics is a focus of this course, which prepares students the required thermodynamic skill for compositional petroleum reservoir simulation. Cubic equations of state and their strengths are discussed for pure components and mixtures. In particular, Peng-Robinson equation of state and its modeling parameters are addressed. Detailed calculation procedures are given to predict volumetric properties, gas and liquid phase compositions, thermal properties and sonic velocities of reservoir fluids. Algorithms on flash calculation and stability analysis are considered. We study bisection and successive substitution techniques based on the Rachford-Rice equation as well as Newton's method. Optional advanced topics in this course include 1) statistical thermodynamics and molecular simulation for phase behaviors of fluids, 2) nonequilibrium and irreversible thermodynamics, especially as applied to reservoir grading, and 3) interfacial thermodynamics and its application to micro-pores and nano-particles for oil reservoirs.

ErSE 310 – Seismology II (3-0-3)

Prerequisite: ErSE 253 and any of ErSE 210, ErSE 211, ErSE 213.
Part I: Whole Earth wave propagation (body waves, surface waves, normal modes); imaging Earth 3D structure with ray-based methods; introduction to methods beyond ray-theory; attenuation and scattering of seismic waves. Part II: Earthquake source mechanics; earthquake kinematics and scaling laws; earthquake dynamics, fracture modes and crack propagation; introduction to probabilistic seismic hazard assessment. The course provides an introduction to global seismology and earthquake physics, and consists of two (2) parts. Part I: Whole Earth wave propagation (body waves, surface waves, normal modes); imaging Earth 3D structure with ray-based methods; introduction to methods beyond ray- theory; attenuation and scattering of seismic waves. Part II: Earthquake source mechanics; earthquake kinematics and scaling laws; earthquake dynamics, fracture modes and crack propagation; introduction to probabilistic seismic hazard assessment. Throughout the semester, students work in teams towards a term project, with intermediate discussion sessions and short reports leading up to a final project report and presentation.

ErSE 315 – Geomechanics ll (3-0-3)

Prerequisite: ErSE 215 or consent of instructor.
Application of Geomechanics I to reservoir characterization; borehole imaging and borehole stresses; borehole failure analysis; pore pressure prediction and effective stress concepts; sand production and sand failure modelling; effects of water on sand production; wellbore stability; drilling practice.

ErSE 325 – Physical Fields Methods in Geophysics I (3-0-3)

Prerequisite: PDEs and course in basic EM physics.
General concepts of electromagnetic field behavior. Electromagnetic properties of rocks. Direct current methods, natural- field electromagnetic methods, magnetotelluric field, numerical modelling, magnetotelluric survey methods. Controlled source electromagnetic methods, electromagnetic sounding and profiling. Computer simulation and interpretation of electromagnetic geophysical data.

ErSE 328 – Advanced Seismic Inversion I (3-0-3)

Prerequisite: Include courses in linear algebra and partial differential equations, as well as ErSE 260. Corequisite: ErSE 260 taken simultaneously. Knowledge of linear inversion and exploration seismology is helpful. Consent of instructor is required.Overview of non-linear seismic inversion methods that invert for earth parameters from seismic data. The inversion procedure is a multiscale iterative method (typically, non-linear conjugate gradient) that employs preconditioning and regularization. Solution sensitivity is analyzed by model covariance matrices, the slice-projection theorem, and the generalized Radon transform. Methods for waveform inversion, wave path traveltime tomography, and least squares migration are presented.

ErSE 329 – Advanced Seismic Inversion II (3-0-3)

Prerequisite: ErSE 328
Codes for waveform tomography, wavepath traveltime tomography, traveltime tomography, least squares migration, and skeletalized inversion are used to help student evaluate limits and benefits of these methods, image domain inversion, and extend the frontier of seismic inversion. A term project is required that will be written as a paper, and possibly submitted to a relevant scientific journal.

ErSE 330 – Pore-Scale Modeling of Subsurface Flow (3-0-3)

This course will lay out the tools and fundamentals essential to carry out modeling, computation, analysis of flow at a pore scale. In particular, numerical techniques used to solving Stokes and Navier-Stokes within the framework of staggered-grid finite-difference methods will be introduced. The student will learn the basic principle of multiphase flow at a pore scale as well as its numerical modeling. Pore-scale flow and transport in geological formation and its applications to oil industry problems will be emphasized.

ErSE 345 – Seismic Interferometry (3-0-3)

Prerequisite: None.
The main objective is to present the key ideas of seismic interferometry and illustrate them with seismic examples from marine data, land data, and synthetic data. MATLAB exercises will be presented that educate the user about the benefits and pitfalls of interferometric imaging. Examples will be presented that use interferometry for 2D deconvolution, data extrapolation, data interpolation, super-stacking, passive seismology, surface-wave interferometry, and super-illumination.

ErSE 353 – Data Assimilation (3-0-3)

Prerequisite: ErSE 253.
Data assimilation (DA) is the process of optimally combining observations with the predictions of numerical models to make the best possible estimate of the time-varying state of the phenomenon under study. In particular, DA forms a basis for the forecast of the future and re analysis of the past. In the last 20 years, DA has gained center stage in many computational disciplines at both universities and research centers starting with geoscience applications. DA is a subject that requires a balanced understanding of statistics and applied mathematics as well as the relevant geophysical systems. This course introduces the concepts of data assimilation derived in the context of the statistical estimation theory and the deterministic inverse theory. The course covers a variety of assimilation methods for numerical weather prediction, ocean forecasting, reservoir history matching, 4D seismic inversion, and hydrology assimilation. These include, but not limited to, optimal interpolation and three (3) dimensional variational (3D VAR) methods, Kalman filtering, smoothing and fourdimensional variational (4D VAR) methods, low rank Kalman filtering, ensemble Kalman filtering and ensemble square-root filters. Advanced topics based on the fully nonlinear Bayesian estimation theory, such as the particle filter and the Gaussian Mixture filters, and the state of art data assimilation systems will also be discussed.

ErSE 360 – Mathematical Methods for Seismic Imaging (3-0-3)

Prerequisite: ErSE 260.
This course will be devoted to mathematical algorithms and methods for seismic imaging. We will learn how to extrapolate wavefields efficiently and accurately. Distribution, sampling and representation theorems are among the mathematical concepts covered in the course. We will also look at scattering and inverse scattering theory and relate them to the imaging process. To simplify the understanding of these concepts, we will look at them as well under the high frequency asymptotic assumption as we focus on solutions to the eikonal and dynamic ray tracing problems.

ErSE 390 – Advanced Topics (3-0-3)

Advanced Topics Specialized Ph.D.-level courses that cover subjects of particular interest, augment 300-level courses with in-depth coverage of the foundations, or provide computational applications and extended projects. Special Topics may also introduce new scientific fields and research areas, or broaden and challenge the students experience and expertise in other ways.

ERSE 390C –Topics in Computational Geophysics (3-0-3)

An introduction to finite-difference, pseudo-spectral, finite-element, and spectral-element methods will be presented and applied to basic geophysical problems including heat flow and wave propagation. The course offers hands-on lab experience in numerically solving partial differential equations relevant to geophysics.

ERSE 390D –Topics in Multiphase Flow in Reservoirs (3-0-3)

Mixture of physical understanding, mathematical theory, and hands-on development of numerical and engineering skills. MATLAB will be used as the computing environment for the coursework. Continuum transport equations; semi-analytic models of contaminant transport; numerical approximations of boundary-value problems.

ErSE 390K – Multiscale Geological Reservoir Modeling (3-0-3)

The course covers a number of basic multiscale methods with applications in geological reservoirs. Individual topics include: basic multiscale methods; homogenization techniques; heterogeneous multiscale methods; multiscale finite element methods; permeability upscaling single-phase and multiphase flows at multiple scales in geological reservoirs; multiscale multicomponent transport simulation; pore-scale modeling of reservoirs; molecular dynamics simulation of reservoir fluids.

ErSE 390M – Earthquake Physics (3-0-3)

Prerequisites: ErSE 210, ErSE 211, ErSE 217, or consent of instructor
This course exposes students to the fundamentals and latest developments in Earthquake Physics. Using continuum mechanics and dynamic elasticity, we first develop quantitative earthquake source characterizations and study their associated seismic radiation. Introducing linear elastic fracture mechanics (LEFM), we discuss the dynamics of the earthquake rupture process. Conditions for nucleation, propagation and arrest of earthquake ruptures will be discussed, also in the presence of geometrical fault complexity. Earthquake scaling, earthquake statistics, the long-term earthquake cycle and short-term earthquake predictability will be further topics of the course.

Seismic hazard and tsunami generation will be discussed in the context of earthquake-engineering applications. Earthquakes induced by human industrial activities will be discussed, as well as the role of natural fluids in the earthquake fault zones. The course will also present several numerical methods used in studying earthquake physics, and the students will learn to use one (or more) computer codes.

ErSE 390N – Seismic Waves (3-0-3)

Prerequisites: ErSE 210, 211, 217
In this course, the students will learn the theoretical and computational fundamentals of global seismic wave propagation. Major concepts about body and surface waves, as well as normal modes are introduced. Connections to imaging Earth 3D structure with ray-based methods, and methods beyond ray-theory are shown. Wave propagation phenomena such as attenuation, scattering and ambient noise are presented and studied by hands-on exercises.

ErSE 393 – Traveling Scholar (variable credit)

Doctoral level traveling scholar.

ErSE 394 – Contemporary Topics in Earth Science (3-0-3)

A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

ErSE 395 – Internship (variable credits)

Prerequisite: Approval of Academic Advisor.
Doctoral level internship.

ErSE 397 – Doctoral Dissertation Research (variable credit)

Doctoral level research leading to a formal written dissertation and oral defense.

ErSE 398 – Graduate Seminar (non-credit)

Prerequisite: None.
Graduate seminar focusing on special topics within the field.

ErSE 399 – Doctoral Directed Research (variable credit)

Prerequisite: Approval of Dissertation Advisor.
Doctoral level supervised research.

ESL

English as a Second Language
University Wide Courses

ESL 101 – English as a Second Language I (6-0-0)

ESL 101 is a foundational English skills course for reading, listening, speaking and writing. The course has a strong focus on teaching students the basics of academic writing and grammar structures in preparation for thesis work. Course materials are typically A2 level to help students acquire basic academic English skills required for graduate coursework.

ESL 102 – English as a Second Language II (3-0-0)

ESL 102 is a pre- English skills course for reading, listening, speaking and writing. The course continues to focus on building academic writing and grammar skills and also have more emphasis on reading for academic purposes. Course materials are typically B1 level to help students further develop pre-intermediate English skills required for graduate coursework.

ESL 103 – English as a Second Language III (3-0-0)

ESL 103 is an upper-intermediate English skills course for reading, listening, speaking and writing. The course helps to further develop academic English skills necessary to successfully complete research and thesis work. Course materials are typically B2 level to help students refine upper- intermediate English skills required for graduate coursework.

IED

Innovation and Economic Development
University Wide Courses

IED 210 – Technology Innovation and Entrepreneurship (3-0-3)

This course introduces students to using an entrepreneurial and design thinking view to solving real-world challenges including the pathway to commercializing research. It is about changing methods of thinking and equipping graduate students to be able to understand and manage innovation in the corporate world.

IED 220 – New Venture and Product Innovation Challenge (6-0-6)

This intensive 8 week module will give a small select group of students, the opportunity and time to develop a detailed value proposition for a product based on an existing piece of intellectual property. This technology may be from the KAUST IP portfolio or potentially from a corporate partner. As part of the program, students will be provided with an overview of key creative subjects related to new product development including; key aspects of intra/entrepreneurship, innovation management including new product development, Go-to-Market strategies as part of commercialization roadmaps, as well as general knowledge on relevant creativity and design thinking. It will also enable students to develop these skills in a full-time, heavily mentor-led and experiential learning environment that includes regular pitches and feedback from a wide range of pre-selected mentors from both inside and outside KAUST including international experts.

MarS

Marine Science
Division of Biological and Environmental Science and Engineering (BESE)

MarS 199 – Directed Study in Marine Science (variable contact hours, non-credit)

A course of self-study in a particular topic as directed by faculty and approved by the division.

MarS 221 – Marine Life (3-0-3)

Prerequisite: Undergraduate course in ecology, zoology, or marine science. Students from programs other than MarS must have instructor permission to register for this course.
An overview of marine biology that surveys the diversity of marine habitats, major groups of taxa inhabiting those habitats and the general biology of the various taxa. Topics include the impacts of climate change and other anthropogenic impacts in the ocean. Species diversity, structure of marine food webs and the flow of energy within different marine habitats will be detailed and contrasted. The course will cover the major marine ecosystem types and the ecology of the adaptations of marine life occupying these habitats. There will be a particular emphasis on Red Sea systems.

MarS 228 – Marine Ecosystems (3-0-3)

Prerequisite: Marine Life (MarS 221)
Structure and Function of marine ecosystems – This course gives an overview of marine ecology. It addresses the global production and distribution of plankton and fish, the vertical distribution of both pelagic and benthic organisms as well as predator-prey interactions among organisms in different habitats. It describes ecosystems from the intertidal zone to the deep sea and outlines ecological principles governing the distributions of organisms and their adaptations to be successful in the different environments. Marine Life (MarS 221) is a prerequisite for this course.

MarS 293 – Traveling Scholar (variable credit)

Master's level traveling scholar.

MarS 294 – Contemporary Topics in Marine Science (3-0-3)

A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

MarS 295 – Internship (6-0-6 or variable credit)

Master's level internship.

MarS 297 – Master's Thesis Research (variable credit)

Master's level research leading to a formal written dissertation and oral defense.

MarS 299 – Master's Directed Research (variable credit)

Master's level supervised research.

MarS 323 –-Pelagic Ecology (3-0-3)

Prerequisite: Undergraduate course in marine science. Students from programs other than MarS must have instructor permission to register for this course.
The course will address one or a few central topics in pelagic ecology in-depth. It will primarily be based on seminars in which the students will present and discuss scientific papers. The aims are to acquire knowledge of the state-of-the-art of current research questions, as well as to train communication skills and the ability to critically read research papers. Assessment includes a final oral exam.

MarS 326 – Coral Reef Ecology (3-0-3)

Marine Life (MarS 221) is a prerequisite for this course or consent of instructor. (Please note: prerequisites are for M.Sc. students only).
This course will cover coral reef distributions, biogeography, and ecological processes important to reefs. Basic coral anatomy and physiology will be discussed. Reef fishes and their interaction with coral communities will be highlighted, along with coral reef fisheries. Modern threats to coral reefs, including thermal bleaching, ocean acidification and diseases of corals will be examined with particular emphasis on processes affecting the future status of reef communities. As a Ph.D. level course, assessment of students and participation expectations will be commensurate with the level of student experience.

MarS 329 – Marine Microbial Ecology (3-0-3)

Environmental Microbiology (EnSE 203) is a prerequisite for this course or consent of instructor. (Please note: prerequisites are for M.Sc. students only.)
Recent developments in the field of marine microbial ecology and will give an overview on structure and function of microbial communities in the oceans including discussions on novel methods, results and hypotheses. Among the topics covered are: Photoheterotrophic bacteria, Marine Bacteria and the Carbon Cycle, UV radiation effects on Microbes and Microbial Processes, Uptake and Regeneration of Inorganic Nutrients by Marine Heterotrophic Bacteria, Bacterivory: Interactions between Bacteria and their Grazers, Symbiosis and Mixotrophy Among Pelagic Microorganisms, Marine Viruses and their ecological impact, Global Ocean Survey of Marine Metagenomics, Single cell activity in marine bacterioplankton. As a Ph.D. level course, assessment of students and participation expectations will be commensurate with the level of student experience.

MarS 330 – Marine Ecological Genomics (3-0-3)

Ecological genomics describes the application of genomic tools (high throughput sequencing, microarrays, quantitative PCR etc.) to solve questions of ecology. Its purpose is to increase understanding of the responses and interactions of organisms to the environment and to one another by analyzing genomic sequences, gene expressions and genome evolution. This course will give an overview over the methods utilized and the questions asked by ecological genomics with a particular emphasis on marine ecological genomics. As a Ph.D. level course, assessment of students and participation expectations will be commensurate with the level of student experience.

MarS 332 – Optical Oceanography (3-0-3)

This course in ocean optics is intended to be a practical introduction to the theory and use of ocean optics. Ocean optics spans the areas of radiative transfer within seawater, the role of particles and dissolved organic matter in modifying the inherent optical properties and the use of remotely sensed ocean color to measure biogeochemical properties and processes within the ocean. The course will include theory of inherent and apparent optical properties, the use of modeling tools to propagate light within seawater and the practical use of in situ instrumentation to make measurements of inherent and apparent optical properties within the ocean.

MarS 335 – Oceanography (3-0-3)

This course is an introduction to oceanography that focuses on the interaction between organisms and their physical environment. The course incudes discussions of ocean basins, major currents and water property distributions; properties of seawater: equation of state, temperature and salinity analysis; basic dynamical ideas: hydrostatic balance, Coriolis force, geostrophy, turbulence; forcing of the ocean: solar radiation, winds, heat and freshwater fluxes; Ekman transport; the observed ocean: major currents, gyres, meridional overturning, eddies, sill flows, upwelling, monsoons, equatorial motions, El Niño, marginal seas; time dependence: inertial oscillations, long gravity waves, Rossby waves; tides: astronomical forcing, basin modes, local resonances, tidal mixing. The course includes a practical portion focusing on oceanographic measurements and will include a small field effort. Analysis and reporting of the results from this effort is a requirement of the course.

MarS 390 – Special Topics: Movement Ecology (3-0-3)

This course will focus on several aspects of movement ecology in the marine environment. The topics will span a range of spatial and temporal scales, ranging from feeding mechanics and daily home ranges to ocean-scale migrations and evolutionary connectivity. An emphasis will be placed on concepts with case studies to investigate in further detail.

MarS 393 – Traveling Scholar (variable credit)

Doctoral level traveling scholar.

MarS 394 – Contemporary Topics in Marine Science (3-0-3)

A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

MarS 395 – Internship (variable credit)

Doctoral level internship.

MarS 397 – Doctoral Dissertation Research (variable credit)

Doctoral level research leading to a formal written dissertation and oral defense.

MarS 398 – Graduate Seminar (non-credit)

Graduate seminar focusing on special topics within the field.

MarS 399 – Doctoral Directed Research (variable credit)

Doctoral level supervised research.

ME

Mechanical Engineering
Division of Physical Science and Engineering (PSE)

ME 100 – Basic Principles of Mechanics (3-0-0)

Prerequisite: None.
SOLID MECHANICS: Equilibrium conditions and determination of forces on structures, Determination of internal force systems in structures, Definitions of stress and strain, Mechanical properties of solid materials, Structural components under axial loads, torsional loads, bending, and combined loads, beam theory.
FLUID MECHANICS: Fluid properties, fluid forces, fluid statics and kinematics, Conservation of mass, momentum and energy in fixed, deforming, and moving control volumes, boundary layer concept, lift and drag, pressure and friction drag, streamlining and drag reduction.
DYNAMICS & VIBRATIONS: Kinematics of particles, Kinetics of a particles, Work and energy methods for particles, Vibrations of particles, Planar kinematics of rigid bodies, Planar kinetics of rigid bodies, Work and energy methods for rigid bodies, Vibrations of rigid bodies

ME 101 – Basic Principles of Thermodynamics (3-0-0)

Prerequisite: None.
Pressure, temperature and general properties, work and heat transfer in processes, power, conservation principle for mass and energy, reversible processes, the 2nd law of thermodynamics, steady state devices, transient processes, heat engines, power producing cycles, refrigerator and heat pumps, basic constrained optimization based on Lagrange multipliers (needed for chemical equilibrium), basic differentiation skills and understanding of homogeneous functions (for mathematical thermodynamics).

ME 199 – Directed Study in Mechanical Engineering (variable contact hours, non-credit)

A course of self-study in a particular topic as directed by faculty and approved by the division.

ME 200 A, B – Fluid Mechanics (3-0-3)

Prerequisite: ME 200B requires ME 200A.
Fundamentals of fluid mechanics. Microscopic and macroscopic properties of liquids and gases; the continuum hypothesis; review of thermodynamics; general equations of motion; kinematics; stresses; constitutive relations; vorticity, circulation; Bernoulli's equation; potential flow; thin-airfoil theory; surface

gravity waves; buoyancy-driven flows; rotating flows; viscous creeping flow; viscous boundary layers; introduction to stability and turbulence; quasi one-dimensional compressible flow; shock waves; unsteady compressible flow; acoustics.

ME 211A – Mechanics of Structures and Solids (3-0-3)

Prerequisite: None.
Review of basic concepts of continuum mechanics. Statics: static stress analysis, stress tensors. eigenvalues and principal stresses, equilibrium, concept of static admissibility, Airy functions. Kinematics: transformations. expansion and deformation tensors, transport equations, linearization for small perturbations. Linear elasticity. Strong form solutions. Energy theorems and approximations: theorems of potential and complementary energy, Ritz approximations, weak form and variational formulations. Introduction to fracture, damage and plasticity.

ME 211B – Mechanics of Structures and Solids (3-0-3)

Prerequisite: ME 211B requires ME 211A.
A variety of special topics will be discussed in the second term such as, but not limited to: homogenization strategies (Voigt, Reuss, Hill Mandel, asymptotic, concepts of representative volume element), isotropic and anisotropic damage theory, micromechanics of cracking in laminated media and micromechanics based damage models, identification of parameters of models of materials by Digital Image Correlation.

ME 212 – Continuum Mechanics (3-0-3)

Prerequisite: ME 212b. Requires ME 211a and ME 212a.
Elements of Cartesian tensors. Configurations and motions of a body. Kinematics—study of deformations, rotations and stretches, polar decomposition. Lagrangian and Eulerian strain velocity and spin tensor fields. Irrotational motions, rigid motions. Kinetics—balance laws. Linear and angular momentum, force, traction stress. Cauchy's theorem, properties of Cauchy's stress. Equations of motion, equilibrium equations. Power theorem, nominal (Piola- Kirchoff) stress. Thermodynamics of bodies. Internal energy, heat flux, heat supply. Laws of thermodynamics, notions of entropy, absolute temperature. Entropy inequality (Clausius- Duhem). Examples of special classes of constitutive laws for materials without memory. Objective rates, corotational, convected rates. Principles of materials frame indifference. Examples: the isotropic Navier-Stokes fluid, the isotropic thermoelastic solid. Basics of finite differences, finite elements, boundary integral methods and their applications to continuum mechanics problems illustrating a variety of classes of constitutive laws

ME 214 – Experimental Methods (2-1-3)

Prerequisite: ME 200 A, B or ME 211 A, B or equivalent (may be taken concurrently).
Lectures on experiment design and implementation. Measurement methods, transducer fundamentals, instrumentation, optical systems, signal processing, noise theory, analog and digital electronic fundamentals, with data acquisition and processing systems.

ME 221 A – Control Theory (2-1-3)

Prerequisite: Calculus & ordinary differential equations, exposure to linear algebra and complex variables
This course presents fundamental topics for the analysis of linear dynamical systems, i.e., systems that evolve in time and which admit an underlying linear structure. The material in this course serves as the foundation for continued study in more advanced courses in control design and system theory. The course covers the following topics: state space equations, interconnections, linearization, solutions of state space equations, Transfer functions, Stability of linear systems, Lyapunov, input/output stability, Controllability and observability, state feedback, observer and an introduction to linear quadratic regulator (LQR).

ME 221 B – Control Theory (2-1-3)

Prerequisite: Control theory A, linear algebra, differential equations
The aim of this course is to introduce the student to the area of nonlinear control systems with a focus on systems' analysis and control design. The course will include the introduction of nonlinear phenomena including multiple equilibria, limit cycles and bifurcations, Lyapunov and input output stability, examples of control design such as feedback linearization, backstepping control and sliding mode control. Many examples will be provided and designed controllers will be illustrated by simulation using Matlab and through experimental implementation in the control lab.

ME 222 A, B – Mechatronics and Intelligent Systems (2-1-3)

Prerequisite: ME 222B requires ME 222A.
Introduction to Mechatronics principles, MEMS and Microsystems, Data Acquisition, Operational Amplifiers, Microcontrollers and Microprocessors, Signal Processing, FFT, Vibrating MEMS, Gyroscopes, Accelerometers, Band-Pass Filters, Sensing and Actuation, Electro thermal, Piezoelectri, Electromagnetic, Peizoresistive, Electrostatic, Elements of Lumped- Parameter Modeling, Stiffness Elements, Spring-Mass Models, Damping in MEMS, Introduction to Nonlinear Modeling, Fixed Points and Linearization, Bifurcations of Fixed Points, Phase Portraits, Nonlinear Oscillations, Case Studies: Capacitive RF Switches, AFM, Torsional Actuators and Micromirrors. Basic electronic devices, embedded microprocessor systems and control, power transfer components and mechanism design. Hardware-in-the-loop simulation and rapid prototyping of real- time closed-loop computer control of electromechanical systems; robotic manipulation.

ME 224 – System Identification and Estimation (3-0-3)

Prerequisite: ME 221 A, B (ME 221B can be taken concurrently).

Deterministic state estimation, recursive observers, estimation for uncertain process dynamics; SISO and MIMO least-squares parameter estimation, linear system subspace identification. Random variables and random processes: linear systems forced by random processes, power-spectral density. Bayesian filtering including Kalman filter. Jump- Markov estimation and fault diagnosis. Nonlinear estimation, particle filters, unscented Kalman filter. Introduction to estimation for hybrid systems.

ME 232A – Advanced Dynamics (3-0-3)

The course discusses fundamentals of linear dynamics, kinetics and kinematics, of particles and rigid bodies; both in 2-D and 3-D. 3-D rotation is emphasized. Lagrangian, Newtonian, and Euler dynamics are discussed as applied to variety of rigid body problems. Hamilitonian principles are also discussed.
Topics include
-Review of Kinetics and Kinematics of Particles, And Planar Rigid Bodies, 3D Rotation, Angular Velocity, Time Derivative of a Vector
-Five-Term Acceleration Equation, Coriolis Acceleration, Phase Portrait, Virtual Work, D'A Lembert Principle, Lagrange Equations of Particles, Conservative Forces, Linearization, Free Vibration, Hamiltonian's Principle, Lagrange Equations of Rigid Bodies, Cyclic Variables, Hamiltonian, Lagrange Multiplier, Hamilton Canonical Equations, Ruth Equations, Moment of Inertia, Principals Directions, Euler Angles, Euler Equations

ME 232B – Advanced Dynamics (3-0-3)

Prerequisite: ME 232A.
Linear Dynamics: Planar Kinetics and Kinematics of Rigid Bodies, 3D Rotation, Angular Velocity, Time Derivative of a Vector, Five-Term Acceleration Equation, Coriolis Acceleration, Phase Portrait, Virtual Work, D'A Lembert Principle, Lagrange Equations of Particles, Conservative Forces, Linearization, Free Vibration, Hamiltonian's Principle, Lagrange Equations of Rigid Bodies, 15 Cyclic Variables, Hamiltonian, Lagrange Multiplier, Hamilton Canonical Equations, Ruth Equations, Moment of Inertia, Principals Directions, Euler Angles, Euler Equations. Nonlinear Dynamics: phase space, phase portraits, linear oscillators, equilibrium solutions (continuous systems and maps), stability concepts, linearization and stability analysis, bifurcation types, periodic solutions, Floquet theory, shooting technique, Poincare sections, quasi-periodic solutions, nonlinear oscillations, multiple scales, Duffing, secondary resonances, self-excitation, parametric excitation, chaos, crises escape from potential well, tangling.

ME 241 – Thermodynamics (3-0-3)

Fundamentals of classical and statistical thermodynamics. Basic postulates, thermodynamic potentials, chemical and phase equilibrium, phase transitions, and thermodynamic properties of solids, liquids and gases. Exergy analysis. Power generation.

ME 242 – Heat and Mass Transfer (3-0-3)

Transport properties, conservation equations, conduction heat transfer, forced and natural convective heat and momentum transfer in laminar and turbulent flows, boundary layer concepts, thermal radiation and mass diffusion.

ME 243 – Statistical Mechanics (3-0-3)

Prerequisite: ME 241 or equivalent.
This is a course on Statistical mechanics that is divided into four (4) parts of assorted topics. It starts from an overview of some basic concepts in thermodynamics and exposes the formal structure of equilibrium statistical mechanics with applications to ideal non-interacting and interacting systems. The course then dwells on more advanced topics such as the liquid state, critical phenomena, Ising model and the renormalization group. In the third part, Kinetic theory is presented through a thorough discussion of the Boltzmann equation and the derivations of the continuum equations. Transport processes are then discussed and transport coefficients are calculated. The theory of Brownian motion is also described as another approach to describe non-equilibrium processes. In the last section, Monte Carlo methods are applied to calculate various macroscopic properties for some lattice models.

ME 244 – Combustion (3-0-3)

Prerequisite: ME 241 or equivalent.
Basic principles including chemical equilibrium, Arrhenius law, and Rankine-Hugoniot relations will be first discussed. Multi-component conservation equations with chemical reaction will be introduced. Various characteristics of premixed and diffusion flames will be studied which covers flame structure, flame stability, flame stabilization, flammability limit, quenching distance and thermal explosion. Combustion phenomena in gas turbines, gasoline engines, diesel engines and power plants will be discussed. A matched asymptotic expansion technique will be introduced and applied in analyzing flame structures.

ME 250 – Energy (3-0-3)

Prerequisite: ME 241 or equivalent.
Review of first and second laws of thermodynamics. Principles of energy conversion: vapor power cycles, combustion, combined cycle and fuel cells. Modeling and forecasting. Heating, transportation, and electricity demand. Fossil-fuel supplies: oil, natural gas, coal, oil sands and oil shale. Alternative energy sources: hydroelectric, nuclear fission and fusion, wind, biomass, geothermal, biofuels, waves, ocean thermal, solar photovoltaic and solar thermal. Transportation systems: internal combustion engines, gas turbines and electric vehicles. Energy systems: pipelines, rail and water transport, shipping, carbon capture and sequestration, transmission lines and electricity distribution networks.

ME 252 – Sustainable Energy Engineering (3-0-3)

Prerequisite: AMCS 201 and AMCS 202 (may be taken concurrently), ME 250.

An in-depth examination of engineering systems to convert, store, transport, and use energy, with emphasis on technologies that reduce or eliminate dependence on fossil fuels and/or emission of greenhouse gases. Topics include thermodynamics of energy conversion, energy resources, stationary power generation (vapor power cycles, combined cycles, solar thermal systems, nuclear fission and fusion, solar photovoltaics, fuel cells, wind, geothermal), carbon sequestration, alternative fuels (hydrogen, biofuels), and transportation systems (internal combustion engines, gas turbines, fuel cell and electric vehicles). The course will emphasize quantitative methods to assess and compare different technologies.

ME 261 – Application of Atmospheric Pressure Plasma (3-0-3)

Prerequisite: None.
Introduction to plasma sources in atmospheric pressure condition: dielectric barrier discharge, pulsed corona, arc, elongated arc and microwave plasma. Application fields for mechanical engineers. Energy: fuel reforming and combustion. Environment: after-treatment of hazardous gases. Manufacturing: surface treatment of materials. Plasma devices for bio-medical application.

ME 293 – Traveling Scholar (variable credit)

Master's level traveling scholar.

ME 294 – Contemporary Topics in Mechanical Engineering (3-0-3)

A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

ME 295 – Internship (6-0-6 or variable credit)

Master's level internship.

ME 297 – Master's Thesis Research (variable credit)

Master's level research leading to a formal written thesis and oral defense.

ME 299 – Master's Directed Research (variable credit)

Prerequisite: M.Sc. status and consent of instructor.
Master's level supervised research.

ME 300 – Advanced Fluid Mechanics (3-0-3)

Prerequisite: ME 200 a, b or equivalent; AMCS 201 and AMCS 202 (may be taken concurrently).
A more rigorous mathematical introduction to fluid mechanics. Derivation of Navier-Stokes; physical properties of real gases; the equations of motion of viscous and inviscid dynamics; the dynamical significance of vorticity; vortex dynamics; Kelvin circulation theorem and consequences; Biot-Savart Law, exact solutions in vortex dynamics; motion at high Reynolds numbers; hydrodynamic stability; boundary layers; flow past bodies; compressible flow; subsonic, transonic, and supersonic flow; Lax theory of shock waves.

ME 302 – Multi-Phase Flows (3-0-3)

Prerequisite: ME 241, AMCS 201 and AMCS 202, ME 200 a, b, ME 211 a, b or equivalents.
Selected topics in engineering two-phase flows with emphasis on practical problems in modern hydro-systems. Fundamental fluid mechanics and heat, mass and energy transport in multiphase flows.
Liquid/vapor/gas (LVG) flows, nucleation, bubble dynamics, cavitating and boiling flows, models of LVG flows; instabilities, dynamics and wave propagation; fluid/structure interactions.
Discussion of two-phase flow problems in conventional, nuclear and geothermal power plants, marine hydrofoils, and other hydraulic systems.

ME 304 – Experimental Methods in Fluid Mechanics (2-1-3)

Prerequisite: ME 200 a, b or equivalent
Basic sampling theory. Spectral decomposition, aliasing, Nyquist criterion and dynamic range. Basic optics, lasers, diffraction limit. Particle tracking and streak photography. Point measurements of velocity, pitot static tube, hot wires, and laser-doppler velocimetry. Measurements of velocity fields in planes and volumes, using particle image velocimetry. Micro-PIV. Measurement of scalar fields. Holographic PIV. High-speed video technology. This course has a significant laboratory component.

ME 305 A, B – Computational Fluid Dynamics (3-0-3)

Prerequisite: ME 200 a, b or equivalent; AMCS 201 and AMCS 202 or equivalent; ME 305b requires ME 305a.
Introduction to floating point arithmetic. Introduction to numerical methods for Euler and Navier-Stokes equations with emphasis on error analysis, consistency, accuracy and stability. Modified equation analysis (dispersion vs. dissipation) and Von Neumann stability analysis. Finite difference methods, finite volume and spectral element methods. Explicit vs. implicit time stepping methods. Solution of systems of linear algebraic systems. Higher-order vs. higher resolution methods. Computation of turbulent flows. Compressible flows with high-resolution shock-capturing methods (e.g. PPM, MUSCL, and WENO). Theory of Riemann problems and weak solutions for hyperbolic equations.

ME 306 – Hydrodynamic Stability (3-0-3)

Prerequisite: ME 200 a, b or equivalent; AMCS 201 and AMCS 202 (may be taken concurrently).
Laminar-stability theory as a guide to laminar-turbulent transition. Rayleigh equation, instability criteria and response to small inviscid disturbances. Discussion of Kelvin-Helmholtz, Rayleigh-Taylor, Richtmyer-Meshkov and other instabilities, for example, in geophysical flows. The Orr-Sommerfeld equation, the dual role of viscosity, and boundary-layer stability. Modern concepts such as pseudo-momentum conservation laws and nonlinear stability theorems for 2-D and geophysical flows.

ME 307 – Turbulence (3-0-3)

Prerequisite: ME 200 a, b; AMCS 201 and AMCS 202. Introduction to turbulence. Fundamental equations of turbulent flow. Statistical description of turbulence. Experimental methods for turbulence. Reynolds equations. Kolmogorov's theory. Scales of turbulence. Homogeneous turbulence. Free-shear flows. Bounded flows. Boundary layers. Simulating turbulent flows. Reynolds Average Navier-Stokes approach. Introduction to Large Eddy.

ME 308 – Introduction to Plasma Physics and Magneto-hydrodynamics (3- 0-3)

Prerequisite: ME 200 ab; AMCS 201 and AMCS 202. Motion of charged particles; Statistical behavior of plasmas. Vlasov and Fokker-Planck equations and derivation of fluid models for plasmas; closure problem and models. Dispersive waves in plasmas. Ideal and non-ideal magneto-hydrodynamics. Exact solutions. Alfvén and shock waves in MHD. MHD instabilities.

ME 310 – Mechanics and Materials Aspects of Fracture (3-0-3)

Prerequisite: ME 211 A, B or equivalent.
Analytical and experimental techniques in the study of fracture in metallic and nonmetallic solids. Mechanics of brittle and ductile fracture; connections between the continuum descriptions of fracture and micro mechanisms. Discussion of elastic-plastic fracture analysis and fracture criteria. Special topics include fracture by cleavage, void growth, rate sensitivity, crack deflection and toughening mechanisms, as well as fracture of nontraditional materials. Fatigue crack growth and life prediction techniques will also be discussed. In addition, "dynamic" stress wave dominated, failure initiation growth and arrest phenomena will be covered. This will include traditional dynamic fracture considerations as well as discussions of failure by adiabatic shear localization.

ME 313 – Theory of Structures (3-0-3)

Prerequisite: ME 313B requires ME 313A.
Geometry of spatial curves; finite 3-D rotations; finite deformations of curved rods; dynamics of rods; strings and cables; theory of plastic rods; statistical mechanics of chains; applications including frames and cable structures, polymers, open-cell foams, DNA mechanics, cell mechanics; small strain and von Karman theory of plates; applications to thin films, layered structures, functionally graded thin films, delamination, plastic collapse; surface geometry; finite deformations of shells; dynamics of plates and shells; membranes; theory of plastic plates and shells; fracture of plates and shells; elastic and plastic stability; wrinkling and relaxation; applications including solar sails, space structures, closed cell foams, biological membranes; numerical methods for structural analysis; discrete geometry; finite elements for rods, plates and shells; time-integration methods; thermal analysis.

ME 314 – Plasticity (3-0-3)

Prerequisite: ME 211 a, b.
Theory of dislocations in crystalline media. Characteristics of dislocations and their influence on the mechanical behavior in various crystal structures. Application of dislocation theory to single and polycrystal plasticity. Theory of the inelastic behavior of materials with negligible time effects. Experimental background for metals and fundamental postulates for plastic stress- strain relations. Variational princiremental elastic plastic problems, uniqueness. Upper and lower bound theorems of limit analysis and shakedown. Slip line theory and applications. Additional topics may include soils, creep and rate- sensitive effects in metals, the thermodynamics of plastic deformation, and experimental methods in plasticity.

ME 316 – Micromechanics (3-0-3)

Prerequisite: AMCS 201 and AMCS 202 or equivalent, ME 211 a, b and ME 212 a, b or instructor's permission. The course gives a broad overview of micromechanics, emphasizing the microstructure of materials, its connection to Mechanical Engineering. Courses molecular structure and its consequences on macroscopic properties. Topics include phase transformations in crystalline solids, including martensitic, ferroelectric and diffusional phase transformations, twinning and domain patterns, active materials; effective properties of composites and polycrystals, linear and nonlinear homogenization; defects, including dislocations, surface steps and domain walls; thin films, asymptotic methods, morphological instabilities, self-organization; selected applications to micro actuation, thin-film processing, composite materials, mechanical properties and materials design. Open to undergraduates with instructor's permission.

ME 317 – Mechanics of Composite Materials and Structures (3-0-3)

Prerequisite: ME 211a; ME 212a; ME 317b requires ME 317a.
Introduction and fabrication technologies. Elastic response of composite materials (especially fiber and particulate reinforced materials) from the fabrication to the in-service structure. Up scaling strategies from the microstructure to the single ply: kinematic and static bounds, asymptotic expansion and periodical homogenization. Up scaling strategies from the single ply to the structural scale: elastic deformation of multidirectional laminates (lamination theory, ABD matrix). Mechanics of degradation in composite materials: fiber-matrix debonding, plasticity, micro cracking and induced delamination. Tools for description of non-linear effects: damage mechanics for laminates, applications of fracture mechanics. Aging and fatigue. Basic criteria-based theories will also be reviewed, including first ply failure, splitting and delamination. Basic experimental illustration will include: hand lay up of a simple laminate, characterization using full field measurement of its material properties.

ME 319 – Computational Solid Mechanics (3-0-3)

Prerequisite: AMCS201 and AMCS202 or equivalent; ME 211 A, B or ME 212 A, B (may be taken concurrently); ME 319B requires ME 319A.
Variational principles in linear elasticity. Finite element analysis. Error estimation. Convergence. Singularities. Adaptive strategies. Constrained problems. Mixed methods. Stability and convergence. Variational problems in nonlinear elasticity. Consistent linearization. The Newton-Rahpson method. Bifurcation analysis. Adaptive strategies in nonlinear elasticity. Constrained finite deformation problems. Contact and friction. Time integration. Algorithm analysis. Accuracy, stability, and convergence. Operator splitting and product formulas. Coupled problems. Impact and friction. Space-time methods. Inelastic solids. Constitutive updates. Stability and convergence. Consistent linearization. Applications to finite deformation viscoplasticity, viscoelasticity and Lagrangian modeling of solids.

ME 320 – Geometry of Nonlinear Systems (3-0-3)
Prerequisite: AMCS 202
Basic differential geometry, oriented toward applications in control and dynamical systems. Topics include smooth manifolds and mappings, tangent and normal bundles. Vector fields and flows. Distributions and Frobenius' theorem. Matrix Control and Dynamical Systems. Lie groups and Lie algebras. Exterior differential forms and Stokes' theorem.

ME 324 – Advanced Control Systems (3-0-3)
Prerequisite: AMCS 201 and AMCS 202 or equivalent; ME 221 ab or equivalent.
Introduction to modern control systems with emphasis on the role of control in overall system analysis and design. Input-output directions in multivariable systems: eigenvalues and singular value decomposition. System norms and introduction to MIMO robustness. Controller design for multivariable plants: linear quadratic regulator, linear quadratic Gaussian optimal control, H-infinity and H-2 control, sampled-data, model predictive control. Convex design methods: Youla parameterization, linear matrix inequalities; adaptive control, neural networks, fuzzy logic systems; introduction to neuro-fuzzy systems and soft computing. Multivariable control design examples drawn from throughout engineering and science in the field of aerospace, automotive, chemical-and energy-efficient buildings.

ME 326 – Robust Control (3-0-3)
Prerequisite: AMCS 201 and AMCS 202 or equivalents; ME 221 ab or equivalent.
Linear systems, realization theory, time and frequency response, norms and performance, stochastic noise models, robust stability and performance, linear fractional transformations, structured uncertainty, optimal control, model reduction, m analysis and synthesis, real parametric uncertainty, Kharitonov's theorem and uncertainty modeling.

ME 340 – Advanced Combustion Theory (3-0-3)
Prerequisite: ME 244 or equivalent.
Review of chemical thermodynamics and kinetics. Conservation equations of multi-component reacting flows. Transport properties. Asymptotic analysis of premixed flames. Flame speed and extinction. Theory of laminar premixed and nonpremixed flames. Aerodynamics of premixed flames. Computational simulations of premixed and nonpremixed flames. Theory of ignition and extinction.

ME 342 - Combustion Kinetics (3-0-3)
Prerequisite: ME 244 or ME 241
Non-equilibrium processes in chemically reacting gases. Example applications to combustion, atmospheric chemistry, plasmas, chemical and materials processing, rocket nozzles and gaseous lasers. Bimolecular reaction theory (collision theory); transition state theory; unimolecular and association reactions; complex reactions; straight chain reactions; explosions and branched chain reactions; photochemistry, photophysics; energy transfer in fuel tracers; vibrational relaxation; experimental techniques.

ME 344 – Gas Dynamics (3-0-3)
Prerequisite: ME 241.
Concepts and techniques for description of high-temperature and chemically reacting gases from a molecular point of view. Introductory kinetic theory; chemical thermodynamics; statistical mechanics as applied to properties of gases and gas mixtures; transport and thermodynamic properties; law of mass action; equilibrium chemical composition; Maxwellian and Boltzmann distributions of velocity and molecular energy; examples and applications from areas of current interest such as combustion and materials processing.

ME 346 – Turbulent Combustion (3-0-3)
Prerequisite: ME 244, ME 307 or equivalent.
Governing equations of reactive fluid flow. Review of fundamental concepts in turbulence. Non-premixed turbulent combustion. Conserved scalar modeling approach and turbulent non-premixed combustion models. Premixed turbulent combustion fundamentals and combustion regimes. Canonical models for premixed turbulent combustion. Partially premixed combustion. Scaling laws for lifted turbulent jet flames.

ME 348 – Introduction to Spectroscopy and Laser Diagnostics (3-0-3)
Prerequisite: ME 241 or ME 243 or equivalent
Fundamentals of microwave, infrared, Raman, and electronic spectroscopy. Laser-based diagnostic techniques for measurements of species concentration, temperature, pressure, velocity, and other flow field properties. Topics: rotational, vibrational, and electronic transition frequencies; spectral line shapes and line-broadening mechanisms; nuclear spin effects; electronic spectra of atoms and molecules; absorption; emission; laser induced fluorescence (LIF); Rayleigh and Raman scattering methods; Mie theory; laser Doppler

velocimetry (LDV) and particle image velocimetry (PIV); applications and case studies. Laser Diagnostics for Thermal Engineering.

ME 376 – Introduction to Combustion Engines (3-0-3)
Prerequisites: ME 241 or ME 244
The objective of the course is to provide a thorough understanding of the processes that occur in an internal combustion engine and the reason why it is designed as it is. The course will after an introduction deal with the performance measures of ICE, the link between engine performance and vehicle requirements, fundamental combustion, thermodynamic cycles, multicylinder balance, in-cylinder flow and turbulence, Spark Ignition Combustion, Spark Ignition engine emissions, the combustion in Compression Ignition engines and it's after treatment needs. The course ends with a rather comprehensive description of the gas exchange system with valve system, gas dynamics in inlet and exhaust systems, two-strokes and finally supercharging/turbocharging.

ME 377 – Advanced Internal Combustion Engines (3-0-3)
Prerequisites: ME 376
Introduction to Combustion Engines. The course starts with an in-cylinder pressure analysis for heat release evaluation. Modern and advanced Otto and Diesel type engines are investigated as well as the historical development of engines.
Advanced gas ex-change systems are discussed and special emphasis is provided on direct fuel injection since such systems have evolved dramatically the last years. New types of internal combustion engines such as HCCI and PPC are explained. Measuring techniques for the analyzing of engines as well as engine control are presented. Fuel aspects with emphasis on engine performance and emissions are presented.

ME 378 – Experimental Combustion (3-0-3)
Prerequisites: ME 244
Experimental methods for combustion study will be instructed. Widely studied canonical flames and burners, which include a coflow burner, a counterflow burner, jet flames and outwardly propagating flames will be introduced and detailed experimental conditions to control various flame characteristics, such as flame temperature and burning velocity, will be instructed. Practical diagnostic methods such as laser induced fluorescence and particle image velocimetry will be covered. Complementary experiments will be provided for practical knowledge and experience.

ME 393 – Traveling Scholar (variable credit)
Doctoral level traveling scholar.

ME 394 – Contemporary Topics in Mechanical Engineering (3-0-3)
A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

ME 394A – Contemporary Topics in Fluid Mechanics (3-0-3)
Prerequisite: ME 200 a, b and consent of the instructor.
Lecture and/or seminar course on advanced topics in fluid mechanics. Topics are determined by the instructor and may vary from year to year. The course may be repeated for credit.

ME 394B – Contemporary Topics in Solid Mechanics (3-0-3)
Prerequisite: ME 211 a, b, ME 212 a, b and consent of the instructor.
Lecture and/or seminar course on advanced topics in solid mechanics. Topics are determined by the instructor and may vary from year to year. The course may be repeated for credit.

ME 394C – Contemporary Topics in Control Theory and Practice (3-0-3)
Prerequisite: ME 221 a, b and consent of the instructor.
Lecture and/or seminar course on advanced topics in control theory and practice. Topics are determined by the instructor and may vary from year to year. The course may be repeated for credit.

ME 394D – Contemporary Topics in Dynamics (3-0-3)
Prerequisite: ME 232 a, b and consent of the instructor
Lecture and/or seminar course on advanced topics in dynamics. Topics are determined by the instructor and may vary from year to year. The course may be repeated for credit. Maximum number of credits is 3 per semester.

ME 394E – Contemporary Topics in Thermal Science and Engineering (3-0-3)
Prerequisite: ME 241 and ME 242 or ME 244 and consent of the instructor.
Lecture and/or seminar course on advanced topics in thermal science and engineering. Topics are determined by the instructor and may vary from year to year. The course may be repeated for credit.

ME 395 – Internship (variable credit)
Prerequisite: Approval of Academic Advisor.
Doctoral level internship.

ME 397 – Doctoral Dissertation Research (variable credit)
Doctoral level research leading to a formal written dissertation and oral defense.

ME 398 – Graduate Seminar (non-credit)
Prerequisite: None.
Graduate seminar focusing on special topics within the field.

ME 399 – Doctoral Directed Research (variable credit)
Prerequisite: Approval of Dissertation Advisor.
Doctoral level supervised research.

MSE

Material Science and Engineering
Division of Physical Science and Engineering (PSE)

MSE 100 – Basic Principles of Physics (3-0-0)

Prerequisite: None.

This course is a review of physics content normally taught at the senior undergraduate level. The course will cover electric field and potential, DC and AC current circuits, magnetism, magnetic induction, electromagnetic waves and optical phenomena (transmission, reflection, diffraction, interference, etc.). Further topics will include Blackbody radiation, photoelectric effect, atomic line spectra, Bohr hydrogen atom, de Broglie waves, Heisenberg Uncertainty Principle, free particle, particle in a box, particle on a ring, simple harmonic oscillation, quantum numbers and angular momentum. Finally, an overview of the first, second, and third laws of Thermodynamics along with heat capacity, enthalpy, thermal conduction is presented.

MSE 199 – Directed Study in Materials Science (variable contact hours, non-credit)

A course of self-study in a particular topic as directed by faculty and approved by the division.

MSE 200 – Engineering Mathematics (3-0-3)

Prerequisite: None.

This course presents basic mathematical methods for engineers including: differentiation and integration, Taylor's expansion, linear systems resolution and matrix formalism, partial differential equations, Laplace, Fourier and Legendre transforms, statistics and probability.

MSE 201 – Fundamentals of Materials Science and Engineering (3-0-3)

Prerequisite: None.

This course is intended for students who do not have a materials science and engineering background. The course will cover four major topics including: fundamental concepts, microstructure development and phase equilibria, material properties and fabrication methods and applications. The course will cover atomic structure, atomic bonding, crystal structures, defects and diffusion in materials. It also will cover phase transformations and phase equilibria and how they impact microstructure development. The electrical, magnetic, optical, thermal and mechanical properties of materials will also be reviewed. The course will also highlight modern fabrication technologies and applications of metals, ceramics, semiconductors, and polymers.

MSE 221 – Crystallography and Diffraction (3-0-3)

Prerequisite: None.

The objective of this course is to present the basic concepts needed to understand the crystal structure of materials. Fundamental concepts including lattices, symmetries, point groups, and space groups will be discussed and the relationship between crystal symmetries and physical properties will be addressed. The theory of X-ray diffraction by crystalline matter along with the experimental x-ray methods used to determine the crystal structure of materials will be covered. Application of X-ray diffraction to proteins, electron diffraction and neutron diffraction will be briefly discussed.

MSE 225 – Electronic Properties of Materials (3-0-3)

Prerequisite: Basic knowledge of quantum mechanics, electromagnetism and solid state physics.

The objective of this course is to present the fundamental concepts of structural, electrical and optical properties needed to understand the behavior of the materials. The course includes a brief description of crustal structure of solids and the basics of x-ray diffraction theory; free electron theory in metal and band theory will be addressed. A brief review of thermal and lattice vibration properties will be presented. A brief introduction on key electronic devices based on homo p-n junctions and hetero-junctions. A brief description of dielectric materials.

MSE 226 – Thermodynamics & Equilibrium Processes (3-0-3)

Prerequisite or Co-Requisite: MSE 200 or any AMCS Course

The course offers a modern fundamental understanding of the main concepts and practical applications of thermodynamics in materials science. The following major topics are discussed: review of the laws of classical thermodynamics, introduction to statistical thermodynamics phase equilibria, including phase diagrams, theory of solutions, chemical reactions involving gasses and condensed matter, Elligham diagrams, surface and interfacial phenomena and thermodynamics at the nanoscale.

MSE 227 – Applied Quantum Mechanics (3-0-3)

Prerequisite or Co-Requisite: MSE 200 or any AMCS Course

Introduction to non-relativistic quantum mechanics. Summary of classical mechanics and electrodynamics. Postulates of quantum mechanics, wave functions, operator formalism and Dirac notation. Stationary state problems, including quantum wells and tunneling. Harmonic oscillator. Time evolution. Approximation methods for time-independent as well as time-dependent interactions.

MSE 228 – Biomaterials (3-0-3)

Prerequisite: None.

This course offers a basic understanding of the concepts underlying the design and selection of materials for use in biological applications. It focuses on both hard and soft tissue materials. The class addresses modern topics including biosensors, surface and interface functionalization. Further topics include: A brief introduction to relevant tissue types: anatomy, biochemistry and physiology; concepts of biocompatibility, host response, material degradation, testing and selection criteria; an overview of current research on biomechanics and its relevance to prosthesis design and tissue engineering; basic concepts of drug delivery and molecular biomechanics.

MSE 229 – Polymeric Materials (3-0-3)

Prerequisite: None.
This course describes polymerization processes; polymer solutions (Flory-Huggins model and application to polymer blends); polymer chain conformations; calculation of end-to-end distribution function W(r) for short range interacting chains; rotational isomeric state scheme and temperature dependence; chain with long range interactions (excluded volume effect); radius of gyration; the crystalline and amorphous states of polymers; the glass transition (configurational entropy model); mechanical, electrical and optical properties and characterization of polymers.

MSE 293 – Traveling Scholar (variable credit)

Master's level traveling scholar.

MSE 294 – Contemporary Topics in Materials Science (3-0-3)

A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

MSE 295 – Internship (6-0-6 or variable credit)

Master's level internship.

MSE 297 – Master's Thesis Research (variable credit)

Master's level research leading to a formal written thesis and oral defense.

MSE 299 – Master's Directed Research (variable credit)

Prerequisite: Approval of Academic Advisor.
Master's level supervised research.

MSE 305 – Kinetics and Phase Transformations (3-0-3)

Prerequisite: MSE 226
The course offers a modern and fundamental understanding to the main concepts and practical applications of Kinetics and Phase Transformations in materials science. The following major topics are discussed within the frame of this course: kinetics of homogenous chemical reactions, thermodynamics of irreversible processes including an introduction to the Onsager postulates, mathematical description of Diffusion in Materials (Fick's Laws and an atomistic description via random-walk process). Basic concepts of phase transformation theories, including homogeneous and heterogeneous nucleation and growth, spinodal decomposition and Landau theory of phase transformation.

MSE 307 – Materials Characterization (3-0-3)

Prerequisite: None.
This course will introduce the basic principles of materials characterization and the common characterization techniques available at KAUST. It will cover the following topics: Diffraction methods: basic principles, interaction of radiation and particle beams with matter, XRD, scattering techniques; Spectroscopic methods; Imaging: optical including confocal microscopy, scanning, transmission electron, scanning tunneling and field ion microscopy; Microanalysis and Tomography: energy dispersive, wavelength dispersive, Auger Processes, Electron, Ion and Atom Probe Tomography, SIMS, photoelectron spectroscopy; thermal analysis: DTA, DSC. Lab visits and demonstrations will be scheduled to the class to discuss some case studies.

MSE 310 – Materials for Energy (3-0-3)

Prerequisite: None.
This course is intended as a review of the challenges facing materials scientists working in renewable energy and sustainability science and technology. It aims to give the student a birds-eye view of the current topics in energy harvesting and storage materials. The potential of various energy harvesting approaches will be discussed in the context of energy needs facing the world. This will be done with particular focus on materials innovations required to improve the state of the art. After this thorough introduction, the course will discuss solar power and electrochemical energy storage in more depth.

MSE 311 – Soft Materials (3-0-3)

Prerequisite: None.
This course covers chemical and physical aspects of soft materials such as gels, polymers, lipids, surfactants and colloids; physical chemistry of soft materials; phase transformations and self-assembly; the role of intermolecular and surface forces in determining morphology and hierarchy. Membranes, catalysis, drug delivery, flexible and stretchable materials and devices.

MSE 313 – Functional Oxides (3-0-3)

Prerequisite: MSE 227
Fundamental concepts relevant to functional oxides will be reviewed, including common structures, defect chemistry and reactions, Brouwer diagrams, Ellingham diagrams, Heckman diagrams, ionic and electronic transport and tensor notation. The physics, materials, and applications for the following classes of functional oxides will be covered: linear dielectrics, ferroelectrics, multiferroics, piezoelectric, pyroelectrics, electro optics, thermoelectrics and semiconducting oxides. Selected technological applications will be reviewed including sensing, actuation, energy harvesting, and oxide electronics.

MSE 314 – Ab-Initio Computational Methods (3-0-3)

Prerequisite: MSE 227
Introduction into the theory and application of materials modeling techniques. Comparison of analytical and numerical methods. Introduction into basic numerical

algorithms. Fundamentals of density functional theory. Band structure approaches for crystalline solids. Introduction into commercial and freeware computer packages. Advanced applications of ab-initio computational techniques.

MSE 315 – Thin Film Science & Engineering (3-0-3)

Prerequisite: None.

Thin films and coatings are the material building blocks of many modern and pervasive technologies ranging from electronics to optics and photovoltaics and from anti-counterfeiting to glazings and hard coatings. The fundamentals and atomistics of thin film growth are discussed in detail. Deposition techniques for thin films and coatings are presented, including physical and chemical vapor depositions, molecular beam epitaxy, atomic layer deposition and low-pressure plasma processes. Organic thin film deposition. Solution-processing and printing of inorganic and hybrid organic-inorganic thin films. Artificially structured and chemically modulated layered and nanocomposite materials. Ex-situ/in-situ characterization of thin films and coatings.

MSE 316 – Magnetic Materials (3-0-3)

Prerequisite: None.

This course introduces fundamental concepts in modern magnetic materials together with the electronic properties of magnetic hybrid structures. (i) Diamagnetism, para-magnetism, ferromagnetism and anti-ferromagnetism will be introduced and the microscopic origin of magnetism will be addressed (metals, semiconductors, oxides, insulators, etc.). (ii) Experimental techniques to investigate magnetism and magnetic behavior will be mentioned (X-ray dichroism, Magneto-Optical Kerr effect, etc…). (iii) Advanced applications of modern magnetic materials will be presented and the electronic properties as well as magnetization dynamics of magnetic hybrid structures will be covered.

MSE 318 – Nanomaterials (3-0-3)

Prerequisite: None.

This course describes the most recent advances in the synthesis, fabrication and characterization of nanomaterials. Topics to be covered: Zero-dimensional nanomaterials, including nanoparticles, quantum dots and nanocrystals; one dimensional materials including nanowires and nanotubes; two (2)-dimensional materials: including self-assembled monolayers, patterned surfaces and quantum well; three (3)-dimensional nanomaterials: including Nano porosity, nanocomposites, block copolymers and supra-crystals. Emphasis on the fundamental surface and size-related physical and chemical properties of nanomaterials; and their applications in bio sensing, nanomedicine, catalysis, photonics and Nano electronics.

MSE 320 – Solar Cell Materials and Devices (3-0-3)

Prerequisite: None.

This course will provide the students with an up-to-date basic knowledge of the physical and chemical principles of materials used in solar cells of various kinds including but not limited to technologies such as: 1) silicon-based solar cells, 2) CIGS, CIS and other inorganic thin film solar cells, 3) multi-junction solar cells, 4) nanoparticles and quantum dots solar cells, 5) organic and hybrid solar cells and 6) thermal and concentrator solar power generation.

MSE 321 – Optical Properties of Materials (3-0-3)

Prerequisite: Basic knowledge of quantum mechanics, electromagnetism, and solid state physics.

Introduction to optical coefficients and optical materials, classical propagation of light, Interband absorption processes and photodetectors, excitons, light emission including photoluminescence and electroluminescence, quantum confined structures, free electrons and plasmons, optical properties of molecules and polymers, color centers, phonons, polaritons, polarons and inelastic light scattering, introduction to nonlinear optical properties of materials including second and third order nonlinearities.

MSE 322 – Semiconductor Materials (3-0-3)

Prerequisite: None.

The course covers the physico-chemical and electronic properties of advanced semiconductor materials other than Si and GaAs. The materials that will be covered include elemental semiconductors such as Ge and carbon (in the form of carbon nanotubes and graphene), compound semiconductors such as III-V and II-VI compounds, and wide-band gap semiconductors such as carbides and nitrides. Special classes of semiconductors such as oxides, chalcogenides, and polymeric semiconductors will be included. In each material category, the material processing and fabrication of select devices will be discussed including 1-dimensional and 2-dimensional devices. Measurement protocols for the devices will be presented.

MSE 324 – Photophysics of Organic Semiconductors (3-0-3)

This course offers an introduction to electronic processes in conjugated organic materials nowadays used in many different optoelectronic devices such as lightemitting diodes and organic solar cells. The theoretical basics of electronic transitions and excited states (excitons) are discussed first, followed by an overview of basic measurement (spectroscopy) techniques. Furthermore, emission spectra of single molecules,ensembles, and aggregates are reviewed and basic concepts of energy transfer and photoexcitations in conjugated polymers are introduced. Finally, the course offers an overview of technological applications of semiconducting organic materials and an introduction to advanced (time-resolved) spectroscopy and data analysis techniques.

MSE 390B – Electronic Processes in Organic Semiconductors (3-0-3)

This course offers an introduction to electronic processes in organic materials including small molecules and polymers, nowadays used in many optoelectronic devices such as light-emitting diodes and organic solar cells. Theoretical basics of electronic transitions and excited state dynamics are discussed, specifically emission spectra of single molecules, molecular aggregates, and bulk samples as well as concepts of energy transfer, charge transport, and photo physical processes in conjugated polymers and organic photovoltaic devices. Furthermore, the course offers an introduction to analysis of experimental data from (ultrafast) transient laser spectroscopy and modeling of excited state dynamics using different tools, for instance multivariate curve resolution analysis of complex spectra consisting of several components.

MSE 393 – Traveling Scholar (variable credit)
Doctoral level traveling scholar.

MSE 394 – Contemporary Topics in Materials Science (3-0-3)
A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

MSE 395 – Internship (variable credit)
Prerequisite: Approval of Dissertation Advisor.
Doctoral level internship.

MSE 397 – Doctoral Dissertation Research (variable credit)
Doctoral level research leading to a formal written dissertation and oral defense.

MSE 398 – Graduate Seminar (non-credit)
Graduate seminar focusing on special topics within the field.

MSE 399 – Doctoral Directed Research (variable credit)
Prerequisite: Approval of Dissertation Advisor.
Doctoral level supervised research.

PS
Plant Science
Division of Biological and Environmental Science and Engineering (BESE)

PS 199 – Directed Study in Plant Science (variable contact hours, non-credit)
A course of self-study in a particular topic as directed by faculty and approved by the division.

PS 201 – Concepts of Developmental Biology and Genetics (3-0-3)
The course provides a basic understanding of important developmental processes. It explains core developmental mechanisms, including pattern formation, cell determination, differentiation and specification of tissue types. The course will illustrate the mode of action of developmental control genes, in particular those encoding transcription factors, cell-cell communication molecules and signal transduction components. The course will cover different aspects and mechanisms in developmental biology and compares them between different model organisms. In addition to lectures, computer cases and literature presentations complementary to each topic will be implemented to provide "hands-on" insight into the topics of interest, recent sophisticated techniques for developmental analysis will be introduced and observations on real samples will be performed.

PS 202 – Plant Physiology and Adaptation (3-0-3)
The aim of this course is to provide an overview of plant structure and function, covering a range of plant processes such as water and nutrient transport and the central plant operation of photosynthesis and C metabolism. The course will end with an introduction to the interactions of plants with their environment, studying responses to challenges from both the biotic and abiotic world.

PS 293 – Traveling Scholar (variable credit)
Master's level traveling scholar.

PS 294 – Contemporary Topics in Plant Science (3-0-3)
A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

PS 295 – Internship (6-0-6 or variable credit)
Master's level internship.

PS 297 – Master's Thesis Research (variable credit)
Master's level research leading to a formal written thesis and oral defense.

PS 299 – Master's Directed Research (variable credit)
Master's level supervised research.

PS 301 – Advanced Plant Growth & Development (3-0-3)
The course will include latest methods to analyze genes involved in and regulating plant growth and development, in particular, latest developments in the control of cell cycle and cell expansion at the cellular, tissue and organismic level. Furthermore, the role of hormones and environmental factors on the development of roots, leaves and flowers will be discussed in a seminar style.

PS 302 – Biochemistry and Metabolic Engineering (3-0-3)
The course will provide an overview on cell metabolism and biochemical pathways, covering primary, lipid and isoprenoid metabolism. This will be followed by an introduction of the concept of Metabolic Engineering, highlighting key factors that regulate natural and synthetic pathways. Examples for engineered pathways will be presented and discussed in depth. The course

also includes practical introduction in metabolite analysis.

PS 303 – Advanced Plant Molecular Genetics (3-0-3)
This course will cover the key biological processes of plants in a molecular, genetics and genomics context. The course will provide a broad coverage of the current concepts and techniques of plant molecular genetics and genomics and their application to crop productivity and improvement. Special emphasis will be placed on recent publications in the research of these topics involving plant growth and development, abiotic/biotic stresses, metabolism, hormones, nutrient relations and epigenetics.

PS 393 – Traveling Scholar (variable credit)
Doctoral level traveling scholar.

PS 394 – Contemporary Topics in Plant Science (3-0-3)
A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

PS 395 – Internship (variable credit)
Doctoral level internship.

PS 397 – Doctoral Dissertation Research (variable credit)
Doctoral level research leading to a formal written dissertation and oral defense.

PS 398 – Graduate Seminar (non-credit)
Graduate seminar focusing on special topics within the field.

PS 399 – Doctoral Directed Research (variable credit)
Doctoral level supervised research.

STAT
Statistics
Division of Computer, Electrical and Mathematical Science and Engineering (CEMSE)

STAT 199 – Directed Study in Statistics (variable contact hours, non-credit)
A course of self-study in a particular topic as directed by faculty and approved by the division.

STAT 210 – Applied Statistics and Data Analysis (3-0-3) (Equivalent to AMCS 110)
Prerequisites: Advanced and multivariate calculus. For students outside STAT wishing to obtain an introduction to statistical method. No degree credits for STAT or AMCS majors.
Provides fundamentals of probability and statistics for data analysis in research. Topics include data collection, exploratory data analysis, random variables, common discrete and continuous distributions, sampling distributions, estimation, confidence intervals, hypothesis tests, linear regression, analysis of variance, two-way tables and data analysis using statistical software.

STAT 215 – Applied Statistics with R (3-0-3)
Corequisites: STAT 220, STAT 230, STAT 250
This course is an introduction to practical applied statistics with R, a programming language and software environment for statistical computing, and with RStudio, an integrated development environment for R. Topics include introduction to R, data and programming, summarizing data, probability and statistics in R, simple and multiple linear regression, categorical predictors and interactions, model diagnostics, collinearity, variable selection and model building, selected data analyses.

STAT 220 – Probability and Statistics (3-0-3)
Prerequisites: Advanced and multivariable calculus, linear algebra.
This course is an introduction to probability and statistic for students in statistics, applied mathematics, electrical engineering and computer science. This core course is intended to provide a solid general background in probability and statistics that will form the basis of more advanced courses in statistics. Content: Probability; Random variables; Expectation; Inequalities; Convergence of random variables. Statistical inference: Models, statistical inference and learning; Estimating the CDF and statistical functionals; The bootstrap; Parametric inference; Hypothesis testing and p-values; Bayesian inference; Statistical decision theory. Statistical models and methods: Multivariate models; Inference about independence.

STAT 230 – Linear Models (3-0-3)
Prerequisites: Advanced and multivariable calculus, linear algebra.
This course is an introduction to the formulation and use of the general linear model, including parameter estimation, inference and the use of such models in a variety of settings. Emphasis will be split between understanding the theoretical formulation of the models and the ability to apply the models to answer scientific questions.

STAT 240 – Bayesian Statistics (3-0-3)
Prerequisites: Advanced and multivariable calculus, linear algebra.
This course will provide an introduction to the theory and methods of Bayesian statistics. In Bayesian statistics, one's inference about parameters and hypotheses are updated, using Bayes rule, as evidence/data accumulates. We will discuss the theory and how to do Bayesian data analysis. Computational aspects will also be discussed, and we will make use of R, JAGS/Stan, to do the inference.

STAT 250 – Stochastic Processes (3-0-3)
Prerequisites: Advanced and multivariate calculus, linear algebra.

Introduction to probability and random processes. Topics include probability axioms, sigma algebras, random vectors, expectation, probability distributions and densities, Poisson and Wiener processes, stationary processes, autocorrelation, spectral density, effects of filtering, linear least-squares estimation and convergence of random sequences.

STAT 260 – Nonparametric Statistics (3-0-3)

Prerequisites: STAT 220, 230, 240 and 250 or permission of instructor.
This course is an introduction to nonparametric function estimation. Topics include kernels, local polynomials, Fourier series, spline methods, wavelets, automated smoothing methods, cross-validation, large sample distributional properties of estimators, lack-of-fit tests, semiparametric models, recent advances in function estimation.

STAT 270 – Statistical Design of Experiments (3-0-3)

Prerequisites: STAT 220, 230, and 250
This course is an introduction to the statistical design of experiments and the role of random effects in data analysis. Topics include randomization tests, blocking, Latin squares, split plots, repeated measures and crossover designs, incomplete block designs, lattice designs, two level factorials, experiments without replication, factorials in incomplete blocks, confounding, fractional factorials, response surface methodology, Bayesian designs, and basics of design of computer experiments.

STAT 290A – Special Topic in Statistical Data Science in R (3-0-3)

Corequisites: STAT 220, 230, 250, or permission of instructor
Statistical Data Science in R teaches the details involved in solving real computational problems encountered in data analysis through a collection of case studies. It reveals the dynamic and iterative process by which data analysts approach a problem and reason about different ways of implementing solutions.

STAT 293 – Traveling Scholar (variable credit)

Master's level traveling scholar.

STAT 294 – Contemporary Topics in Statistics (3-0-3)

A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

STAT 295 – Internship (6-0-6 or variable credit)

Master's level internship.

STAT 297 – Master's Thesis Research (variable credit)

Master's level research leading to a formal written thesis and oral defense.

STAT 299 – Master's Directed Research (variable credit)

Prerequisite: Sponsorship of advisor and approved prospectus. Master-level supervised research.
Master's level supervised research.

STAT 310 – Environmental Statistics (3-0-3)

Prerequisites: STAT 220, 230, 240, 250.
This course is an introduction to statistical methods for environmental data, with a focus on applications. Learn, discuss and apply statistical methods to important problems in environmental sciences. Topics include sampling, capture-recapture methods, regression, toxicology, risk analysis, time series, spatial statistics and environmental extremes.

STAT 320 – Advanced Statistical Inference (3-0-3)

Prerequisite: STAT 220, 230, 240, 250.
The course aims to provide a solid presentation of the main approaches to statistical inference, in particular of those formulations based on the so-called likelihood function, and of the most important statistical methods in current use for data modeling and for the interpretation of the uncertainty inherent in the conclusions from statistical analyses. The course is intended for students in science, engineering and statistics. At the end of the course, the student should be able to select and apply the main statistical procedures to a wide range of practical problems.

STAT 330 – Multivariate Statistics (3-0-3)

Prerequisite: STAT 220, 230, 240, 250.
An introduction to multivariate statistical models, well balancing three equally important elements: the mathematical theory, applications to real data, and computational techniques. Traditional multivariate models and their recent generalizations to tackle regression, data reduction and dimensionality reduction, classification, predictor and classifier instability problems. Tools for analyzing unstructured multivariate data.

STAT 340 – Computational Statistics (3-0-3)

Prerequisites: STAT 220, 230, 240, 250.
This course discusses computational techniques for statistical inference, including exact recursions for hidden Markov chains, Gaussian Markov random fields and their applications in latent Gaussian models, inference for latent Gaussian models using Markov chain Monte Carlo with block-sampling and auxiliary variables, deterministic approximations using integrated nested Laplace approximations (INLA), and the EM algorithm.

STAT 350 – Time Series Analysis (3-0-3)

Prerequisites: STAT 220, 230, 240, 250.
This course will cover models for analyzing time series data from both time and frequency domain perspectives. The emphases will be a balance of theory and applications. The course is intended to prepare the student for methodological research in this area and to train the students on cutting-edge data analytic methods for time series. The primary topics include

ARMA/ARIMA models; spectral and coherence estimation; transfer function modeling; and classification and discrimination of time series. The course will conclude with advanced topics on non-stationary time series, time-frequency analysis and state-space models.

STAT 360 – Functional Data Analysis (3-0-3)
Prerequisites: STAT 220, 230, 240, 250, 260.
This course will be a broad overview of the analysis of data of multiple curves that may be considered to arise from smooth functions. The course is intended to prepare the students for methodological research in this area and to train them on cutting-edge methods for analyzing functional data. The primary topics covered include visualization of curves and data exploration, nonparametric smoothing (including splines and wavelets), functional principal components analysis, mixed effects models and functional mixed effects models.

STAT 370 – Spatial Statistics (3-0-3)
Prerequisite: STAT 220, 230, 240, 250. Recommended: STAT 320.
This course is an introduction to the concepts and applications of spatial statistics. It covers the following topics. Geostatistical data: Random Fields; Variograms; Covariances; Stationarity; Non-stationarity; Kriging; Simulations. Lattice data: Spatial regression; SAR, CAR, QAR, MA models; Geary/Moran indices. Point patterns: Point processes; K-function; Complete spatial randomness; Homogeneous/ inhomogeneous processes and Marked point processes.

STAT 380 – Statistics of Extremes (3-0-3)
Prerequisites: STAT 220, 230, 240, 250. Recommended: STAT 320, 370.
This advanced statistics course aims at providing a rather deep understanding of Extreme-Value Theory results, models, and methods, as well as some experience in the practical application of these tools to real data using the statistical software R. Theoretical and practical aspects will be covered. Topics covered include (a) Univariate Extreme-Value Theory: Extremal-Types Theorem; GEV distribution; return levels; Domains of attraction; Threshold-based methods; GPD distribution; Point process representation; r-largest order statistics approach; Likelihood inference; Modelling of non-stationarity; Dependent time series; Clustering and declustering approaches. (b) Multivariate Extreme-Value Theory: Modelling of componentwise maxima; Spectral representation; Parametric models; Dependence measures; Asymptotic dependence/independence; Threshold methods; Likelihood-based inference. (c) Spatial Extremes: Gaussian processes; correlation functions; Max-stable processes and models.

STAT 390 – Special Topics in Statistics (3-0-3)
Doctoral-level lectures focusing on statistics.

STAT 393 – Traveling Scholar (variable credit)
Doctoral level traveling scholar.

STAT 394 – Contemporary Topics in Statistics (3-0-3)
A course of current interest. Topics are not permanent and the content of the course will change to reflect recurring themes and topical interest. The content will be approved by the division.

STAT 395 – Internship (variable credit)
Doctoral level internship.

STAT 397 – Doctoral Dissertation Research (variable credit)
Doctoral level research leading to a formal written dissertation and oral defense.

STAT 398 – Graduate Seminar (non-credit)
Graduate seminar focusing on special topics within the field.

STAT 399 – Doctoral Directed Research (variable credit)
Prerequisite: Sponsorship of advisor. Supervised research.
Doctoral level supervised research.

WE
Winter Enrichment Program
University Wide Courses

WE – Winter Enrichment Program (non-credit)
The Winter Enrichment Program (WEP) takes place in January each year and is designed to broaden students' horizon. WEP is an essential and core requirement of the degree programs at KAUST. Satisfactory completion of at least one WEP is required of all M.Sc. students as part of the completion of the degree requirements. Ph.D. students who did not receive their M.Sc. degree at KAUST are also required to satisfactorily complete at least one WEP. To satisfy this mandatory requirement, full participation must occur within a single WEP period.