Energy Resources and Petroleum Engineering

Program Guide 2018-2019

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1. 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.S. and Ph.D. students focusses 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.

2. Assessment Test (If applicable)

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 admitted students without an MS 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 remedial study plan requirements must be satisfactorily completed, in addition to the University degree requirements.

3. Master's Degree Requirements

It is the sole responsibility of the student to plan her/his graduate program in consultation with her/his advisor. Students are required to meet all deadlines. Students should be aware that most Core Courses are offered only once per year.

The Master's Degree (M.S.) 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.S. degree 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.S. degree has the following components:

- Core Courses
- Elective Courses
- Research/Capstone Experience
- Graduate Seminar 298 (non-credit): All students are required to register and receive a Satisfactory grade for every semester of the program they attend.

3.1 M.S. Course Requirements

3.1.1 Core Courses (twelve credits)

- 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

These Core Courses are designed to provide a student with the background needed to establish a solid foundation in the program area.

3.1.2 Elective Courses (twelve credits)

- 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 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

Additional courses from the “Core Courses” listed above.

The elective courses are designed to allow each student to tailor his/her educational experience to meet individual research and educational objectives, with the permission of the student's Academic Advisor.

Students may select four courses from any 200 or 300 level courses, excluding research, internship credits, and IED courses. The list includes those courses most often selected by ErPE students. (Note: selections require approval by the Academic Advisor).

3.1.3 Research/Capstone Experience

See sections for thesis and non-thesis options below.

3.1.4 Winter Enrichment Program

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

3.2 M.S. Thesis Option

All M.S. students are encouraged to pursue a thesis. To pursue a thesis, students must develop a thesis proposal during the first semester at KAUST. The proposal must include a timeline for completion that is approved by the Academic Advisor. Students wishing to pursue the thesis option must apply by the ninth week of their second semester for a thesis and must have at least a 3.2 cumulative GPA.

The selected Academic Advisor must be a fulltime 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.

3.2.1 M.S. Thesis Capstone Experience

The Capstone Experience may involve thesis research at KAUST, a research-based Summer internship, or a combination to be defined

The Capstone Experience may involve thesis research at KAUST, a research-based Summer internship, or a combination to be defined by the student and the Academic Advisor:

- ErPE 295 – Internship in Industry. Students are only allowed to take one internship
- ErPE 297 – Thesis Research

3.2.2 M.S. Thesis Defense Requirements

An oral defense of the M.S. Thesis is required, although it may be waived by the Dean's Office under exceptional circumstances. A requirement of a public presentation and all other details are left to the discretion of the thesis committee.

A written thesis is required. It is advisable that the student submits a final copy of the thesis to the Thesis Committee Members at least two weeks prior to the defense date.

- Students are required to comply with the university formatting guidelines provided by the library **CLICK HERE**
- Students are responsible for scheduling the thesis defense date with his/her thesis committee.
- A pass is achieved when the committee agrees with no more than one dissenting vote, otherwise the student fails. The final approval must be submitted at the latest two weeks before the end of the semester.

3.2.3 M.S. Thesis Defense Committee

The M.S. Thesis Defense Committee, which must be approved by the student's 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

Member	Role	Program Status
1	Chair	Within Program
2	Faculty	Within Program
3	Faculty or Approved Research Scientist	Outside Program
4	Additional Faculty	Inside or Outside KAUST

Notes:

- Members 1-3 are required. Member 4 is optional.
- Co-Chairs may serve as Members 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: **CLICK HERE**

3.3 M.S. Non-Thesis Option

Students may pursue a non-thesis option, which still requires a capstone experience. Students wishing to pursue the non-thesis option must complete a minimum of six credits of Directed Research (299). Summer internship credits may be used to fulfill the research requirements provided that the Summer internship is research-based. Summer internships are subject to approval by the student's academic advisor.

3.3.1 Non-Thesis Capstone Experience (12 credit hours)

The Capstone Experience may be a combination of research at KAUST, a research-based Summer internship or additional coursework to be defined by the student and the Academic Advisor.

- ErPE 295 - Internship in Industry. Students are only allowed to take one internship
- ErPE 299 - Directed Research

The experience that is approved must include at least 6 credits of research, either in the form of Directed Research or an approved internship.

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.S. experience.
- PhD Courses: Courses numbered at the 300 level.

4. Doctor of Philosophy

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 fulltime program.

There is a minimum residency requirement at KAUST of three and a half years for students entering with a B.S. Degree and two and a half years for students entering with a M.S. Degree. A minimum GPA of 3.0 must be achieved on all doctoral coursework. Individual courses require a minimum of a 'B-' to earn 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.

4.1 Ph.D. Course Requirements

The required coursework varies for students entering the Ph.D. Degree with a B.S. Degree or a relevant M.S. Degree. Students holding a B.S. Degree must complete all Program Core Courses and Elective Courses outlined in the M.S. Degree section and are also required to complete the Ph.D. courses below. Students entering with a B.S. Degree may also qualify to earn the M.S. Degree by satisfying the M.S.

Degree requirements; however, it is the student's responsibility to declare their intentions to graduate with an M.S.

Students entering the Ph.D. Degree with a relevant M.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.
- Students with a KAUST MS degree but not in ErPE or with a MS degree from another university must take a minimum of two ErPE Core Courses in addition to two 300-level ErPE 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: 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.S. Degree are not required to enroll in a full WEP for a second time in the Ph.D. Degree.
- Satisfactory participation in every KAUST's Summer Session is mandatory. Summer Session courses are credit bearing and apply towards the degree.

4.2 Ph.D. Designation of Dissertation Advisor

The selected Academic Advisor must be a full time program-affiliated Professor at KAUST. The student may also select an Academic Advisor from another program at KAUST. The Academic 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.

View a list of faculty and their affiliations: **CLICK HERE**

4.3 Ph.D. Candidacy

In addition to the coursework requirements, the student 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.

4.3.1 Ph.D. Dissertation Proposal Defense Committee

The Ph.D. Dissertation Proposal Defense Committee, which must be approved by the student's 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

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 Dissertation Advisor and the Dean.

View a list of faculty and their affiliations: **CLICK HERE**

4.3.2 Ph.D. Dissertation Proposal Defense

The purpose of the Dissertation Proposal Defense is to demonstrate that the student has the ability and is 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 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 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.

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 students fails.

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.

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.

A student who successfully passes the Dissertation Proposal Defense is deemed a Ph.D. Candidate.

4.4 Ph.D. Defense

To graduate, a Ph.D. candidate has to form a Ph.D. Dissertation Defense Committee, finalize the Ph.D. dissertation and successfully defend his/her Ph.D. dissertation.

4.4.1 Ph.D. Dissertation Defense Committee

The Ph.D. Dissertation Defense Committee, which must be approved by the student's 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 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 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.

If the student has 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).

4.4.2 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.

The student 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 his/her progress. It is the responsibility of the student to submit the required documents to the Graduate Program Coordinator at the beginning of the semester they intend to defend. It is also expected that the student submits 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 which are on the library website: **CLICK HERE**

There are four possible outcomes from 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 student fails. 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 complete the revisions is up to one month after the defense date, unless the committee unanimously agrees to reduce 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 reduce it. Students who fail without retake the Dissertation Defense 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 Examination form within three days after the Defense to the Registrar's Office.

5. Program Courses and Descriptions

Course Notation:

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 student workload during the semester.
C = the recitation or laboratory hours
R = the credit hours towards fulfilling a degree course requirement.

E.g. CS 220 Data Analytics (3-0-3) has a total of three hours of lectures per week, has no labs and earns three credits for the semester.
100-level courses are preparatory in nature and do not count towards the MS or PhD degrees.

Courses in the Energy Resources and Petroleum Engineering program are selected and designed to provide students with the knowledge-base and intellectual foundation required to advance scientific research and engineering solutions in the energy sector.

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 295 – Internship (six credits)

Prerequisite: Approval of Academic Advisor.

Master's-level summer internship.

ErPE 297 – Thesis Research (variable credits)

Master's-level thesis research.

ErPE 298 – Graduate Seminar (non-credit)

Master's-level seminar focusing on special topics within the field.

ErPE 299 – Directed Research (variable credits)
Master-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 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 395 – Internship (six credits)
Doctoral-level summer internship.

ErPE 396 – Special Seminar (non-credit)
Doctoral-level seminar focusing on special topics within the field.

ErPE 397 – Ph.D. Dissertation Research (variable credits)
Doctoral-level dissertation research.

ErPE 398 – Graduate Seminar (non-credit)
Doctoral-level ErPE program seminar.

ErPE 399 – Directed Research (variable credits)
Doctoral-level supervised research

6. University Wide Courses

University wide courses are courses in areas not tied to any specific degree program. They are designed to meet institutional requirements, provide broadening experience or to provide supplemental preparation to support students in their degree.

These are listed below:

6.1 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 or proficiency.

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.

6.2 Enrichment Program – WEP Courses

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.S. students as part of the completion of the degree requirements. Ph.D. students who did not receive their M.S. 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.

6.3 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.

6.3.1 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. This course is open to all M.S. students as an elective and to Ph.D. students with permission of their academic advisors.

6.3.2 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.

7. Grading

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

A	=	4.00	C	=	2.00
A-	=	3.67	C-	=	1.67
B+	=	3.33	D+	=	1.33
B	=	3.00	D	=	1.00
B-	=	2.67	D-	=	0.67
C+	=	2.33	F	=	0.00
I	=	Incomplete			
IP	=	In-Progress			
W	=	Withdrew			
S	=	Satisfactory			
U	=	Unsatisfactory			
WF	=	Withdrew-Failed			

7.1 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 the instructor of the course after the instructor and the student have agreed on the academic work that needs to be completed and the date it is due (but no later than the end of the second week of the following semester or session). When the requirements for the course are completed, the instructor will submit a grade that will replace the Incomplete grade on the student's academic record. 'Incompletes' not completed by the end of the second week of the following semester or session will be changed to Failing (F) grades.

Grades for students that are due to Graduate

Note that any Incomplete grades (as well as Fail grades) will mean a student will not graduate or receive a diploma during the Commencement Ceremony.

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. Students are allowed only one Incomplete grade while in a degree program at KAUST.

7.2 In-Progress Grades

Thesis Research (297) or Dissertation Research (397) should be graded as In-Progress (IP) or Unsatisfactory (U) for each semester. These 'IP' Grades will be converted by the Registrar's Office to 'S' Grades for all semesters once the office has been notified that the thesis or dissertation has been submitted to the library.

7.3 Research and Seminar Courses

297 =	Thesis Research	-Either 'IP' or 'U'
397 =	Dissertation Research	-Either 'IP' or 'U'
295/395 =	Summer Internship	-Either 'S' or 'U'
298/398 =	Seminar	-Either 'S' or 'U'
299/399 =	Directed Research	-Either 'S' or 'U'

8. Academic Standing

A student's academic standing is based on his/her cumulative performance assessment and a semester performance based on the number of credits earned and GPA during the most recently completed semester.

Academic Standing classifications are divided into four categories of decreasing levels of Academic Performance:

- Good Standing
- Academic Notice
- Academic Probation
- Academic Dismissal

Cumulative Grade Point Average

- A minimum GPA of 3.0 must be achieved in all coursework.
- Individual courses require a minimum of a B- for Course credit.

Cumulative Assessment

GPA	**Academic Standing**
3.00-4.00	Good Standing
2.67-2.99	Academic Notice
2.33-2.66	Academic Probation
Below 2.33	Academic Dismissal

S/U Performance	**Academic Standing**
0-2 Credits	GPA Standing
3-5 Credits	GPA Standing less one category
6-8 Credits	GPA Standing less two categories
9+ Credits	Academic Dismissal

Semester Assessment (Registered in 12 Credits)

Credits Earned	**Academic Standing**
12+ Credits	GPA Standing
9-11 Credits	GPA Standing less one category

6-8 Credits	GPA Standing less two categories
0-5 Credits	Academic Dismissal

Semester Assessment (Registered in 9 Credits)

Credits Earned	**Academic Standing**
9+ Credits	GPA Standing
6-8 Credits	GPA Standing less one category
3-5 Credits	GPA Standing less two categories
0-2 Credits	Academic Dismissal

Summer Session Assessment

Credits Earned	**Academic Standing**
6 Credits	GPA Standing
3-5 Credits	GPA Standing less one category
0-2 Credits	GPA Standing less two categories

Definitions:

Good Standing
Student is making satisfactory academic progress towards the degree.

Academic Notice
Student is not making satisfactory progress towards the degree. A student placed on Academic Notice will be monitored in subsequent semesters to ensure satisfactory progress towards the degree (see Good Standing). If the student's performance does not improve in the following semester, the student will be placed on Academic Probation.

Academic Probation
Student is not making satisfactory progress towards the degree. A student placed on Academic Probation will be monitored in subsequent semesters to ensure satisfactory progress towards the degree (see Good Standing). If the student's performance does not improve in the following semester, the student will be academically dismissed.

Academic Dismissal
Student is not making satisfactory progress towards the degree and is unlikely to meet degree requirements. Dismissed students will be required to leave the University. If deemed eligible, dismissed students will have one week from receiving Notice of Dismissal to file an Appeal.

Appeal Process for Students Academically Dismissed
If the student is eligible to appeal, he/she must submit a written explanation why the dismissal should be rescinded along with any supporting documentation. The Committee on Academic Performance will hear the appeal and make a decision to grant or deny the appeal based on the appeal and documentation, the student's past performance and the likelihood that the student is capable of successfully completing his/her academic program. If the appeal is denied, the student will be required to leave the University. The decision of the committee is final – no additional appeals are permitted.

S/U Protection
Due to the significant impact of Unsatisfactory (U) Grades, a Faculty Member giving a 'U' Grade for a course involving six or more credits must obtain concurrency of the Dean prior to submitting the grade. If the grade is given for only a single class (including Research Credit), the number of credits will be capped at six when using the Academic Standing Table displayed above.

Returning to Good Standing

A student not in Good Standing due to a GPA deficiency may return to Good Standing by improving his/her cumulative GPA such that it meets or exceeds 3.0. A student not in Good Standing due to 'U' Grades may return to Good Standing by completing at least twelve credits during the subsequent semester with no 'U' grades and a semester GPA of at least 3.0 in traditionally graded courses.

9. Transferring Credits

A student may petition to transfer graduate credits from KAUST or another University upon approval of the Program Director and the Registrar.

Each student's application will be reviewed on a case-by-case basis.

The following rules apply:

- Students entering the program with an M.S. Degree from KAUST may transfer unused coursework toward the Ph.D. program requirements subject to program level approval.
- Up to three graduate-level courses not to exceed nine credits may be transferred for credit. Courses already used for another degree cannot be used as transferred credits.
- The course grade for any course to be transferred must be a 'B' or above.
- Courses transferred for degree credit must have been taken within three years prior to admission to KAUST.
- The student must submit a completed KAUST Transfer of Credit Form and include the Course Syllabus and Course Description.
- The student is responsible for supplying an official transcript:
- The transcript may be no more than three months old.
- The transcript must be in English or accompanied by a certified English translation.
- The Grading Key must be included with the transcript.
- The Transcript must include the course name, level, grade and credit value.
- The credit value of the course must be equivalent to a minimum of three KAUST credit hours.

Course Transfer and Equivalency

Graduate credit hours taken from any KAUST program may be applied to other KAUST graduate programs under the guidelines of the degree program to which the student is admitted. Graduate courses taken from another University or KAUST program that are equivalent in level and content to the designated courses in a major track may be counted towards meeting the major track requirement if their equivalence is confirmed by the Program Director.

Students transferring from other Ph.D. programs may receive some Dissertation Research and Coursework credit units on a case-by-case basis for related work performed at their original Institution. However, such students must satisfy the written and oral requirements for a research proposal (if the proposal had been submitted and approved at the original Institution, the proposal may be the same, if approved by the Academic Advisor). The minimum residency requirement for enrolment of such students at KAUST is two years.

10. Policy for Adding and Dropping Courses

A course may be added during the first week of the semester. Students may add courses after the first week with the permission of the instructor. Instructors have the right to refuse admission to a student if the instructor feels that the student will not have the time to sufficiently master the material due to adding the course late. A course may be dropped without penalty at any time during the first two weeks of the semester. Between the second and ninth week, students can drop a course but the course will appear on the student's transcript with the grade of Withdraw (W). After the ninth week of a full semester, courses may be dropped only under exceptional circumstances and with the approval of the Course Instructor, the Program Director and the Registrar.

11. Program Planning

It is the sole responsibility of the student to plan her/his graduate program in consultation with her/his Academic Advisor. Students are required to meet all deadlines. Students should be aware that most Core Courses are offered only once per year.