Institution Submitting Request: *University of Utah*
Proposed Title: *Master of Science in Petroleum Engineering*
School or Division or Location: *College of Engineering*
Department(s) or Area(s) Location: *Chemical Engineering*
Recommended Classification of Instructional Programs (CIP) Code : *14.2501*
Proposed Beginning Date: *08/2013*
Institutional Board of Trustees' Approval Date: 3/12/2013

Proposal Type (check all that apply):

R401-4 Items submitted will be reviewed by the Office of the Commissioner of Higher Education (OCHE), then forwarded to the Chief Academic Officers (CAO) and Program Review Committee (PRC) before being presented to the Regents. K-12 Personnel Programs are also reviewed by appropriate officials and faculty of the schools and colleges of education. See R401-4.2.2 for all programs requiring specialized reviews.		
4.1.1	☐	Non-Credit Certificate of Proficiency Eligible for Financial Aid
	☐	Credit Certificate of Proficiency Eligible for Financial Aid
4.1.1	☐	Non-Credit Certificate of Completion
	☐	Credit Certificate of Completion
4.1.9	☐	Fast-Tracked Certificate
4.1.2	☐	Associate of Applied Science Degree
4.1.3	☐	Associate of Science Degree
	☐	Associate of Arts Degree
4.1.5	☐	Bachelor's Degree
4.1.6	☐	K-12 School Personnel Programs
4.1.7	☒	Master's Degree
4.1.8	☐	Doctoral Degree

Chief Academic Officer (or Designee) Signature:
I certify that all required institutional approvals have been obtained prior to submitting this request to the Office of the Commissioner.

Signature _____ Date 2/14/13

Printed Name: *Name of CAO or Designee* Michael L. Hardman

Executive Summary

University of Utah
Masters of Science in Petroleum Engineering
01/28/2013

Program Description

The proposed Masters of Science degree in Petroleum Engineering will be a 33 credit hours, sixteen-month (September through December of the following year) program of course work, practical field and design work, and a substantial research project resulting in a project-based thesis (internal publication only). The degree will be housed within the Department of Chemical Engineering. The course work will involve petroleum engineering fundamentals and advanced topics, fundamental petroleum geologic concepts as well as exposure to constraints on energy technologies (geopolitical and economic considerations, environmental issues). The motivation and intent is a program that will meet the needs of students, including working students, industry, the state and the nation. Teaching would be collaboratively done with primarily the Department of Chemical Engineering, Energy & Geoscience Insititute (EGI) and Department of Geology and Geophysics.

To meet the needs of the anticipated local ,national, and international students, classes will be offered through class room lectures and distance education. Short-term field studies and projects will require all students to participate locally. The University of Utah currently has a MS Chemical Engineering program with a project-based thesis requirment that can be completed with distance education. The thesis is defended, but it is not published through the Univeristy. All of the departments in the college of engineering offer non-thesis Master of Science degrees. This degree is very much in line with those programs.

Role and Mission Fit

The Department of Chemical Engineering has recently received increased interest in its petroleum-related offerings. Furthermore, students involved in specific, petroleum-related programs have indicated the need for a more fitting title for their degree. Industry has also observed that “retraining” engineers with more petroleum-related courses is essential. It is clear that the name “petroleum” is needed for individuals trained in this specific area and that this degree will fill a particular niche due to its research collaborations with EGI.

Students will learn from, and collaborate with, faculty and industry professionals who are at the forefront of their disciplines. The program is an excellent example of collaborative scholarship, accelerated to meet the demands of the state and the nation. It embodies domestic and international involvement and explictily incorporates social responsibility. This degree will give exposure of the Department's research to an international corporate audience which, in turn, will strengthen the department’s research in the areas of Petroleum Engineering.

Faculty

The proposed degree is based in the College of Engineering. The qualified ChEn faculty available to participate in this MS degree include: Milind Deo (Professor, Chemical Engineering); John McLennan (Associate Professor, Chemical Engineering); Richard Roehner (Associate Professor [Lecturing], Chemical Engineering); and Ian Walton (Adjunct Professor, Chemical Engineering). EGI will be an essential partner due to the impressive industrial expertise and distance education experience of its faculty (i.e., R. Sorkhabi

and Bill Keach). The Geology and Geophysics Department will participate by teaching one course and by participating in the projects as appropriate.

Both on-campus and distance education students will take the courses in this program. Total enrollment in the production and reservoir engineering courses may grow to the point that additional sections of these courses must be added. To support the teaching needs of the program, an additional faculty member will be hired. The Dean of the College of Engineering and the state-wide Utah Technology Initiative Advisory Board have supported our request for this position with the idea that the new program brings additional students and distance education opportunities to the state. In-house faculty are recognized experts in petroleum and natural resource engineering and will be able to lecture, mentor, advise and participate in this program without supplementary development.

Market Demand

Alumni and industrial colleagues have encouraged the Department of Chemical Engineering to develop graduate-level Petroleum Engineering courses (see letters of support). In addition, the U.S. Energy Information Administration projects that the United States and the world will continue to rely on petroleum for decades. These advocates and the Department of Energy (DOE) emphasize the following:

- The department needs to offer a degree in Petroleum Engineering. While Chemical Engineering currently has an emphasis on energy, industrial advisors insist that it must offer a degree, as opposed to a certificate or other specialty designation.
- Three students from Quester recently gained MS degrees in Chemical Engineering through a professional MS. They studied in Petroleum Engineering related areas but expressed the need for a degree that is entitled "Petroleum Engineering."
- Innovative engineers are needed in new energy sectors to manage conventional and unconventional opportunities efficiently and in an environmentally responsible manner.
- Demographics suggest that large numbers of engineers will soon be needed to fill the positions of those who will soon retire. In the petroleum industry, this is often colloquially known as the Great Crew Change.
- There will be a continuing demand for petroleum.

Student Demand

In addition to industrial support, in a spring 2012 survey of 70 juniors in Chemical Engineering, students indicated a strong interest in petroleum engineering. Students are requesting additional electives, and the enrollment in petroleum electives is strong. In the spring of 2012, the enrollment in two existing petroleum-related courses offered in Chemical Engineering was over 30 students with 2/3 undergraduates and 1/3 graduate. Department alumni working in the oil and gas industry have reviewed the program, and their suggestions have been incorporated. Local and national companies have indicated their interest in the program (see attached letters of support).

Statement of Financial Support

Appropriated Fund ☐
Special Legislative Appropriation ☒
Grants and Contracts ☐
Special Fees/Differential Tuition ☒
Other (please describe) ☐

On-campus students will pay the regular University of Utah tuition and the College of Engineering differential tuition. Distance-education students will join the program through continuing education by paying special fees. A new faculty slot has been given to the department through the Engineering Initiative.

Similar Programs Already Offered in the USHE

There are no similar programs in the USHE. The program is not an attempt to duplicate others, but to create a new educational experience, unique in Utah and in the United States. A similar program exists at Imperial College, London, United Kingdom. A key is the synergy between people in the Department and EGI, not replicated anywhere else. The department anticipates a strong statewide collaborative effort because of:

- Collaboration with Uintah Basin Applied Technology College – offers hands-on training as needed for oil and gas field operations.
- Strong partnership to USTAR - strategically well positioned to act on the state's critical energy needs
- Existing collaborations between the Department and EGI.
- Distance education features will allow Utah energy professionals to participate statewide

Program Description

University of Utah
Master of Science in Petroleum Engineering
09/01/2012

Section I: The Request

The University of Utah requests approval to offer an "executive" Master of Science in Petroleum Engineering effective fall 2013.

Section II: Program Description

Complete Program Description

The MS degree in Petroleum Engineering is a sixteen-month program of course work, practical field and design work, and a project (September through December of the following year) which results in a project-based thesis. A written report and oral presentation are required, but the thesis is not published beyond the department. The course work involves petroleum engineering fundamentals and advanced topics, fundamental petroleum geologic concepts as well as exposure to constraints on energy technologies (geopolitical and economic considerations, environmental issues). A minimum of 33 semester hours is required.

Purpose of Degree

Justification for this request is based on several factors.

- Student Interest: Based on a spring 2012 survey of our 70 juniors, interest in petroleum engineering is increasing and students are requesting additional courses. Current enrollments in Production and Reservoir Engineering elective courses are 31 and 35, with approximately 1/3 of the enrollees being graduate students and 2/3 under graduates. Clearly the topic is one of interest to our students. However, industry has stated that a certificate or specialization is not adequate to

meet their needs for placement. The program must be a degree with Petroleum Engineering in the name.

- Societal Contributions: Engineering students are appreciating the fact that energy is an important component in their discipline. They are asking for more exposure to energy related courses because there are jobs in the energy sector and because they feel that they can make a difference by working in this field. The petroleum industry is also diversifying into cleaner energy alternatives and graduates will have opportunities in these sectors once they are within a particular company.
- Accelerated Contribution to Employer: "A 2008 human resources benchmark study prepared for SPE [sic, Society of Petroleum Engineers] by Schlumberger Business Consulting shows that the fastest companies take six to seven years to develop new employees into professionals who can work autonomously, because of the complex decision-making and ability to exploit advanced technology needed by today's professionals. The report concludes that human capital is the longest lead-time component of E&P [sic: Exploration and Production] delivery."[1] The professional MS program will reduce this development period.
- Aging Workforce and Employment Opportunities:
  "We have all heard about the "great crew change," the coming decade in which 50% of experienced and managerial personnel of international oil companies industry wide are expected to retire. While this will not all happen on a single day, it will create simultaneous gaps of unprecedented proportions in the staffs of many international and national oil companies."[2]

  "An aging workforce and the "big crew change" in the oil and gas industry have been widely publicized as a disaster waiting to happen. So much publicity has been given to this topic that many oil and gas executives that I have spoken with have become desensitized; they no longer see the "crew change" as a looming threat. This is understandable since this was supposed to have started several years ago and companies are actually laying off employees now rather than struggling to find new employees. But the crew change is upon us; however, likely delayed due to the poor economy. Many senior employees are postponing retirement trying to rebuild their retirement funds and waiting for the economy to stabilize. For 10 companies the results suggest that between 30% and 46% of the total companies' current workforces are likely to retire by 2019."[3]
- Meets the Needs of the State of Utah: This is a reasonable venture for a state university, particularly in Utah, recognizing that hydrocarbon-based resources (oil, gas and coal) provide significant royalty support to state (second only to tourism); and further recognizing an underlying public desire for environmentally appropriate extraction and use of these resources. Natural gas activity in the state is poised to expand, conditional on ultimate increases in commodity pricing. Utah also provides a natural geologic classroom for students. There are abundant unconventional hydrocarbon sources (oil shale, oil sands, and unminable coal) and the program is designed to promote effective, environmentally sound development. "Sound" development can be achieved in a variety of ways, including reduced surface footprints, recovery methods that require less water and vehicular emissions, and improved monitoring.
- Meets the goals of the Department's Strategic Plan: The proposed program will certainly increase the visibility of the department internationally. Much of the research underway for petroleum engineering is a result of work with companies. The projects and students will help foster additional research which could potentially transfer to our PhD program. In addition, an

[1] www.spe.org/press/docs/SPE_WhitePaper_GraduateHiring2010.pdf
[2] www.spe.org/jpt/print/archives/2011/04/16TalentTechnology.pdf
[3] http://www.jptonline.org/index.php?id=357

additional faculty member helps us meet the increasing interest in this area at the BS, MS, and PhD level.

As evidenced by the letters of support, the department anticipates a strong statewide collaborative effort with:

- Uintah Basin Applied Technology College – offers hands-on training as needed for oil and gas field operations.
- Strong partnership to USTAR - strategically well-positioned to act on State's critical energy needs
- Existing collaborations between the Department and the University's Energy and Geoscience Institute (EGI).
- Distance education features which will allow Utah energy professionals to participate statewide.

Institutional Readiness

As indicated in the Executive Summary, with faculty strength, the University of Utah is already positioned with expertise to offer the program. The researchers at EGI and the Departments of Chemical Engineering and Geology and Geophysics currently co-advise students on petroleum-related projects. One new faculty member was approved as part of the Engineering Initiative funding for 2012, and will enable us to continue to deliver our undergraduate electives in this area while maintaining a cohort of professionals within the program. Space and startup funding are available for this new hire. Initially, the program will use existing advising and administrative staff within the department. As the program grows, an additional person will be hired for the program.

The Department of Chemical Engineering has a history of graduate education using distance learning tools. A previous collaboration existed with ATK for PhD and MS students. This program is an off shoot of our successful implementation of that curriculum. In addition, a project-based thesis MS (course credit is given in Advanced Design) is already in place and operational. While the thesis is reviewed and presented, it does not get published by the University and is only an internal publication.

The faculty of the Department of Chemical Engineering has been involved in the process of the formation of this degree. In April 2012 the concept was presented to the faculty and, in turn, our Industrial Advisory Board (IAB). The IAB unanimously and enthusiastically supported the. Additional details and discussion occurred during our annual faculty retreat, August 15, 2012. Comments and recommendations were integrated from faculty and additional feedback from some industrial contacts. A final vote was taken at our faculty meeting on September 21, 2012, and it was approved to move forward.

Faculty

The faculty will comprise tenure/tenure-track faculty, professionals working in EGI (full-time non-tenured), and lecturing faculty in the department. In addition, faculty from Geology and Geophysics will teach, but they are not included in the numbers below. Differential tuition will help with costs associated with having adjunct faculty (lecturing and research) teach the courses. The existing faculty will contribute only a portion of their FTE to the program.

Faculty Category	Faculty Headcount – Prior to Program Implementation	Faculty Additions to Support Program	Faculty Headcount at Full Program Implementation
With Doctoral Degrees			
Full-time Tenured	2	1	3
Full-time Non-Tenured	5	0	5
Part-time Tenured			
Part-time Non-Tenured			
With Master's Degrees			
Full-time Tenured			
Full-time Non-Tenured	1		1
Part-time Tenured			
Part-time Non-Tenured	1		1
With Bachelor's Degrees			
Full-time Tenured			
Full-time Non-Tenured			
Part-time Tenured			
Part-time Non-Tenured			
Other			
Full-time Tenured			
Full-time Non-Tenured			
Part-time Tenured			
Part-time Non-Tenured			
Total Headcount Faculty			
Full-time Tenured	2	1	3
Full-time Non-Tenured	6	0	6
Part-time Tenured	1		1
Part-time Non-Tenured			
Total Department Faculty FTE (As reported in the most recent A-1/S-11 Institutional Cost Study for "prior to program implementation" and using the A-1/S-11 Cost Study Definition for the projected "at full program implementation.")	3.25	1	4.25

Staff

The program will leverage the support staff already within the Department of Chemical Engineering and EGI in the short term. As the program becomes more established, staff will be hired to aid in administration and advising.

Library and Information Resources

Library facilities at EGI and at the Marriott library will be appropriate for the proposed program (see letter of support). In addition, the department, EGI and research groups subscribe to one-petro, an on-line digital database with about 250,000 articles and papers.

Admission Requirements

The program is designed for students with a B.S. degree in engineering, typically, chemical, mechanical, civil or geological engineering. Entering students without industrial experience will be expected to take the GREs. Professor McLennan will oversee admissions to the program with guidance from the Departmental Graduate Committee. Exceptions to a B.S. in engineering will be handled on a case-by-case basis, particularly for students in the industry. For foreign students, the results of the TEOFL test will be used to establish English competency as is the current graduate school requirement.

Student Advisement

The Department has a full-time advisor and a faculty Graduate Director. Students meet with the graduate advisor when they arrive on campus and the advisor keeps track of paperwork and helps students stay on track. The department will hire a TA/part-time advisor to enroll and track students in the program. As more students become involved, the department anticipates the need to hire an additional staff for advising and marketing.

Justification for Graduation Standards and Number of Credits

Thirty-three credit hours are required. The proposed 16 month course schedule is outlined below. The schedule could be extended in exceptional circumstances, on a case-by-case basis.

Coursework (24 Credit Hours)

- Engineering Basics for Petroleum Engineers (3 credits). [Fall]
  This will be taught by the new faculty member that is being recruited currently.
  - Rock mechanics for petroleum specialists
  - Fluid mechanics for petroleum specialists
  - Thermal engineering for petroleum specialists
  - Principles of chemistry for petroleum specialists
- Midstream and Downstream Petroleum Engineering (3 credits) [Fall]
  The course will cover pipeline and refinery engineering.
- Petroleum Geology (3 credits) [Fall]
  This course will cover fundamental aspects of geology that are important to a petroleum engineer. This course will cover fundamental aspects of geology that are important to a petroleum engineer. This includes relevant stratigraphic concepts, rudimentary geochemical concepts appropriate for exploration, structural geologic basics and their relevance to drilling, production and reservoir management. Reservoir characterization methodologies are introduced.
- Drilling and Field Operations for Engineers and Geologists (3 credits) [Spring]

This will be two term-length courses (Production Engineering I and II, CH EN 6157 and 6159) which are currently taught. The coursework includes all facets of well construction, including drilling, cementing, acidizing and hydraulic fracturing; onshore and onshore for conventional and unconventional applications.

- Reservoir Engineering (3 credits) [Spring]
  This will be the current semester length course (CH EN 6155). It includes the fundamentals of reservoir engineering principles and will include the basics for modern reservoir simulation with hands on simulation experience.
- Petroleum Production Engineering (3 credits) [Spring]
  This will be taught in four modules. These modules will be:
  - Well testing and pressure transient analysis
  - Logging and in-well measurements
  - Pumping and surface facilities
  - Operational safety
- Energy and Society (3 credits) [Summer]
  - Environmental and legal considerations for petroleum specialists
  - Co-location and resource utilization
  - Environmental impact of drilling and hydraulic fracturing
  - Air and water quality considerations and waste minimization
- Simulation (3 credits) [Summer]
  This course, will use the visualization center at EGI, a unique facility, to take generic and library three-dimensional geologic models and use these to develop rationale drilling programs, to develop and simulate completion and stimulation campaigns and to use commercial and in-house reservoir simulators to infer production and provide options for future reservoir management (waterflooding, workover…). The intent is to use engineering simulators to optimize exploitation in various geologic environments.

Field Study (3 credit hours) [Summer]
Each student will be required to spend at least two weeks in the summer in the Uintah basin on a field study. The study will be coordinated by EGI. EGI runs a number of field trips a year and is uniquely positioned to offer thematic field trips to students; for example, carbonates or shales or tight sands. The field trips will consist of studying outcrops and other exposures. As appropriate, the data and insight from the field studies will be integrated into the project.

Project (6 credit hours)
Each student will need to select a project within the first semester. The project will have specific petroleum engineering applications – upstream, midstream or downstream. This is a research-based project with a required written, peer-reviewed report. The project will be spread out over the 16 months with a focus during the last four months. Students will be required to present their project to a committee of three faculty.

External Review and Accreditation
Not required.

Projected Program Enrollment and Graduates; Projected Departmental Faculty/Students:

Data Category	Current – Prior to New Program Implementation	Projected Year 1	Projected Year 2	Projected Year 3	Projected Year 4	Projected Year 5
Data for Proposed Program						
Number of Graduates in Proposed Program	N/A	0	10	25	45	65
Total # of Declared Majors in Proposed Program	N/A	10	15	20	20	20
Departmental Data – For All Programs Within the Department						
Total Department Faculty FTE (as reported in Faculty table above)	3.25	4.25	4.25	4.25	4.25	4.25
Total Department Student FTE (Based on Fall Third Week)	0	10	15	20	20	20
Student FTE per Faculty FTE (ratio of Total Department Faculty FTE and Total Department Student FTE above)	0	2.3	3.5	4.7	4.7	4.7
Program accreditation-required, if applicable:	None					

Please note that some classes will still be offered to the undergraduates and graduate students; and the courses will be in separate sections.

Expansion of Existing Program
N/A

Section III: Need

Program Need
On the recommendations of alumni, industrial associates and the requests of students (see letters of support), this new degree program is intended to:

- Provide energy-related opportunities for students currently employed in petroleum producing or related organizations, or anxious to enter those same organizations

- Hydrocarbon production will be a critical energy component for the next few decades – at a minimum. This degree recognizes the national interest related to energy security.
- The national interest is also served by students who recognize the environmental and legal aspects of hydrocarbon production and who recognize pathways and requirements for environmental stewardship.
- The need from a state perspective relates to an educated work force that can assist in developing Utah's abundant fossil fuel resources with a reduced energy footprint.
- Significant ancillary research funding opportunities are envisioned with the relationships developed between the University and these professional students.
- Students recognize the opportunities associated with petroleum engineering and recognize the opportunities for implementing greener technologies that are possible if they are employed by larger multi-energy organizations.
- With demographics in the petroleum industry showing the requirement for engineers because of retirements, this is an excellent employment opportunity.

Labor Market Demand

Alumni and industrial colleagues have encouraged the Department of Chemical Engineering to develop graduate level Petroleum Engineering courses. Estimates indicate that the United States will continue to rely on hydrocarbons for decades. These advocates emphasize the following:

- Half-measures are inadequate. This Degree needs to have "petroleum" branding – Industrial colleagues have been clear that this must be a degree and that the degree must have the name "petroleum engineering" as opposed to specialty designation or certificate within Chemical Engineering.
- Local and multinational oil and gas companies have shown support for a Master's degree in Petroleum Engineering at the University of Utah.
- Track Record - Three students from Questar recently gained MS degrees in Chemical Engineering through our non-thesis Master's program. These were all in Petroleum Engineering related areas.
- Innovative engineers are needed to manage conventional and unconventional sectors efficiently and responsibly. The dramatic change in resource recovery methods in the United States adds to the need for engineers trained in unconventional recovery..
- Demographics suggest that large numbers of engineers are needed to fill anticipated retirements. In the petroleum industry, this is often colloquially known as the Great Crew Change. Data from Schlumberger Business Consulting suggested that by 2014 there would be a 5,000 person shortage of qualified petrotechnical staff over the age of 35.

The fossil energy sector is expected to play a dominant role in energy supply over the next decades. These degreed students will have flexible enough backgrounds to participate in these petroleum-related ventures as well as low-carbon, green energy efforts by the same multinational and domestic organizations that would hire them as petroleum engineering specialists.

Student Demand

In a spring 2012 survey of 70 juniors in Chemical Engineering, students indicated a strong interest in petroleum engineering. Students are requesting additional electives and the enrollment in petroleum electives is strong. In the spring of 2012, the enrollment in two existing petroleum-related courses offered in Chemical Engineering was:

	Course Name	Undergraduate Enrollment	Graduate Enrollment	Total Enrollment
CH EN5155/ 6155	Reservoir Engineering	24	11	35
CH EN5157/59 6157/59	Production Engineering	22	10	32

With this level of interest, the department believes it will be able to attract 15 on-campus students consistently. This program will also expand this interest to industry professionals that need additional training to work within petroleum areas. Courses will be aggressively marketed using the distance education model. Various local and national companies have been consulted regarding the program and its content. The companies have been very responsive to the plan. The department believes that the program will attract 10-15 distance education students on a consistent basis.

Similar Programs

There are no similar programs in the USHE. There is a similar program at Imperial College, London, United Kingdom. The program is not an attempt to duplicate others, but to create a new educational experience unique in Utah and in the United States. It will be differentiated by its broad, robust curriculum, field study, and interactions with EGI and industry.

Collaboration with and Impact on Other USHE Institutions

Due to the fact that there are strong unconventional resources in the state, the program expect collaborations with other institutions, specifically:

- Collaboration with Uintah Basin Applied Technology College – offers hands-on training as needed for oil and gas field operations.
- Strong partnership to USTAR - strategically well positioned to act on state's critical energy needs
- Strengthen existing collaborations between Department and EGI
- The program is a combination of distance education (targeted toward international students and working professionals outside of the Salt Lake metropolitan area), cohort experiences, and a two-week field study. Engineers within the state will also be targeted as a method of developing their skills in a new field.

Benefits

There is an inescapable need for fossil fuel over the next decades and the mutual requirement for engineering talent to participate in more efficient recovery and use of hydrocarbons with a smaller footprint (energy, carbon, carbon dioxide, surface disturbance minimized). In conjunction is the requirement to develop alternative energy sources meeting evolving societal criteria. The benefits to the individual are an accelerated pathway to contributing to a secure energy future, the flexibility, and intellectual guidance to implement change in hydrocarbon and other energy production. These are collaterally tangible benefits to

the state and the university. There is a substantial employment opportunity and this is coupled with the opportunities to make a difference in energy extraction processes.

Consistency with Institutional Mission

The Department of Chemical Engineering has seen a large interest in its petroleum-related offerings. Furthermore, the students involved in specific, petroleum-related programs have indicated the need for a more fitting title for their degree. Industry has also seen that "retraining" of an engineer toward more petroleum-related courses is a need. It is clear that the name "petroleum" is needed and that the Department could have a particular niche due to its close collaborations with EGI and the expertise of that organization. For these reasons, the Department has formed the proposed program and its structure.

The proposed program will accelerate dissemination of knowledge through teaching, effective presentation in the classroom and in the field, and will provide technology transfer with dissection of the knowledge and principles associated with those technologies. Students will learn from and collaborate with faculty and industry professionals who are at the forefront of their disciplines. The program is an excellent example of collaborative scholarship, accelerated to meet the demands of the state and the nation. It embodies domestic and international involvement and explictily incorporates social responsibility.

Section IV: Program and Student Assessment

Program Assessment

The goals for the program and the metrics for success are as follows.

- Accommodate growing enrollment;
- Continue to recruit from major companies, internationally and locally;
- Ensure that the program is financially solvent;
- Increase research opportunities and funding through faculty, student and corporate involvement. This involves working with student projects.

Expected Standards of Performance

There is no deviation from standards already in place for the Graduate School of the University of Utah and the Department of Chemical Engineering. In particular:

- All coursework must be completed with no grade less than C and an overall average of B.
- A project-based thesis is required. It must reflect six credit hours of effort and there must be a written report with oral presentation of the contents. A committee of three faculty review the written and oral work of the student. This group decides on the award of the Advanced Design credit. Use of any proprietary or confidential information needs to be agreed upon at the commencement of the project work and an agreement must be in place. The work is an internal publication only.

Section V: Finance

Budget

In addition to two regular and one instructional faculty with this area of expertise, the department is in the process of recruiting a new faculty. An additional faculty search (not specifically in this area) is also underway. Funding has been approved and searches are underway for the new faculty. These additions will enable us to readjust teaching loads to deliver the program without significant effect on the faculty teaching load. The program will enroll students for on-campus classes and offer these classes by distance education. The department has offered this type of instruction to students from the industry interested in an advanced degree. A number of students have graduated from the department by using this method. For budgetary purposes, it is assumed that the program is able to enroll on the average five (5) distance education students. The distance education piece is expected to increase to 10-15 students as the program grows. However, from a budgeting standpoint, conservative estimates are used. The on-campus number of students is expected to grow from five to 15 as the program goes into the fifth year for a total of 20 students. If additional revenue is realized, it will be used to support the core graduate mission of the department.

To involve the industrial expertise of EGI, faculty members from the institute have been included in teaching various courses. They are considered auxiliary faculty and must be compensated. While this is an additional cost, they will provide a unique industrial connection to students in the program. A budget of $20,000 per class, four classes expected, has been estimated for the classes and field study.

The distance education model is something that we have used in the department for several years. Courses will be taped and streamed so that the distance education students will have access to the material at their convenience. The cost of taping and streaming courses is $2,000/course.

In the field studies course, students will be expected to spend at least a week in the field studying and gathering data. The field trip costs are estimated at $3,000/student - $340 for transportation, $1,680 for hotel accommodations and $980 for meals and incidentals for a 14-day trip. The students are expected to pay a course fee to cover the field-trip costs.

5-Year Budget Projection						
Departmental Data	Current Budget—Prior to New Program Implementation	Year 1	Year 2	Year 3	Year 4	Year 5
Personnel Expense						
Salaries & Wages	0	80,000	80,000	80,000	80,000	80,000
Benefits	0	28,800	28,800	28,800	28,800	28,800
Academic Coordinator	0	15,000	20,000	25,000	30,000	30,000
Total Personnel Expense	0	$123,800	$128,800	$133,800	$138,800	$138,800
Non-personnel Expense						
Field Studies	0	$30,000	$45,000	$60,000	$60,000	$60,000
Continuing Education	0	5,500	5,500	5,500	5,500	5,500
Distance Education Streaming	0	16,000	16,000	16,000	16,000	16,000
Miscellaneous program management	0	1,000	2,000	3,000	3,000	3,000
Total Non-personnel Expense		$52,500	$68,500	$84,500	$84,500	$84,500
Total Expense (Personnel + Current)	$0	$176,300	$197,300	$218,300	$223,300	$223,300
Departmental Funding		Year 1	Year 2	Year 3	Year 4	Year 5
Distance Education Fee	0	$137,500	$137,500	$137,500	$137,500	$137,500
Engineering differential tuition	0	$10,395	$20,790	$31,185	$31,185	$31,185
Field Studies Fee	0	$30,000	$45,000	$60,000	$60,000	$60,000
Total Revenue	$0	$177,895	$203,290	$228,685	$228,685	$228,685
Difference						
Revenue - Expense	$0	$1,595	$5,990	$10,385	$5,385	$5,385
Departmental Instructional Cost/Student Credit Hour* (as reported in institutional Cost Study for "current" and using the same Cost Study Definition for "projected")	$	$	$	$	$	$

* Projected Instructional Cost/Student Credit Hour data contained in this chart are to be used in the Third-Year Follow-Up Report and Cyclical Reviews required by R411.

Funding Sources

The funding source will be distance education fee ($2,500/course), engineering differential tuition ($63/credit hour for 6000-level courses) and a course fee expected at $3,000/student for field studies as described above. The field studies cost will be adjusted according to the real costs incurred.

Reallocation

None.

Impact on Existing Budgets

None.

Section VI: Program Curriculum

All Program Courses

All the courses are listed below. New ones are also included. Not that the existing courses will have separate sections to meet the demands of other students, undergraduates and graduates, who are not in the program.

Course Prefix and Number	Title	Credit Hours
Required Courses		
CH EN 6161	Engineering Basics for Petroleum Engineers	3
CH EN 6157, 6159	Drilling and Production Operations[4]	3
CH EN 6155	Reservoir Engineering4	3
CH EN 6167	Petroleum Production Engineering	3
CH EN 6165	Midstream and Downstream Petroleum Engineering	3
CH EN 6163	Petroleum Geology	3
CH EN 6156	Simulation	3
CH EN 6158	Energy and Society	3
CH EN 6171	Field Study	3
CH EN 6169	Advanced Design: Petroleum Engineering Project	6
	Sub-Total	33
Elective Courses		
	Sub-Total	
Track/Options (if applicable)		
	Sub-Total	
Total Number of Credits		33

New Courses to Be Added in the Next Five Years

The degree program is new and many of the courses will be new courses implemented in the first year. Modifications, additions, and improvements will follow as appropriate from faculty insight and student feedback. Below is a detail of the courses and when they are offered. Also in the list are existing courses.

[4] Existing courses

Program Schedule

Semester	Course	Course Title and Description	Credit Hours
Fall – Year 1	CH EN 6161	Engineering Basics for Petroleum Engineers: This will be taught in five modules. The intention is that all degree participants be nominally on the same level by the Spring Semester, whether they have come from a science or an engineering background. The five course modules are: 1. Fluid mechanics for petroleum specialists – including porous medium, multiphase flow 2. Rock mechanics for petroleum specialists 3. Thermal engineering for petroleum specialists 4. Principles of chemistry for petroleum specialists	3
	CH EN 6163	Petroleum Geology. Petroleum Geology: This course will cover fundamental aspects of geology that are important to a petroleum engineer. This includes relevant sedimentary, stratigraphic, and geochemical concepts appropriate for exploration, structural geologic basics and their relevance to drilling, production and reservoir management. Reservoir characterization methodologies are introduced.	3
	CH EN 6165	Midstream and Downstream Petroleum Engineering. Often lost in the glamor of exploration are the midstream – pipelines, transportation, pumping; and the downstream – refining – aspects of petroleum engineering. The Department of Chemical Engineering has a strong and supportive relationship with local pipeline and refining organizations. A key component of this is Nodal Analysis and coupling to subsurface constraints and variability.	3
Spring – Year 1	CH EN 6157/ 6159[5]	Drilling and Field Operations: This will cover the basics of drilling, completions, and stimulation. The specifics may be catered to the background of the student and their particular specialties – for example, their employer specializes in offshore activities. The format of the class is designed to enfranchise students and take advantage of previous experience in these areas. The coursework includes all facets of well construction, including drilling, cementing, acidizing and hydraulic fracturing, onshore and onshore for conventional and unconventional applications.	3
	CH EN 6155[5]	Reservoir Engineering: This existing course covers the basics of single and multiphase fluid flow and flow phenomena that are required for a production or a reservoir engineer. It includes the fundamentals of reservoir engineering principles and will include the basics for modern reservoir simulation with hands on simulation experience.	3

[5] Existing courses

	CH EN 6167	Petroleum Production Engineering: Pumping, Wellhead and Surface Operations. After hydrocarbon is at the surface and before it enters the pipeline there can be complex processes required for separation of fluids and ensuring that the product is ready for transportation by truck, pipeline. Well testing and pressure transient analysis Logging and in-well measurements Monitoring (microseismicity and tracers) Operational safety	3
	CH EN 6169	Advanced Design	2
Summer – Year 1	CH EN 6171	Field Study. Petroleum geologic principles are best illustrated by surface exposures. The same can be said for engineering components such as pipeline facilities, drilling operations and refining operations.	3
	CH EN 6158	Energy and Society. Environmental and legal considerations for petroleum specialists. Economics, risk and PRMS (Petroleum Resource Management Systems)	3
	CH EN 6156	Simulation: In this course, we will use the visualization center at EGI, a unique facility, to take generic and library three-dimensional geologic models and use these to develop rationale drilling programs, to develop and simulate completion and stimulation campaigns and to use commercial and in-house reservoir simulators to infer production and provide options for future reservoir management (waterflooding, workover …). The intent is to use engineering simulators to optimize exploitation in various geologic environments.	3
Fall – Year 2	CH EN 6169	Advanced Design	4
Total			33

Section VII: Faculty

Qualified faculty are prepared to participate in this executive MS Program. These include:

- *Milind Deo, Professor, Department of Chemical Engineering, and Associate Dean of Academic Affairs, College of Engineering*
  (Ph.D. 1987, Chemical Engineering, University of Houston) Deo is a petroleum engineering specialist and recognized leader in reservoir modelling. In addition, his administrative experience will be useful for student advising, curriculum development and program assessment. He currently teaches courses on reservoir engineering and will teach this course in the program (CH EN 6155)
- *John McLennan, USTAR Associate Professor, Department of Chemical Engineering*
  (Ph.D. 1980, Civil Engineering (Rock Mechanics), University of Toronto) McLennan has 30 years of industrial experience in drilling, resource assessment, and hydrocarbon recovery. He currently

teaches courses in production engineering which encompass these aspects and he will teach this course (CH EN 6157/9)

- *Richard Roehner, Associate Professor (Lecturing), Department of Chemical Engineering*
  (Ph.D. 2000, Chemical & Fuels Engineering, University of Utah) Roehner is a well-known and authoritative consultant on midstream and downstream activities, encompassing, pipeline transportation of hydrocarbons and refineries. He will teach CH EN 6165.
- *Ian Walton, Research Professor, Department of Chemical Engineering, EGI*
  (Ph.D. 1972, Applied Mathematics, Manchester University) Walton's areas of expertise include fluid mechanics, near-wellbore geomechanics, rock-fluid interactions, unconventional gas production and mathematical modeling. He has more than 20 years at Schlumberger and has taught numerous courses at Imperial College and for EGI.
- *Rasoul Sorkhabi, Research Professor, Department of Civil and Environmental Engineering, EGI*
  Ph.D., 1991, Geology, Kyoto University) Global Structure and Tectonics expert with 22 years' experience (Japan National Oil Company) and EGI. Sorkhabi has run major global projects for industry from Utah and Wyoming to India, Africa, and SE Asia. In addition, he is the author of numerous books and has taught short-courses. He has extensive expertise on structures and faults.
- *Bill Keach, Research Scientist, EGI*
  (M.S. 1986, Geophysics, Cornell University) Keach has 28 years of geophysical experience, starting at Cornell, to BP and then at Landmark (as head of the GeoProbe global product line). He is currently teaching at the BYU master's program and has taught for the Univeristy of Utah's Geology and Geophysics department. He has expertise is the visualization capabilities at EGI and, as such, will team teach CH EN 6156.
- *Lauren Birgenheier, Assistant Professor, Department of Geology and Geophysics*
  (Ph.D. 2007, Geoscience, University of Nebraska-Lincoln) Birgenheier's research interests lie at the intersection of sedimentary geology and geochemistry. Recently, she has been working on mud-dominated depositional systems that are of interest as unconventional, shale gas or shale oil, resources.
- *Lisa Stright, Assistant Professor, Department of Geology and Geophysics*
  (Ph.D. 2011, Interdisciplinary Geosciences, Stanford University) Stright's research focuses on combining quantitative observations from modern, outcrop and subsurface processes and deposits with geostatistical modeling. The goal is to expand our understanding of how to build predictive geospatial models for the purpose of more efficient hydrocarbon exploration and recovery.

Additional Faculty Requirements

A new faculty member with expertise in Petroleum Engineering is required. A search for this person, whose home department is Chemical Engineering, begins Fall Semester 2012. This person will teach CH EN 6167, Drilling Production.