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**Master Syllabus**

**Course: EGE 303: Engineering Economy**

**Cluster Requirement: 4B The Nature of US Society**

*This University Studies Master Syllabus serves as a guide and standard for all instructors teaching an approved in the University Studies program. Individual instructors have full academic freedom in teaching their courses, but as a condition of course approval, agree to focus on the outcomes listed below, to cover the identified material, to use these or comparable assignments as part of the course work, and to make available the agreed-upon artifacts for assessment of learning outcomes.*

**Course Overview:**

Engineering Economy is a course designed to bridge engineering knowledge to human society. It educates students in the ways decisions are made in American capitalist economy. The course enables students to see engineering as a means of serving societies by providing technologies and services for human comfort while using earth's scarce resources most efficiently. The course also enables students to see the American society as a member of the large human society with corresponding means of collaborations and competitions. Furthermore the course has been designed to link the profitability of engineering activities with environmental concerns and sustainable use of resources. It addresses the engineering profession as a means of responding to the needs of US society within a global environment. The course has many similarities with another University Studies approved course (ECO231) but the approach is somewhat more analytical.

**Learning Outcomes:**

 Course Specific Learning Outcomes:

* Use economic tools to make decisions on feasibility of engineering projects
* Balance profitability of engineering projects vs. their impacts on environment and global sustainability.
* Estimate chances of long term success of engineering projects in international and competitive markets.
* Consider global factors in outsourcing decisions.
* Include national and international implications of tangible and intangible profits of public projects
* Realize the impact of taxes on engineering decisions.
* Make economic decisions under risk and uncertainty.
* Select among feasible public projects under resource constraints.

University Studies Learning Outcomes:

After completing this course students will be able to:

1. Explain: c) the different facets of citizenship in the United States

2. Locate, analyze, summarize, paraphrase and synthesize material from a variety of sources.

3. Evaluate arguments made in support of different perspective on US society.

***University Studies Course Rationale***. *This statement, no longer than 500 words, should describe the general content and goals of the course, the pedagogical approaches and types of assignments and the ways in which the course will attempt to help students meet the University Studies learning outcomes for that Cluster requirement. This statement is an opportunity for the sponsoring faculty to speak directly about how the course will fit into the Cluster requirement's scope and goals.*

EGR 303, Engineering Economy, is a bridge between what students learn as an engineer and what they will be expected to contribute to US's economic and social well being. The first thing they learn is that engineering is not just mathematics and science. They are educated that expectations from engineers are different in different societies and they could only be successful if they have a better understanding of American social system. Throughout the course they learn to understand the democratic nature of US capitalism, and how to behave smartly, but fairly, in such an environment. They learn how to evaluate private and public engineering projects in a way that while they are profitable for their corresponding investors, they also have long term effects on US economy, the environment and social concerns. They learn about US tax system and its effect on engineering decisions.

 The above principles are emphasized on the type of homework students are responsible to do. In particular, the textbook selected for the course has specifically designated a large number of homework examples as "Green Problems" where economical aspects of green technologies are addressed. Furthermore, in a portion of the course US tax codes are provided so that students could evaluate and make decisions on engineering projects under US tax laws.

 Although students are exposed to above principles throughout this one semester course, the true learning and exposure to how to behave in the US society is accomplished through the term project students are assigned to conduct for the course. Students are organized in teams of 2 to 4 people and are assigned to provide a professional proposal for conducting en engineering economic analysis for a real situation. Teams approach real companies or entrepreneurs and collect information about the operation of an existing system or ideas for new entrepreneurship.

For each project they perform a thorough engineering economic analysis of the way the organization is designed and operated or the way a new operation is imagined to start. Then through their team discussions and communications with directors of the operations they come up with alternative ways of performing the same operation at a higher profitability rate. Most often they consider new directions in green technologies and ways of preserving environment while remaining profitable. Their efforts often results in definition of several other alternatives for conducting the same engineering operations. Their engineering economy skills then allow them to compare the alternatives and end up proposing the best method of operating the system. For most projects their final report consists of an extensive search of literature and internet sources to collect data on costs, prices and markets. They also get a full lesson on how to approach people and how to conduct interviews.

In conclusion it is quite fair to state that upon completion of this course student achieve an entirely new understanding of what the role of an engineer is in US community and how they could help by making right economic decisions when necessary.

**Course Catalog Description (downloaded from the 2012-2013 online catalog):**

**EGR 303 - Engineering Economics**

3 credits **S, G (Update this to US 4B)**
Prerequisites: MTH 114 or 112
Concepts and methods of engineering economics for decision making in engineering. Introduction of common methods of present worth analysis, rate of return, replacement analysis, and decision making under risk. Market evaluation of technology in competitive world markets including technological change, the environment, public goods and governmental trade policies.

**Examples of texts and/or assigned readings:**

Sullivan, W.G.; Wicks, E.M.; and Koelling, C.P., Engineering Economy, 15th Edition, Prentice Hall, 2011

Park C. S., Contemporary Engineering Economics, Prentice Hall, 2007

**Example Assignments:**

*Individual instructors will choose from among these assignments, which are designed to fulfill the university studies learning outcomes but also allow some flexibility for individual sections of the class in terms of topic, placement throughout the semester, and mode of delivery.*

Assignments in the course consist of two parts.

1. A series of problems from the book. As the recent edition of the book has taken much aggressive approach towards paying special attention to environmental issues many of the problems are marked as "Green Engineering Examples". These problems familiarize students with environmental issues involved in making decisions about engineering activities.
2. Additional coverage of issues satisfying university studies criteria are included in a comprehensive project students have to submit as well as orally present at the end of the semester.

**Specific Examples of the Questions and Rubric:**

**a) Assignments from Textbook**

* Problems in chapter 4, 5, and 6 in Sullivan's book make sure students realize the time value of money (interest rates) and the roles banks and government can play in preferring one course of action vs. another(1.c, 3).
* In chapter 7 in Sullivan's book assignments teach students how US government can influence decisions made by the industry and engineers through taxation policies. Students are asked to compare implementation of one policy vs. another based on various tax policies. This subject is discussed in details in the class to make distinction between the ways government policies are implemented in democratic societies vs. those ruled by other political systems. (1.c , and 3)
* Assignments from chapter 10 of Sullivan's book enable students to distinguish the difference in approaches used in choosing projects for private enterprises and public sectors. (3).
* Assignments from chapter 12 are meant to establish the fact of associated risks to private and public projects that affect the well beings of the private and public sectors in a democratic society (3).

b) **Final Term Project**

 Consider a real situation where a project is being considered by a public or a private organization. Perform a comprehensive study of all feasible alternatives for this project including their overall effectiveness in not only financial aspect but the impact on society, environment and sustainability. Considering the preferences of your decision making environment collect appropriate data, decide on the measure of effectiveness, and conduct en engineering economic analysis that would enable you to choose one of the possible alternatives. Also provide a tradeoff analysis comparing the alternative you selected withthe others that were not your first choice.

* Students form teams consisting of two to four persons. The steps involved in these projects are as follows:
	+ The team prepares a proposal for a real project concerning selection of a project from among several alternatives. The proposal contains a description, sources of data, and objectives of conducting the research. (1c, 2, and 3)
	+ Proposals are reviewed by the course instructor to make sure they contain sufficient complexity, address social concerns such as environmental issues and sustainability, as well as to make sure of the reliability of sources of data.
	+ Teams with proper proposals are given a go ahead to start their projects. Other teams are guided to improve their proposals to an acceptable standard before given a go ahead direction.
* Teams select their leader, and get started on performing the project. Specific tasks of the projects are as follows:
	+ Collection of real data from various sources on possible alternatives, costs, revenues, and social and environmental impacts (2).
	+ Defining feasible alternatives that satisfy project objectives, legal issues, environmental constrains and social impacts (2,3).
	+ Using relevant criteria they evaluate each feasible alternative using the analytical techniques they have learned in the course and select the best alternative to implement (2).
	+ Members of the team share duties of presenting the project and their approach and recommendations to the class (2).

**Format for preparing Proposals**

**INSTRUCTIONS FOR TERM PROJECT PROPOSAL**

**EGR 303**

**Engineering Economy**

**Fall 2012**

Proposals for the required term project for EGR 303 are due Tuesday November 8th 2012. Following are the instructions for preparing a proposal for your projects.

1. You need to form groups of 4 for each project. Please discuss with your classmates to form such groups. Each group should have a spokesperson who would e-mail to me the list of members of the group. Please try to do this the first opportunity you get. If you cannot do this by Thursday Nov. 1st, please make sure you could send the list to me by this weekend. If you cannot find enough peoploe to form your group send me an e-mail and I will put you in a group.
2. The project has to consider the process for engineering economic analysis of manufacturing a product, construction of a service facility or building a factory of a kind or some type of infrastructure.
3. the proposal should be between two to three pages and consist of at least the following sections
4. A title
5. An abstract
6. Names of team members
7. Description of the product or project to be analyzed
8. Project Objectives
9. Preliminary alternatives to be analyzed
10. Methods and sources of data collection
11. Methods and sources of cost estimation ( Read chapter 3 for help)
12. Role of each member of the team
13. A time-line for analysis stages
14. Expected results
15. Conclusions

3. The project has to address issues related to environmental costs, sustainability, and taxes.

4. The project should consider life cycle cost analysis.

5. The project should be concluded with a strongly supported decision choice.

All proposals should be submitted through e-mail.

Each proposal will be evaluated and either approved or be discussed with the team for necessary modifications. After proposals are approved teams will start working on it immediately as the time to will be limited to complete a professional quality project.

**Due Dates:**

**Proposal submission:** November 8, 2012

**Approval of proposals:** November 15, 2012

**Progress report** November 29, 2012

**Final submission and presentation:** December 8, 2012

An example of a final report on a term project is attached in the Appendix.

**Sample Course Outline**

**Course Contents No. of Sessions**

Introduction 1

Economic analysis as a decision making tool 2

Time value of money 2

Cost estimation 1

Decision rules for evaluation of projects 2

Decision making for a single project 1

Decision making for multiple projects 2

Using spread sheets 1

Impacts of taxes and regulations 3

Sensitivity and breakeven analysis 2

Public projects evaluation 1

Economics of environmental and sustainability impacts 2

Economic analysis under uncertainty 6

Discussion and presentations of students’ projects 2

**Appendix**

A sample of term projects

Environmentally Friendly Fuel Plant

University of Massachusetts Dartmouth

College of Engineering

Mechanical Engineering

EGR-303

Engineering Economics

Project Team 3

Christian Carey – Spokesman

Eric Kulpa

Cody Santor

Abstract

 A small, low-scale business in the oil industry has decided to expand and overhaul its business to compete with the big names in the United States. Knowing they will not survive competing side-by-side with Exxon or Gulf; they will produce an environmentally friendly plant that can increase its production significantly compared to past numbers. New customers will be acquired within the “going green” community in order to maintain business. The plant that has been chosen is algae, which can be refined to biodiesel. It can be grown at a high rate with low risk to competition of land as it grows in poor conditioned land needing only sunlight, water, and carbon dioxide. Data from fossil fuel based oil and algae based biodiesel will be analyzed to determine whether or not this overhaul of product can be economically justified.

Description and Objective

Two refinery plants: one is petroleum/crude oil and has been standing for years. Because of the significance that oil has in America and around the world, the expected minimum annual rate of return (MARR) of investors is 20%. Even with such a high return rate, increasing taxes for environmental pollution in the air and the grounds surrounding the plant are forcing a conversion to an eco-friendly, bio-fuel production, and refinery plant. The fuel that has been chosen is algae, which can be grown in man-made ponds in hot and humid climates that also have vast amounts of sunlight. For an attempt at a fair comparison, given that the eco-plant is brand new and no investors have any experience with such a plant, a MARR of 10% was set as a mark needed to be reached.

As a group, we plan on analyzing the cost of production of both plants as well as based on land cleaning and construction costs, operating cost and taxes in both scenarios. By the end of our evaluation, we can say with relative certainty that the algae plant will make money based on the criteria laid out by the investors of the project.

Methods and Sources of Data Collection

Most of the data we collected came from scientific journals and government funded websites on the internet. We used a few different company’s estimated numbers in order to represent an average size oil company. The references for these sites are labeled at the end of this document.

We also reached out to few companies, asking questions pertaining to their decision making. Our hopes were to gain insight into how these companies got their start, whether they knew that the bio-fuel was the choice or even if they were willing to share and of their fiscal year analysis. All three questions were never responded by any of the companies that we tried to get in contact.

Description of Selected Alternatives

Oil

The petroleum oil plant is a big industry and is more destructive on the environment than the algae biodiesel. The amount of oil in the world, at the rate the world population continues to use its supply, is estimated to be extinguished in 50-100 years. Along with supply and demand, prices to drill oil out of underground pools or filter out sands continue to increase, reflecting the prices to home and car owners are paying for heating oil and gas respectively. Oil is the most used energy source in the world, with some of the biggest companies and whole countries making enormous profits from its exploitation.

 Fig. 1 – Crude oil refining and its products

Bio-fuel (Algae)

We also analyzed the growth and production of Algae bio-fuel. Algae technology is new and continually growing. Although in order to produce very high quantities of refined fuel, huge amounts of land are needed. Under the right circumstances, it could possibly be the most feasible replacement of petroleum fuel. The algae bio-fuel can be grown in multiple ways, but the most used method is with open ponds. With these open ponds, algae farmers can harvest the algae for the production of bio-fuel over acres of land.

 Fig. 2 – Algae production options. (Top, fermentation. Middle, photobioreactors. Bottom, open ponds.)

The numbers we used for our cost analysis were for production, construction and maintenance, costs and revenues. Also, we will need to analyze the cost to install the new equipment for algae based fuel production. The market and salvage value the plant can receive for the petroleum oil production equipment as well as a land surveyor to check for oil repercussions prior to installing the eco-friendly equipment.

Methods and Sources of Cost Estimation

In order to make an accurate prediction whether or not the transition between fossil and bio fuel production and refining can be smooth and positive, we found ways to estimate costs between the products. One way would be to start by comparing cost of the fuel from the eyes of the consumer. Finding a relation between the prices that the fuel can be purchased, for compared to the cost it took to be produced, packaged and shipped so that the company will make a predetermined rate of return on the product. For example, gasoline currently can currently be purchased for approximately $3.20/gallon in the North Dartmouth, MA area and heating oil costs in Southern Massachusetts is around $3.40/gallon. These prices will vary based on location and season. Just 5 years ago, gasoline could be purchased for $1.75/gallon, which shows the result of diminishing amounts of raw material and government crackdown. Algae fuel, which is a reoccurring raw material, prices will stay low because the only costs will be the growth and maintaining of the ponds.

Other cost elimination strategies occurred during general research for both oil and algae fuel. It was found that the United States federal government has passed bills that enable bio-fuel production companies to receive tax refunds. It is possible for companies to receive a dollar per gallon of fuel for the first 15 million gallons that are made. So under perfect conditions, a company can be refunded up to $15,000,000.00 per year. Small scale companies which may not reach the 15 million gallon mark per year will still be eligible for the dollar per gallon refund and will be a significant percentage in their profit come fiscal year’s end.

Analysis and Calculations

Our data was put together with research from the internet which included scientific journals as well as government run sources. They provide information that had been researched by the experts in their respective fields. ­That data has been outlined in table 1 and table 2 below. The taxes were a complicated issue however. There was multiple conflicting data that outlined partial taxes that energy companies encounter every year. Based on that, we took a roughly estimated average between that that we will apply to both and the benefit of the tax refund of producing bio-fuel will be considered revenue per year. Both projects are currently covering 250 acres of land.

|  |
| --- |
| **Algae Data** |
|  |  |  |  |  |
| **Cost** | **$/acre** | **$** |
| Land Cleaning | $15,000.00 | $3,750,000.00 |
| Plant | $32,500.00 | $8,125,000.00 |
| Refinery | $8,000.00 | $2,000,000.00 |
| Tax | 24% per gallon |
| Maintenance and Operation | $7,000.00 | $1,750,000.00 |
|   |   |   |   |   |   |
| **Revenue** | **$/gal** | **$** |
| Price Per Gallon | $0.65 | $1,625,000.00 |
| Tax Refund | $1.00 | $2,500,000.00 |

Table 1 – Algae cash flow information

|  |
| --- |
| **Oil Data** |
|  |  |  |  |  |  |
| **Cost** | **$/acre** | **$** |
| Land Cleaning | - | - |
| Plant | - | $42,000,000.00 |
| Refinery | - | $8,000,000.00 |
| Tax | 24% per gallon |
| Maintenance and Operation | - | $38,000,000.00 |
|   |   |   |   |   |   |
| **Revenue** | **$/gal** | **$** |
| Price Per Gallon | $1.75 | $49,200,000.00 |
| Tax Refund | - | - |

 Table 2 - Oil cash flow information

By using those numbers and with the help of the Excel software, we were able to calculate an after tax cash flow (ACTF) for both scenarios. Once our ACTF had been calculated, present worth of both were calculated and analyzed. With these numbers, we can study and present our findings about the profit that oil is bringing in and the profit that algae could be bringing in, both at the conditions listed by investors, Marr=20% for oil and Marr=10% for algae.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Algae Refinery* | **Depreciation Deduction** |  |  |  |
| **Year** | **BCTF** | **Cost Basis** | **GDS Rate** | **Deduction** | **TI** | **Cash Flow for TI** | **ATCF** |
| 0 | -$3,750,000.00 | - | - | - | - | 0 | -$3,750,000.00 |
| 1 | -$9,125,000.00 | - | - | - | - | 0 | -$9,125,000.00 |
| 2 | $2,375,000.00 | $12,875,000.00 | 0.1000 | $1,287,500.0000 | $1,087,500.0000 | $261,000.0000 | $2,636,000.00 |
| 3 | $2,375,000.00 | $12,875,000.00 | 0.1800 | $2,317,500.0000 | $57,500.0000 | $13,800.0000 | $2,388,800.00 |
| 4 | $2,375,000.00 | $12,875,000.00 | 0.1440 | $1,854,000.0000 | $521,000.0000 | $125,040.0000 | $2,500,040.00 |
| 5 | $2,375,000.00 | $12,875,000.00 | 0.1152 | $1,483,200.0000 | $891,800.0000 | $214,032.0000 | $2,589,032.00 |
| 6 | $2,375,000.00 | $12,875,000.00 | 0.0922 | $1,187,075.0000 | $1,187,925.0000 | $285,102.0000 | $2,660,102.00 |
| 7 | $2,375,000.00 | $12,875,000.00 | 0.0737 | $948,887.5000 | $1,426,112.5000 | $342,267.0000 | $2,717,267.00 |
| 8 | $2,375,000.00 | $12,875,000.00 | 0.0655 | $843,312.5000 | $1,531,687.5000 | $367,605.0000 | $2,742,605.00 |
| 9 | $2,375,000.00 | $12,875,000.00 | 0.0655 | $843,312.5000 | $1,531,687.5000 | $367,605.0000 | $2,742,605.00 |
| 10 | $2,375,000.00 | $12,875,000.00 | 0.0656 | $844,600.0000 | $1,530,400.0000 | $367,296.0000 | $2,742,296.00 |
| 11 | $2,375,000.00 | $12,875,000.00 | 0.0655 | $843,312.5000 | $1,531,687.5000 | $367,605.0000 | $2,742,605.00 |
| 12 | $2,375,000.00 | $12,875,000.00 | 0.0382 | $491,825.0000 | $1,883,175.0000 | $451,962.0000 | $2,826,962.00 |
|  |  |  |  |  |  |  |  |
|  |  |  | PW MARR=10% | $3,427,197.60 |  |  |  |

 Table 3 – After Tax Cash Flow for Algae Production

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Oil Refinery* | **Depreciation Deduction** |  |  |  |
| **Year** | **BCTF** | **Cost Basis** | **GDS Rate** | **Deduction** | **TI** | **Cash Flow for TI** | **ATCF** |
| 0 | -$50,000,000.00 | - | - | - | - | 0 | -$50,000,000.00 |
| 1 | $11,200,000.00 | $50,000,000.00 | 0.1000 | $5,000,000.0000 | $6,200,000.0000 | $1,488,000.0000 | $12,688,000.00 |
| 2 | $11,200,000.00 | $50,000,000.00 | 0.1800 | $9,000,000.0000 | $2,200,000.0000 | $528,000.0000 | $11,728,000.00 |
| 3 | $11,200,000.00 | $50,000,000.00 | 0.1440 | $7,200,000.0000 | $4,000,000.0000 | $960,000.0000 | $12,160,000.00 |
| 4 | $11,200,000.00 | $50,000,000.00 | 0.1152 | $5,760,000.0000 | $5,440,000.0000 | $1,305,600.0000 | $12,505,600.00 |
| 5 | $11,200,000.00 | $50,000,000.00 | 0.0922 | $4,610,000.0000 | $6,590,000.0000 | $1,581,600.0000 | $12,781,600.00 |
| 6 | $11,200,000.00 | $50,000,000.00 | 0.0737 | $3,685,000.0000 | $7,515,000.0000 | $1,803,600.0000 | $13,003,600.00 |
| 7 | $11,200,000.00 | $50,000,000.00 | 0.0655 | $3,275,000.0000 | $7,925,000.0000 | $1,902,000.0000 | $13,102,000.00 |
| 8 | $11,200,000.00 | $50,000,000.00 | 0.0655 | $3,275,000.0000 | $7,925,000.0000 | $1,902,000.0000 | $13,102,000.00 |
| 9 | $11,200,000.00 | $50,000,000.00 | 0.0656 | $3,280,000.0000 | $7,920,000.0000 | $1,900,800.0000 | $13,100,800.00 |
| 10 | $11,200,000.00 | $50,000,000.00 | 0.0655 | $3,275,000.0000 | $7,925,000.0000 | $1,902,000.0000 | $13,102,000.00 |
| 11 | $11,200,000.00 | $50,000,000.00 | 0.0382 | $1,910,000.0000 | $9,290,000.0000 | $2,229,600.0000 | $13,429,600.00 |
|  |  |  |  |  |  |  |  |
|  |  |  | PW Marr=20% | $4,443,932.76 |  |  |  |

 Table 4 – After Tax Cash Flow for Oil Production

 Fig. 3 – Pie chart of Present Worth

Table 3 shows the calculation of algae after taxes. Having to inform investors whether it is economically justified, we had to find the present worth of data by using the present/future method at each year added together at the respective Marr’s. The same was done in table 4 of the oil data. Finally, presented in figure 3 above, is a visual breakdown relationship of the present worth of the two.

Conclusion

Based on our calculations and present worth values, it can be determined that the eco-friendly and bio-fuel production plant project will be a positive one, though it will not make as much money as the previous oil plant. For the future of the company, it looks like the investors did make the correct decision to make the change. This is due to the thought that oil could really be depleted in year’s time, where algae can continue to be grown. It is a vast opportunity to take advantage of, as the algae refineries also have a far less, if any, negative impact on the atmosphere the way that oil if now if forms of vehicle exhaust or smoke stacks in processing plants, ect. The costs that were encountered related in terms of money needed for land and taxes.

The crucial factor behind decision making is the amount of land that is at the disposal of the investors, which was found to be 250 acres in our study. The more land that is owned, increases how many open pools can be built effecting the algae production. This logic is being very strongly debated by companies and investors who propose to build the open pool farms in the deserts and dry lands of the west and Midwest of the United States. They provide the vast land needed for such projects and also offer dangerous working conditions for the employees running and maintaining the farms. As land increases, so will profit from algae farms as they continue to be built, but for now, oil and gasoline remain.

Work Cited

Briggs, Michael. "Widescale Biodiesel Production from Algae." *Journal of Energy Independence*. n. page. Web. 12 Dec. 2011.

Newman, Stefani. "How Algae Biodiesel Works." *How Stuff Works*. N.p., n.d. Web. 12 Dec 2011. <http://science.howstuffworks.com/environmental/green-science/algae-biodiesel3.htm>.

"Southern Massachusetts." *New England Oil*. N.p., n.d. Web. 12 Dec 2011. <http://www.newenglandoil.com/massachusetts/zone6.asp?x=0>.

Government, United States. Congress. *S.1277*. Washington, D.C.: , 2011. Web. <http://www.biodiesel.org/resources/legissues/S1