Course information:
Copy and paste current course information from Class Search/Course Catalog.

Academic Unit: Ira A Fulton Schools of Engineering

Subject: CHE
Number: 462
Title: Process Design
Units: 3

Is this a cross-listed course? No
If yes, please identify course(s) ____________

Is this a shared course? No
If so, list all academic units offering this course ____________

Requested designation: (Choose One)
Note: a separate proposal is required for each designation requested

Eligibility:
Permanent numbered courses must have completed the university's review and approval process.
For the rules governing approval of omnibus courses, contact Phyllis.Lucie@asu.edu or Lauren.Leo@asu.edu.

Submission deadlines dates are as follow:
For Fall 2015 Effective Date: October 9, 2014
For Spring 2016 Effective Date: March 19, 2015

Area(s) proposed course will serve:
A single course may be proposed for more than one core or awareness area. A course may satisfy a core area
requirement and more than one awareness area requirements concurrently, but may not satisfy requirements in two
core areas simultaneously, even if approved for those areas. With departmental consent, an approved General Studies
course may be counted toward both the General Studies requirement and the major program of study.

Checklists for general studies designations:
Complete and attach the appropriate checklist
- Literacy and Critical Inquiry core courses (L)
- Mathematics core courses (MA)
- Computer/statistics/quantitative applications core courses (CS)
- Humanities, Arts and Design core courses (HU)
- Social-Behavioral Sciences core courses (SB)
- Natural Sciences core courses (SO/SC)
- Cultural Diversity in the United States courses (C)
- Global Awareness courses (G)
- Historical Awareness courses (H)

A complete proposal should include:
- Signed General Studies Program Course Proposal Cover Form
- Criteria Checklist for the area
- Course Catalog description
- Course Syllabus
- Copy of Table of Contents from the textbook and list of required readings/books

Respectfully request that proposals are submitted electronically with all files compiled into one
PDF. If necessary, a hard copy of the proposal will be accepted.

Contact information:
Name: Mia Kroeger
Phone: x7-9318
Mail code: 6106
E-mail: mia.kroeger@asu.edu

Department Chair/Director approval: (Required)

Chair/Director name (Typed): Lenore Dai
Date: 1/21/15
Chair/Director (Signature): [Signature]

Rev. 1/94, 4/95, 7/98, 4/00, 1/02, 10/08, 11/11, 12/11, 7/12, 5/14
Arizona State University Criteria Checklist for

LITERACY AND CRITICAL INQUIRY - [L]

Rationale and Objectives

Literacy is here defined broadly as communicative competence—that is, competence in written and oral discourse. Critical inquiry involves the gathering, interpretation, and evaluation of evidence. Any field of university study may require unique critical skills that have little to do with language in the usual sense (words), but the analysis of written and spoken evidence pervades university study and everyday life. Thus, the General Studies requirements assume that all undergraduates should develop the ability to reason critically and communicate using the medium of language.

The requirement in Literacy and Critical Inquiry presumes, first, that training in literacy and critical inquiry must be sustained beyond traditional First Year English in order to create a habitual skill in every student; and, second, that the skill levels become more advanced, as well as more secure, as the student learns challenging subject matter. Thus, two courses beyond First Year English are required in order for students to meet the Literacy and Critical Inquiry requirement.

Most lower-level [L] courses are devoted primarily to the further development of critical skills in reading, writing, listening, speaking, or analysis of discourse. Upper-division [L] courses generally are courses in a particular discipline into which writing and critical thinking have been fully integrated as means of learning the content and, in most cases, demonstrating that it has been learned.

Notes:

1. ENG 101, 107 or ENG 105 must be prerequisites
2. Honors theses, XXX 493 meet [L] requirements
3. The list of criteria that must be satisfied for designation as a Literacy and Critical Inquiry [L] course is presented on the following page. This list will help you determine whether the current version of your course meets all of these requirements. If you decide to apply, please attach a current syllabus, or handouts, or other documentation that will provide sufficient information for the General Studies Council to make an informed decision regarding the status of your proposal.

Revised April 2014
Proposer: Please complete the following section and attach appropriate documentation.

<table>
<thead>
<tr>
<th>ASU - [L] CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TO QUALIFY FOR [L] DESIGNATION, THE COURSE DESIGN MUST PLACE A MAJOR EMPHASIS ON COMPLETING CRITICAL DISCOURSE—AS EVIDENCED BY THE FOLLOWING CRITERIA:</strong></td>
</tr>
<tr>
<td><strong>YES</strong></td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>❌</td>
</tr>
<tr>
<td><strong>CRITERION 1:</strong> At least 50 percent of the grade in the course should depend upon writing assignments (see Criterion 3). Group projects are acceptable only if each student gathers, interprets, and evaluates evidence, and prepares a summary report. <em>In-class essay exams may not be used for [L] designation.</em></td>
</tr>
</tbody>
</table>

1. Please describe the assignments that are considered in the computation of course grades—and indicate the proportion of the final grade that is determined by each assignment.

2. Also:

   Please circle, underline, or otherwise mark the information presented in the most recent course syllabus (or other material you have submitted) that verifies this description of the grading process—and label this information "C-1".

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>❌</td>
<td>☐</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>CRITERION 2:</strong> The writing assignments should involve gathering, interpreting, and evaluating evidence. They should reflect critical inquiry, extending beyond opinion and/or reflection.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Please describe the way(s) in which this criterion is addressed in the course design.

2. Also:

   Please circle, underline, or otherwise mark the information presented in the most recent course syllabus (or other material you have submitted) that verifies this description of the grading process—and label this information "C-2".

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>❌</td>
<td>☐</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>CRITERION 3:</strong> The syllabus should include a minimum of two writing and/or speaking assignments that are substantial in depth, quality, and quantity. Substantial writing assignments entail sustained in-depth engagement with the material. Examples include research papers, reports, articles, essays, or speeches that reflect critical inquiry and evaluation. Assignments such as brief reaction papers, opinion pieces, reflections, discussion posts, and impromptu presentations are not considered substantial writing/speaking assignments.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Please provide relatively detailed descriptions of two or more substantial writing or speaking tasks that are included in the course requirements.

2. Also:

   Please circle, underline, or otherwise mark the information presented in the most recent course syllabus (or other material you have submitted) that verifies this description of the grading process—and label this information "C-3".
<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
<th>Identify Documentation Submitted</th>
</tr>
</thead>
<tbody>
<tr>
<td>✗</td>
<td></td>
<td><strong>CRITERION 4:</strong> These substantial writing or speaking assignments should be arranged so that the students will get timely feedback from the instructor on each assignment in time to help them do better on subsequent assignments. <em>Intervention at earlier stages in the writing process is especially welcomed.</em></td>
</tr>
</tbody>
</table>

1. Please describe the sequence of course assignments—and the nature of the feedback the current (or most recent) course instructor provides to help students do better on subsequent assignments.

2. **Also:**

   Please circle, underline, or otherwise mark the information presented in the most recent course syllabus (or other material you have submitted) that verifies this description of the grading process—and label this information "C-4".
<table>
<thead>
<tr>
<th>Course Prefix</th>
<th>Number</th>
<th>Title</th>
<th>General Studies Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ChE</td>
<td>462</td>
<td>Process Design</td>
<td>L</td>
</tr>
</tbody>
</table>

Explain in detail which student activities correspond to the specific designation criteria.
Please use the following organizer to explain how the criteria are being met.

<table>
<thead>
<tr>
<th>Criteria (from checklist)</th>
<th>How course meets spirit (contextualize specific examples in next column)</th>
<th>Please provide detailed evidence of how course meets criteria (i.e., where in syllabus)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criterion 1</td>
<td>The writing assignments (Project Reports 1 and 2 are counted 70% towards the final course grade). Project 1 is an individual effort &amp; report. Project 2 is a team effort but each student &quot;gathers, interprets, and evaluates evidence&quot; and prepares and submit an individual report; moreover, Project 2 assignment specifically notes &quot;that there will be some grading as a team but you will be mainly graded individually on your section of (contribution to) the report.&quot;</td>
<td>Please see the circled C-1 items on the last page of the attached course syllabus of 2013 and 2014, respectively. Also, please see the circled statements as C-1 in the actual project assignments of 2013 and 2014, respectively.</td>
</tr>
</tbody>
</table>
| Criterion 2               | The nature of the projects for the writing assignments are technical such as "Design for Produced Water Reclamation" (Project 1, 2013), "Design for Carbon Dioxide-Free Utilities" (Project 2, 2014), "Design for Reduced Semi-Tractor Trailer Vehicle Emission" (Project 1, 2014), and "Design for Water, Electricity and Environmenta Concerns (Project 2, 2014). These projects requires students developing critical thinking skills and "gathering, interpreting, and evaluating evidences" and reflect "critical inquiry."
<p>|                           | The original writing assignments of 2013 and 2014 are attached as whole as C-2.                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                           |
| Criterion 3               | The course includes assignments of two in-depth project written reports and one oral presentation                                                                                                                                                                                                                                 | Please see the circled C-3 items on the last page of the attached course syllabus of 2013 and 2014, respectively. The original writing assignments of 2013 and 2014 are attached as C-3.                                                                 |</p>
<table>
<thead>
<tr>
<th>Criterion 4</th>
<th>The writing assignments start with a designated lecture on &quot;Report Writing Chapter 11&quot;. In addition, there is a requirement to submit a &quot;Project Progress Report&quot; so that the students can receive some feedback. Also, a report grading sheet is provided before each project report is due. There are required team meetings with the instructor before the second report and oral presentation. The course also includes a designated lecture on &quot;how to give an oral presentation CH 11&quot; before the oral presentation. An oral presentation grading sheet is provided to the students prior to the presentation itself. Finally, it is important to note that &quot;the first report is graded by ME and returned to the class within a week - well ahead of the second report due date&quot; (direct quote from the instructor).</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Please see the circled C-4 items in the course syllabus of 2013 and 2014, respectively. Also, the report grading sheets are attached and labeled as C-4. Please see the circled statements as C-4 in the actual project assignments of 2013 and 2014, respectively. Please see the grading sheet of 2013 and 2014 labeled as C-4. Please also see an email communication (labeled as C-4) between Dr. Lenore Dai, the Program Chair of Chemical Engineering and the Dr. James Beckman, the instructor of ChE 462. Dated 1/8-1/9 2015.</td>
</tr>
<tr>
<td>Course</td>
<td>Title</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>CHE 462</td>
<td><strong>Process Design</strong></td>
</tr>
<tr>
<td></td>
<td>Applies economic principles to optimize equipment selection and design; development and design of process systems.</td>
</tr>
<tr>
<td>Allow multiple enrollments: No</td>
<td>Primary course</td>
</tr>
<tr>
<td>Repeatable for credit: No</td>
<td>component: Lecture</td>
</tr>
<tr>
<td>Offered by: Ira A. Fulton Schools of Engineering -- Chemical Engineering Program</td>
<td>Grading method: Student</td>
</tr>
<tr>
<td>Pre-requisites: Engineering BS or BSE student; CHE 432, CHE 442 and CHE 433 with C or better OR Graduate Engineering student</td>
<td>Option</td>
</tr>
</tbody>
</table>
CHE 462: Process Design. 3 credits. Application of economic principles to optimize equipment selection, sizing and cost/design of process systems. Prereq. CHE 432, CHE 433, CHE442 and everything else except lab courses and control!

FORMAT: I’m your first boss and this is your first job. You will be a design engineer in a company that is contracted by a client needing design assistance.

Think of alternatives  On the job environment  Involving group interaction


REFERENCES:


Perry, ed, Chemical Engineers Handbook, all editions.

**TOPICS BY WEEK:**

**Week of**  

**Topics**

Jan 13 M; Introduction to Design, Generation of Alternatives (The Physics Exam) CH 1  
W; process alternatives – example: ammonia production  
      Soft F: process alternatives – example: seawater desalination

Jan 20 M; Martin Luther King Jr B’Day – No Classes Held  
W; Strategy of Process Engineering by D. Rudd/C. Watson, PROJECT 1 ASSIGNED

**PROJECT 1 ASSIGNED Wednesday Jan 22**: Carbon Dioxide Emissions Reductions for semi-Trailer rigs. Maximize ROLSOLO (by yourself)

Soft F: cooling water towers – design and cost

Jan 27 M; show me the money – fundamental effects, CH 6, 7, 8  
W; (Report Writing Chapter 1) PROGRESS MEMO DUE  
      Soft F: process examples p.67 etc  Ch 3

Feb 3 M: heat transfer shell and tube/Reactors size and cost OX, olefins, NH3  CH 14  
      W: Tray Columns – size & cost CH 15  
      Soft F: Materials selection CH 10/Interviews

Feb 10M: Safety Concerns – HAZOP Analysis Ch2  
      W: PROJECT 1 FINAL REPORT DUE, PROJECT 2 ASSIGNED (teams)

**PROJECT 2 ASSIGNED Wed Feb 12**: (DESIGN FOR WATER, ELECTRICITY and the ENVIRONMENT)
Environmental Dream Team

Soft F; Plant Disasters – Examples, Flixborough etc

Feb 17: M: Crystallizers – size and cost (as a reactor kettle) CH13
         W: Centrifugal Pumps – model, size and cost CH 12
         Soft F; Corporate structure, Meetings

Feb 24 M: How to Give an Oral Presentation CH 11
         W: Team Meetings with JRBoss
         F: Team Meetings with JRBoss

Mar 3 M: Team Meetings with JRBoss
         W: Team Meetings with JRBoss
         F: Team Meetings with JRBoss

Mar 10: SPRING BREAK (Break what? Wallets, bones?) or SPRING BRAKE (stop work?)

Mar 17 M: RESEARCH – chem. Labs - chlorination of PVC, sour burp, solar storage
         W: DEVELOPMENT – pilot plants – KZ, KX, solar storage
         Soft F: DESIGN – hydrogen sulfide recovery plant

Mar 24 M: PLANT OPERATION - trouble shooting – POX, control, environment,
         W: PROJECT 2 DUE  Oral presentations start
         F: Oral presentations

Apr 7    M, W, F Oral Presentations

Apr 14   M, W, F Alumni Speakers

Apr 21   M, W, F Oral presentations
**FINAL COURSE GRADE**

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROJECT 1 report</td>
<td>30%</td>
</tr>
<tr>
<td>PROGRESS memos (both)</td>
<td>10%</td>
</tr>
<tr>
<td>PROJECT 2 report</td>
<td>40%</td>
</tr>
<tr>
<td>Homework</td>
<td>10%</td>
</tr>
<tr>
<td>Oral Presentation</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100%</td>
</tr>
</tbody>
</table>

Reports are due on time – late reports will be docked by a-grade-a-day policy

**Academic Integrity (ethics)** - You paid good money to take this design course so you must adhere to the rules of conduct (AIChe ethics based p.13 PTW) in order to achieve the maximum benefit of critical thinking and technical report writing. This course is a prelude to your first job after graduation. Your boss will not tolerate any form of dishonesty and nor will I. In other words, do your own work as required.
Professor Beckman  
BAC 215  
ERC 291  
9:00 – 9:50 AM  
965-4395  
Office Hours 10:00 – 11:00AM M,W,F

**CHE 462:** Process Design. 3 credits. Application of economic principles to optimize equipment selection, sizing and cost(design) of process systems. Prereq. CHE 432, CHE 433, CHE442 and everything else except labs and control courses!

**FORMAT:** I’m your first boss and this is your first job. You will be a design engineer in a company that is contracted by a client needing design assistance.

Think of alternatives  
On the job environment  
Involving group interaction


**REFERENCES:**


Perry, ed, *Chemical Engineers Handbook*, all editions.

**TOPICS BY WEEK:**

<table>
<thead>
<tr>
<th>Week of</th>
<th>Topics</th>
</tr>
</thead>
</table>
| Jan 7   | M; Introduction to Design, Generation of Alternatives (The Physics Exam) CH 1  
         | W; Strategy of Process Engineering by D. Rudd/C. Watson  
         | F; alternatives – Process synthesis CH 3 & 4 example: lets make ammonia |
| Jan 14  | M; show me the money – fundamental $ effects, CH 6, 7.  
         | W; **Project 1 assigned (solo)**, review project 1 2012  
         | s F; alternatives – example: seawater desalination, RO, MEE, MSF, VC, B&T, epsilon, tug |
|         | **PROJECT 1 ASSIGNED Wed Jan 16**: FRACKING – Produced-Water Clean Up |
| Jan 21  | M; **MLK no classes held**  
         | W; Report Writing Chapter 11  
         | s F; Corporate structure, meetings, interviews |
| Jan 28  | M; speaker 1 – Mr. David Burroughs SDC materials corp  
         | W; speaker 2 – Mr. Hank Hamblin SRP Progress Memo 1 due  
         | F; speaker 3 – Ms. Stephanie Archabal ITSI Gilbane |
| Feb 4   | M; speaker 4 – josh brown JACOBS  
         | W; crystallizers CH 15 size and cost, PX plant, MSMPR, R-z, dryers, filter screens  
         | F heat & mass transfer – water cooling tower mass transfer CH 15 |
| Feb 11  | M; tray columns size and cost  
         | W; Project 1 final report due (individual) - Project 2 assigned (teams)  
         | F; speaker 5 - Tammi Westall INTEL |
|         | **PROJECT 2 ASSIGNED Wed Feb 13**: ELECTRICAL, WATER, AND FUELS  
         | PRODUCTION WITH ZERO NET CARBON DIOXIDE EMISSIONS ON PENINSULAS AND ISLANDS |
Feb 18  M; heat transfer reactors, shell and tube size and cost, furnaces CH 14,  
W: materials-selection, pumps and blowers CH 10,12  
s  F: (how to give an oral presentation CH 11) 

Feb 25  M; RESEARCH – chem. Labs - chlorination of PVC, sour burp  
W; DEVELOPMENT – pilot plants – KZ, KX, solar storage  
s  F; plant disaster examples – safety – calculations

Mar 4  M; DESIGN – hydrogen sulfide recovery plant, solar one night heat exchangers  
W; PLANT OPERATION -trouble shooting – POX, control, environment, safety, ic4  
  Progress Memo 2 due  
s  F: project assistance in class

Mar 11  SPRING BREAK ( Break what? Wallets, bones?) or SPRING BRAKE (stop work?)
Mar 18  M, W, F Group Design Review Meetings with JRB

Mar 25  M, W, F Group Design Review Meetings with JRB

Apr 1   M: PROJECT 2 DUE Oral Presentations Begin:
        W, Oral presentations
        F: Oral presentations

Apr 8   M, W, F? Oral presentations continue

Apr 15  M, W, F? Oral presentations continue

Apr 22  M, W, F? Oral presentations continue

Apr 29  M; Oral presentations, final discussions
        (class meetings end when all presentations are finished)

        Course Grade
        PROJECT 1 report 40%
        PROGRESS memos (both) 20%
        PROJECT 2 report 30%
        Oral Presentation 10%
        100%

C4 and C-3
C4 and C-3
C-3

Reports are due on time – late reports will be docked by a-grade-a-day policy

Academic Integrity (ethics)- You paid good money to take this design course so you must adhere to the rules of conduct (AIChE ethics based p.13 PTW) in order to achieve the maximum benefit of critical thinking and technical report writing. This course is a prelude to your first job after graduation. Your boss will not tolerate any form of dishonesty and nor will I. In other words, do your own work as required.
ARIZONA STATE UNIVERSITY
CHEMICAL ENGINEERING PROGRAM
CHE 462
PROJECT 1 – INDIVIDUAL EFFORT & REPORT

VIPER Corp

TO: CHE 462 WORLD CLASS DESIGN ENGINEERS

FROM: J.R. Boss, Vice Pres, R&D, VIPER Corp

DATE: 1/22/14

SUBJECT: DESIGN FOR REDUCED SEMI-TRACTOR TRAILER VEHICLE EMISSIONS

In 1997 an international meeting was held in Kyoto, Japan and 2012 in Doha, Bahrain to discuss the Global Warming trends (climate change) and remediation policies to curb carbon dioxide emissions. The climate change in global rising temperatures has also shifted the weather patterns throughout the world. A shift from conventional fuels to natural gas will significantly reduce carbon dioxide emissions. As an example, switching from diesel or gasoline to methane in transportation vehicles would reduce emissions by 25% for the same miles driven. Motor vehicles produce about 14% of the world carbon dioxide emissions so our attention will focus on CO2 emissions reduction in semi trailers.

We at Vehicle Improved Performance Engineering Retrofitters Corp (VIPER) have been contracted by Reduced Emissions for diesel Semi Trailers LLC (REST LLC) to explore possibilities of reduced carbon dioxide emissions per mile. The only possibility that can not be investigated is storing braking energy into electrical storage (already on the market). Take as a basis, 150,000 miles/year driven. Also you can take carbon dioxide emissions reduction at $0.50/100MJ as a carbon credit.

You will work alone to explore the business venture details to be proposed by VIPER Corp to REST LLC which will reduce emissions in semi trailers. The project objective is to maximize incremental ROI. If needed, you can use a money borrowing rate of 5.4% with an equipment life of 17.4 years. This solo effort by 80 engineers will assure VIPER Corp of multitude design outcomes for future proposal consideration.

Your individual final design report must be on my desk (brought to class) by 9:00 AM Wednesday February 12, 2014.

Also, there will be a progress report due on Wednesday January 29 so as to help assure a strong steady pace of your dedicated participation.
Chemical Engineering
CHE 462
ASU 2/12/14
FIRST REPORT GRADING SHEET

TECHNICAL EXPERTISE: 10 pts each = 50%

1. Identify contracting company of VIPER Corp.

2. Show that you followed the objective function.

3. Show that you can design a reasonable workable system.

4. Demonstrate life-long learning (WEB SITE references).

5. Solve problems involving contemporary issues (show evidence, news releases)

GRAMMAR 50% (spelling, sentence structure, technical writing guidelines, memo format)
ARIZONA STATE UNIVERSITY
CHEMICAL ENGINEERING PROGRAM
CHE 462
PROJECT 2 – Team Effort
Individual reports combine to form the team report
WEEP Inc

TO: CHE 462 CRÈME DE LA CRÈME DESIGN ENGINEERS

FROM: J. R. Boss, Board Chair, President and CEO, WEEP Inc

DATE: 2/12/14

SUBJECT: DESIGN FOR WATER, ELECTRICITY and ENVIRONMENT CONCERNS

The CaliZona Research Academy Partners has contracted with us here at WATER ENERGY and ENVIRONMENTAL PROCESSING Inc (WEEP Inc) to explore the economic feasibility (Maximize Return on Investment) of improving the environment in California and Arizona. Projects of particular interest include:

1. Reduction of water consumption/kWh in Arizona electrical power generating stations
   - How much water is consumed per kWh?
   - Where in the plant is the water used (consumed or discharged)?
   - Water constant but increase electrical generation?
   - Select your piece of the project pie

2. Reduction of salt content in the Salton Sea
   - Salt is over 4.5wt% - reduce to ocean salinity
   - What to do with the salt? Haul away? Sell? Bury?
   - Rate of cleaning?
   - Select your piece of the project pie

3. Supplying potable water from the Sea of Cortez to Phoenix
   - Desalinate the ocean?
   - Pipe transport? Canal flow?
   - Tucson deal/exchange?
   - Select your piece of the project pie

4. Harvest methane clathrates from the West coast continental shelf- make electricity and supply dry 1000psi methane gas to California
   - Clathrates/hydrates? Guest molecule?
   - No carbon dioxide emissions. Sequester methods?
   - Select your piece of the project pie

5. Turning landfill garbage into electricity and methane
   - Pressure?
   - Dehydrate methane?
   - Compress to 1000psi?
Various resources are available for your consideration. Resources include but are not limited to solar, wind, waves, tidal action, ocean water, ocean depth, ocean chemical components, land elevation and so forth. Electrical sales can be made locally at US$ 0.15/kWh. Water values are set at $4.00/1000 gallons (US$ 1.00/cuM) and methane can be sold at $0.50/therm. Equipment purchases will be based on PTW design text unless otherwise agreed to by JRBoss. Land cost needed for the plant site will be locally valued. Calculations must include amortized equipment and land costs. You can use a money borrowing rate of 4.5% with an equipment life of 23 years.

Find news releases concerning your topic. The articles will establish a keen interest in and a need for this most exciting project!

You will assemble into teams of four members and start your brain storming NOW. Having 21 teams will help assure that WEEP Inc. can deliver to CaliZona many possible choices for the future consideration. Today:

- give me a memorandum (all team members names and name of the team).
- Receive your team assignment from JR Boss)
- Give me a memo that reflects your initial brain storming. Also give insight into how the team will divide up individual responsibilities in solving the open ended design problem. Note that there will be some grading as a team but you will be mainly graded individually on your section of (contribution to) the project.

Your final design report must be on my desk by 9:00 AM Monday March 31, 2014. Also, there will be a progress report due on Monday February 24 to help assure an active start and a strong steady pace of your dedicated participation.
TECHNICAL EXPRESSION: 5 pts each = 50%

1. Can function on multidisciplinary teams (che4.1) (state team interaction)

2. Have knowledge of ethics & professionalism (che 4.4) (a brief paragraph how you did your own work and note others help)

3. Understand impact of solution on society(che 4.3) (your work)

4. Demonstrate life-long learning (WEB references) (che 5.1)

5. Have knowledge of contemporary issues(show evidence, news releases of water, electricity and/or fuels needs). (che 4.4)

6. Can design, analyze, and control processes (8) (detailed calculations in appendix)

7. Can follow the objective function (max ROI)

8. Copies of all Oral Presentation slides

9. Perform HAZOP analysis on one process entity

10. Team name and team members

GRAMMAR & TECHNICAL DETAILS 50% (spelling, sentence structure, memo format, clarity, knowledgeable, accuracy)
Outlines, summaries, figures, tables

5. Visual aids effectiveness
Audience eye contact
Speech volume and speed
Articulation/Vocabulary

4. Speaking effectiveness
Explanation, answers to questions

3. Knowledge of topic
Key results, significance

2. Presentation of results
What was done, why and how

1. Clarity of text and approach

STUDENT
CHE 462 ORAL GRADING SHEET 2014

STUDENT
CHE 462 ORAL GRADING SHEET 2014
ARIZONA STATE UNIVERSITY
CHEMICAL ENGINEERING PROGRAM
CHE-462
PROJECT 1 – INDIVIDUAL EFFORT & REPORT

L’Eau Co.

TO: CHE 462 WORLD CLASS DESIGN ENGINEERS

FROM: J.R. Boss, Vice Pres, R&D, L’Eau Co.

DATE: 1/16/13

SUBJECT: DESIGN FOR PRODUCED WATER RECLAMATION

In 1997 an international meeting was held in Kyoto, Japan and 2012 in Doha, Bahrain to discuss the Global Warming trends and remediation policies to curb carbon dioxide emissions. The climate change in global rising temperatures has also shifted the weather patterns throughout the world. A shift from conventional fuels to natural gas will significantly reduce carbon dioxide emissions. As examples, switching from gasoline to methane in transportation vehicles would reduce emissions by 25% for the same miles driven. Switching from coal to methane in electric power generating plants would save over 50% of carbon dioxide emissions while producing the same amount of electricity.

The newly tapped methane resource has been identified in underground shale formations throughout the United States. The method for mining the natural gas is called hydraulic fracturing or fracking. However, fracking is accompanied by water pollution issues.

The Fracking American Natural Gas Inc (FANG Inc) currently produces methane with 100,000 gallons/day of produced water which costs $0.13/gallon to be hauled away. The produced water essentially contains 6wt% sodium chloride, 1wt% ethanol, and 1.3wt% acetic acid. We at L’Eau Co. are proposing to take care of the FANG Inc water problem for them at our cost to them of $0.06/gallon thereby saving FANG Inc almost $3 million/year.

You will work alone to explore the business venture details to be proposed by L’Eau Co. which will reduce the amount of produced water that must be disposed of at $0.13/gallon. Potable water made in this venture can be sold at $2/1000 gallons and organics must be disposed of or sold as a by-product(s). The project objective is to maximize ROI. Use a money borrowing rate of 5.4% with an equipment life of 17.4 years. The solo effort will assure L’Eau Co. of multitude design outcomes for proposal consideration.

Your individual final design report must be on my desk by 9:00 AM Wednesday February 13, 2013. Also, there will be a progress report due on Wednesday January 30 so as to help assure a strong steady pace of your dedicated participation.
Chemical Engineering
CHE 462
ASU 2/13/13
FIRST REPORT GRADING SHEET

TECHNICAL EXPERTISE: 10 pts each = 50%

1. Identify contracting company of L’Eau Co.

2. Show that you followed the objective function

3. Show that you can design a reasonable workable process

4. Demonstrate life-long learning (WEB SITE references)

5. Solve problems involving contemporary issues(show evidence, news releases)

GRAMMAR 50% (spelling, sentence structure, technical writing guidelines, memo format)
ARIZONA STATE UNIVERSITY
CHEMICAL ENGINEERING PROGRAM
CHE.462
PROJECT 2 – Team Effort
Individual reports combine to form the team report
GRIPE Inc

TO: CHE 462 CRÈME DE LA CRÈME DESIGN ENGINEERS

FROM: J. R. Boss, Board Chair, President and CEO, GRIPE Inc

DATE: 2/13/13

SUBJECT: DESIGN FOR CARBON DIOXIDE-FREE UTILITIES

The Peninsula And Island Necessities LLC (PAIN LLC) has contracted with us here at Grass Roots International Process Engineering Corp (GRIPE Inc) to explore the economic feasibility (Maximize Return on Investment) of producing electricity (24 hr/day), liquid fuel, gaseous fuel and potable water with no carbon dioxide emissions. PAIN LLC is particularly interested in the island and peninsula regions throughout the world. The electrical generating station will be sized as a net 10MWe facility for 24 hours operation. Water will be produced at a rate of 5000 BBL/day. Liquid fuel regulations require 100BBBL/day or Gaseous fuels demand is 10,000 SCF/day.

You are to select a specific site for the combined facility on an assigned peninsula or island. Various resources are available for your consideration. Resources include but are not limited to solar, wind, waves, tidal action, ocean water, ocean depth, ocean chemical components, land elevation and so forth. Electrical sales can be made locally at US$ 0.13/kWh. Water sales are set at $3.00/1000 gallons (US$ 0.75/cuM). Equipment purchases will be based on PTW design text unless otherwise agreed to by JRBo. Land cost needed for the plant site will be locally valued. Calculations must include amortized equipment and land costs. Use a money borrowing rate of 4.5% with an equipment life of 23 years.

Find news releases concerning the world wide water, gaseous fuels, liquid fuels and electrical needs and shortages. The articles will establish a keen interest in and a need for this most exciting project!

You will assemble into teams of four members and start your brain storming NOW. Having 19 teams will help assure that GRIPE Inc. can deliver to PAIN LLC many possible choices for the future plant facility. Today, give me a memorandum (all team members names and name of the team) that reflects your initial brain storming. Also give insight into how the team will divide up individual responsibilities in solving the
open ended design problem. Note that there will be some grading as a team but you will be mainly graded individually on your section of (contribution to) the project.

Your final design report must be on my desk by 9:00 AM Monday April 1, 2013. Also, there will be a progress report due on Monday March 4 to help assure an active start and a strong steady pace of your dedicated participation.
Chemical Engineering
CHE 462
ASU 4/1/13
SECOND REPORT GRADING SHEET

TECHNICAL EXPRESSION: 5 pts each = 50%

1. Can function on multidisciplinary teams (che4.1) (state team interaction)

2. Have knowledge of ethics & professionalism (che 4.4) (a brief paragraph how you did your own work and note others help)

3. Understand impact of solution on society(che 4.3) (your work)

4. Demonstrate life-long learning (WEB references) (che 5.1)

5. Have knowledge of contemporary issues(show evidence, news releases of water, electricity and/or fuels needs). (che 4.4)

6. Can design, analyze, and control processes (8) (detailed calculations in appendix)

7. Can follow the objective function (max ROI)

8. Copies of all Oral Presentation slides

9. Perform HAZOP analysis on one process entity

10. Team name and team members

GRAMMAR &TECHNICAL DETAILS 50% (spelling, sentence structure, memo format, clarity, knowledgeable, accuracy)
Outlines, summary, figures, tables
5. Visual aids effectiveness
Audience eye contact
Speech volume and speed
Articulation/vocabulary
4. Speaking effectiveness
Explanation answers to questions
3. Knowledge of topic
Key results, significance
Presentation of results
2. What was done, why and how
1. Clarity of text and approach

STUDENT
CHE 462 ORAL GRADING SHEET

STUDENT
CHE 462 ORAL GRADING SHEET
Lenore Dai

From: James Beckman
Sent: Friday, January 09, 2015 8:57 AM
To: Lenore Dai
Subject: RE: General Studies Courses Losing Designations AND Major Maps

yes. the first report is graded by ME and returned to the class within a week - well ahead of the second report due date.

jim

---

From: Lenore Dai
Sent: Thursday, January 08, 2015 4:32 PM
To: James Beckman
Subject: RE: General Studies Courses Losing Designations AND Major Maps

Wonderful and thank you so much! Would it be possible to me to say something like that the first project report was graded and returned to the students prior to the submission of the second project report? Thanks again!!!
Plant Design and Economics for Chemical Engineers

Fifth Edition

Max S. Peters
Klaus D. Timmerhaus
Ronald E. West
University of Colorado
CONTENTS

Preface xv
Prologue xix

CHAPTER 1

Introduction 1
Chemical Engineering Plant Design 1
General Overall Design Considerations 2
  Process Design Development 2
  Flowsheet Development 5
  Computer-Aided Design 6
  Cost Estimation 6
  Profitability Analysis of Investments 7
  Optimum Design 8
Practical Considerations in Design 11
  The Design Approach 12
Engineering Ethics in Design 13

CHAPTER 2

General Design Considerations 15
Health and Safety Hazards 15
  Sources of Exposure 16
  Exposure Evaluation 18
  Control of Exposure Hazards 20
  Fire and Explosion Hazards 22
  Personnel Safety 27
  Safety Regulations 27
Loss Prevention 29
  HAZOP Study 29
  Fault-tree Analysis 35
  Failure Mode and Effect Analysis 36
  Safety Indexes 36
  Safety Audits 36
Environmental Protection 40
  Environmental Regulations 41
  Development of a Pollution Control System 42
  Air Pollution Abatement 42
  Water Pollution Abatement 47
  Solid Waste Disposal 50
  Thermal Pollution Control 51
  Noise Control 52
Plant Location 52
  Factors Involved 53
  Selection of the Plant Site 56
Plant Layout 56
  Preparation of the Layout 57
Plant Operation and Control 57
  Instrumentation 57
  Maintenance 58
  Utilities 59
  Structural Design 60
  Storage 60
  Materials Handling 61
Patent Considerations 62
  Problems 62

CHAPTER 3

Process Design Development 67
Development of Design Database 67
  Literature Survey 68
  Patent Search 69
Process Creation 69
  Batch Versus Continuous Operation 70
  Raw Materials and Product Specifications 70
  Process Synthesis Steps 71
Process Design 72
  Types of Process Designs 74
Process Flow Diagrams 77
Piping and Instrumentation Diagrams 79
Contents

Vessel and Piping Layout Isometrics 80
Equipment Design and Specifications 81
  Scale-up of Equipment in Design 81
  Safety Factors 81
  Equipment Specifications 84
  Materials of Construction 86
The Preliminary Design—A Specific Example 87
  Problem Statement 87
  Literature Survey 87
  Process Creation 88
  Development of Conventional Base-Case Design 90
  Economic Assessment of Base-Case Design 110
  Assessment of Proposed Base-Case Design Modification 113
Summary 120
Problems 121

CHAPTER 4
Flowsheet Synthesis and Development 125
Flowsheet Synthesis and Development 126
  General Procedure 126
Process Information 130
  Background Information 130
  Molecular Path Synthesis 131
  Selecting a Process Pathway 132
  Production Mode 132
  Recording Decisions 133
Input/Output Structure 135
Functions Diagram 137
  Preprocessing 138
  Reactions 139
  Recycle 139
  By-products, Intermediates, and Wastes 139
  Separations 140
Operations Diagram 143
  Preprocessing 143
  Reactors 143
  Separations Methods 144
  Heating and Cooling 145
  Minimization of Processing 145
Process Flowsheet 149
  Reactors 149
  Mass and Energy Balances 149
  Separation Trains 149
  Heat Exchange 150
Algorithmic Flowsheet Generation 158
  Fundamentals of Algorithmic Process-Network Synthesis 159
  Application of Algorithmic Process-Network Synthesis 165
Comparison of Hierarchical and Algorithmic Results 189
Genetic Algorithms 189
Future Approaches to Flowsheet Synthesis and Development 190
Software Use in Flowsheet Synthesis 190
Analysis and Evaluation of Flowsheets 193
  Criteria for Evaluating Designs 190
Summary 192
Nomenclature 192
  Greek Symbol 193
Problems 193

CHAPTER 5
Software Use in Process Design 196
Software Structure 198
  Chemical Property Estimation 198
  Process Equipment Models 201
  Process Equipment Cost Estimation 202
  Process Economic Evaluation 203
  Heat Integration 203
  Process Control 203
  Process Optimization 204
Software Capabilities 204
  General-Type Software 205
Software for Process Design 208
  Molecular Reaction Databases and Simulators 208
  Chemical Cost Databases 209
  Flowsheeting Software 209
  Unit Operations Simulators 211
CHAPTER 6
Analysis of Cost Estimation 226

Cash Flow for Industrial Operations 226
Cash Flow 226
Cumulative Cash Position 228
Factors Affecting Investment and
Production Costs 230
Sources of Equipment 230
Price Fluctuations 230
Company Policies 230
Operating Time and Rate of Production 231
Government Policies 232
Capital Investment 232
Fixed-Capital Investment 233
Working Capital 233
Estimation of Capital Investment 233
Types of Capital Cost Estimates 235
Cost Indexes 236
Cost Components in Capital Investment 239
Purchased Equipment 241
Estimating Equipment Costs by Scaling 242
Purchased-Equipment Delivery 244
Purchased-Equipment Installation 244
Instrumentation and Controls 245
Piping 245
Electrical Systems 246
Buildings 246

CHAPTER 7
Interest, Time Value of Money,
Taxes, and Fixed Charges 279

Interest 279
Simple Interest 280
Compound Interest 280
Nominal and Effective Interest Rates 281
Continuous Interest 283
Cost of Capital 285
Income Tax Effects 286
Loan Payments 287
Time Value of Money 290
Cash Flow Patterns 292
Discrete Cash Flows 292
Continuous Cash Flows 294
Compounding and Discounting Factors 297
Contents

Income Taxes 303
  Federal Income Taxes 304
  Taxable Income 304
  Capital Gains Tax 305
  Losses 306
  Other Federal Taxes 306
  State Taxes 306
  Nonincome Taxes 306

Fixed Charges 307
  Depreciation 307
  Depreciation and Income Tax 308
  Depreciable Investments 309
  Current Value 309
  Salvage Value 309
  Recovery Period 309
  Methods for Calculating Depreciation 310
  Insurance 313
  Self-insurance 314

Nomenclature 315
  Greek Symbol 316
  Problems 316

CHAPTER 8
Profitability, Alternative Investments, and Replacements 319

Profitability Standards 320
  Cost of Capital 320
  Minimum Acceptable Rate of Return 321

Methods for Calculating Profitability 322
  Methods That Do Not Consider the Time Value of Money 322
  Methods That Consider the Time Value of Money 327
  Selecting a Profitability Method 330
  Effect of Inflation on Profitability Analysis 335
  Start-up Costs 340
  Spreadsheet for Economic Evaluation Calculations 340

Alternative Investments 340
  Analysis When an Investment Must Be Made 342
  Analysis with Small Investment Increments 346

Replacements 348
  Methods of Profitability Evaluation for Replacements 349
  Typical Example of Replacement Policy 349
  Book Values and Unamortized Values 350
  Investment on Which the Replacement Comparison Is Based 350

Practical Factors in Alternative-Investment and Replacement Analysis 352
  Nomenclature 352
  Greek Symbol 353
  Problems 353

CHAPTER 9
Optimum Design and Design Strategy 358

Defining the Optimization Problem 359
  Selecting an Objective Function 361
  Structural Optimization 361
  Parametric Optimization 362
  Variable Screening and Selection 363

Suboptimization 363
  Practical and Intangible Considerations 364
  Programming Optimization Problems 364
  Linear Programming 367
  Generalization of Strategies for Linear Programming 370
  Simultaneous Equations 372
  Nonlinear Programming 373
  Dynamic Programming 377

Optimization Solution Methodologies 379
  Procedure with One Variable 380
  Procedure with Two or More Variables 381
  Break-even Chart for Optimum Analysis of Production 384
  Experimental Design and Analysis of Process Simulations 384
  Algorithm Solutions to Optimization Problems 385

Optimization Applications 390
  Optimization Application: Optimum Production Rates in Plant Operation 390
  Optimization Application: Cyclic Operations 394
CHAPTER 10
Materials and Fabrication Selection 440
Factors Contributing to Corrosion 440
Combating Corrosion 443
Properties of Materials 444
Ferrous Metals and Alloys 444
Nonferrous Metals and Alloys 450
Inorganic Nonmetals 451
Organic Nonmetals 452
Low- and High-Temperature Materials 455
Gasket Materials 457
Tabulated Data for Selecting Materials of Construction 457
Selection of Materials 457
Economics Involved in Selection 464
Fabrication of Equipment 465
Methods of Fabrication 466
Problems 467

CHAPTER 11
Written and Oral Design Reports 469
Written Reports 470
Organization of a Written Report 470
Preparing the Report 473
Presenting the Results 474
Comments on Common Errors 480
Checklist for the Final Report 481
Oral Reports 481
Organization and Presentation of an Oral Design Report 482
Problems 484

CHAPTER 12
Materials-Handling Equipment—Design and Costs 485
Basic Concepts of Fluid Transport 485
Newtonian Fluids 486
Non-Newtonian and Bingham Fluids 488
Vacuum Flow 489
Frictional Losses Encountered in Pipelines 491
Power Requirements for Transport of Liquids and Gases 492
Piping in Fluid Transport Processes 497
Selection of Piping Materials 497
Design of Piping Systems 499
Costs for Piping and Piping System Auxiliaries 502
Pumping of Fluids 508
Selection of Pumps 508
Design Procedures for Pumps 515
Costs for Pumps and Motors 516
Compression and Expansion of Fluids 520
Selection of Compressors 520
Selection of Fans and Blowers 523
Selection of Vacuum System Equipment 524
Selection of Turbines, Expanders, and Other Drivers 525
Design Procedures for Compressors 527
Design Procedures for Turbines and Expanders 529
Costs for Compressors, Fans, Blowers, and Expanders 531
Agitation and Mixing of Fluids 536
Selection of Agitators and Mixers 536
Design Procedures for Agitators and Mixers 539
Costs for Agitators and Mixers 544
Flow Measurement of Fluids 549
### Contents

Storage and Containment of Fluids 552
- Design Procedures for Pressure Vessels 553
- Costs for Tanks, Pressure Vessels, and Storage Equipment 553

Transport of Solids 560
- Selection of Solids Transport Equipment 561
- General Design Procedures for Solids Transport Equipment 565
- Costs for Solids Transport Equipment 572

Handling of Solids 572
- Selection of Solids-Handling Equipment 577
- General Design Procedures for Solids-Handling Equipment 580
- Costs for Solids-Handling Equipment 582

Nomenclature 587
- Greek Symbols 589
- Problems 589

**Chapter 13**

**Reactor Equipment—Design and Costs** 592

**Reactor Principles** 594
- Reactor Types 596
- Space Velocity and Space Time 597
- Batch Reactors 597
- Tubular Plug-Flow Reactors 598
- Back-Mix Reactors 599
- Nonideality of Reactors 599
- Accounting for Reactor Nonideality 600
- Residence Time Distribution 600
- Nonideal Reactor Simulation Using Ideal Reactor Combinations 601
- Recycle Reactors 602

Development of Chemical Reaction Rate Expressions 605
- Types of Reactions 606

Reaction and Reactor Performance 613
- Parallel Reactions 613
- Series Reactions 614
- Systems of Identical Multiple Reactors 614

Reactor and Catalyst Equipment 616
- Selection of Catalyst 616
- Types of Reactors 617
- Selection of Reactors 621
- Design of Reactor Systems 622
- Reactor Design Procedure 626
- Software 626
- Costs for Reactor Equipment 627

Summary 634

Nomenclature 635
- Greek Symbols 636

Problems 637

**Chapter 14**

**Heat-Transfer Equipment—Design and Costs** 642

- Basic Theory of Heat Transfer in Exchangers 643
- Steady-State Heat-Transfer Considerations 644
- Alternative Approaches to Heat Exchanger Performance 652

Determination of Heat-Transfer Coefficients 656
- Film Coefficients for Fluids Flowing Inside of Pipes and Tubes (No Phase Change) 657
- Film Coefficients for Fluids Flowing Outside of Pipes and Tubes (No Phase Change) 659
- Film Coefficients and Overall Coefficients for Various Heat-Transfer Situations 661

Determination of Pressure Drop in Heat Exchangers 664
- Tube-Side Pressure Drop 664
- Shell-Side Pressure Drop 665

Selection of Heat Exchanger Type 669
- Key Heat Exchanger Types Available 670
- Preliminary Selection of Heat Exchanger Types 676
- Costs of Heat Exchangers 676

Design of Key Heat Exchanger Types 694
- Double-Pipe and Multiple Double-Pipe Exchangers 696
- Shell-and-Tube Exchangers 702
APPENDIX A:
The International System (SI) of Units  877

APPENDIX B:
Auxiliary, Utility, and Instrumentation Cost Data  890

APPENDIX C:
Design Problems  899

APPENDIX D:
Tables of Physical Properties and Constants  947

APPENDIX E:
Heuristics for Process Equipment Design  966

APPENDIX F:
Software Useful for Design  977

Author Index  976
Subject Index  979
Because applied economics and plant design deal with practical applications of chemical engineering principles, a study of these subjects offers an ideal way for tying together the entire field of chemical engineering. The final result of a plant design may be expressed in dollars and cents, but this result can only be achieved through the application of various theoretical principles combined with industrial and practical knowledge. Both theory and practice are emphasized in this book, and aspects of all phases of chemical engineering are included.

The authors are indebted to the many industrial firms and individuals who have supplied information and comments on the material presented in this edition. The authors also express their appreciation to the following reviewers who have supplied constructive criticism and helpful suggestions on the presentation for this edition: Luke Achenie, University of Connecticut; Charles H. Barron, Clemson University; James R. Beckman, Arizona State University; David C. Brown, University of Idaho; Stenmar C. H. M. C. J. H. M. Cuypers, Carnegie Mellon University; Marianthi Ierapetritou, Rutgers University; Jan A. K. van Houtte, South Dakota School of Mines and Technology; Johannes Schwank, University of Michigan; Thomas L. Sweeney, Ohio State University; Eric J. Thogerson, Northeastern University; and Bruce Vrana, Dupont Engineering Technology.

Acknowledgment is made to Barr Halevi, HBarr, Inc., for his many contributions to the text and his preparation of Chap. 5 and much of Chap. 13. Special thanks are also expressed to L. T. Fan, Kansas State University, and F. Friedler, Veszprem University, for their preparation of the “Algorithmic Flowsheet Generation” section in Chap. 4. The assistance in typing of the manuscript by Cynthia Ocken, CSLR University of Colorado, and Ellen Romig, chemical engineering department, University of Colorado, is greatly appreciated.

Max S. Peters
Klaus D. Timmerhaus
Ronald E. West