CN4123 Design Project

(2016-17)

Production of Olefins from Methanol

Outline

- Process Design
- Objectives & Outcomes
- Design Brief
- Organization & Resources
- Schedule
- Deadlines, Deliverables & Assessment
- Reports & Their Scope
- Challenges and Communications
- Suggested Schedule
- Questions & Answers

Process Design

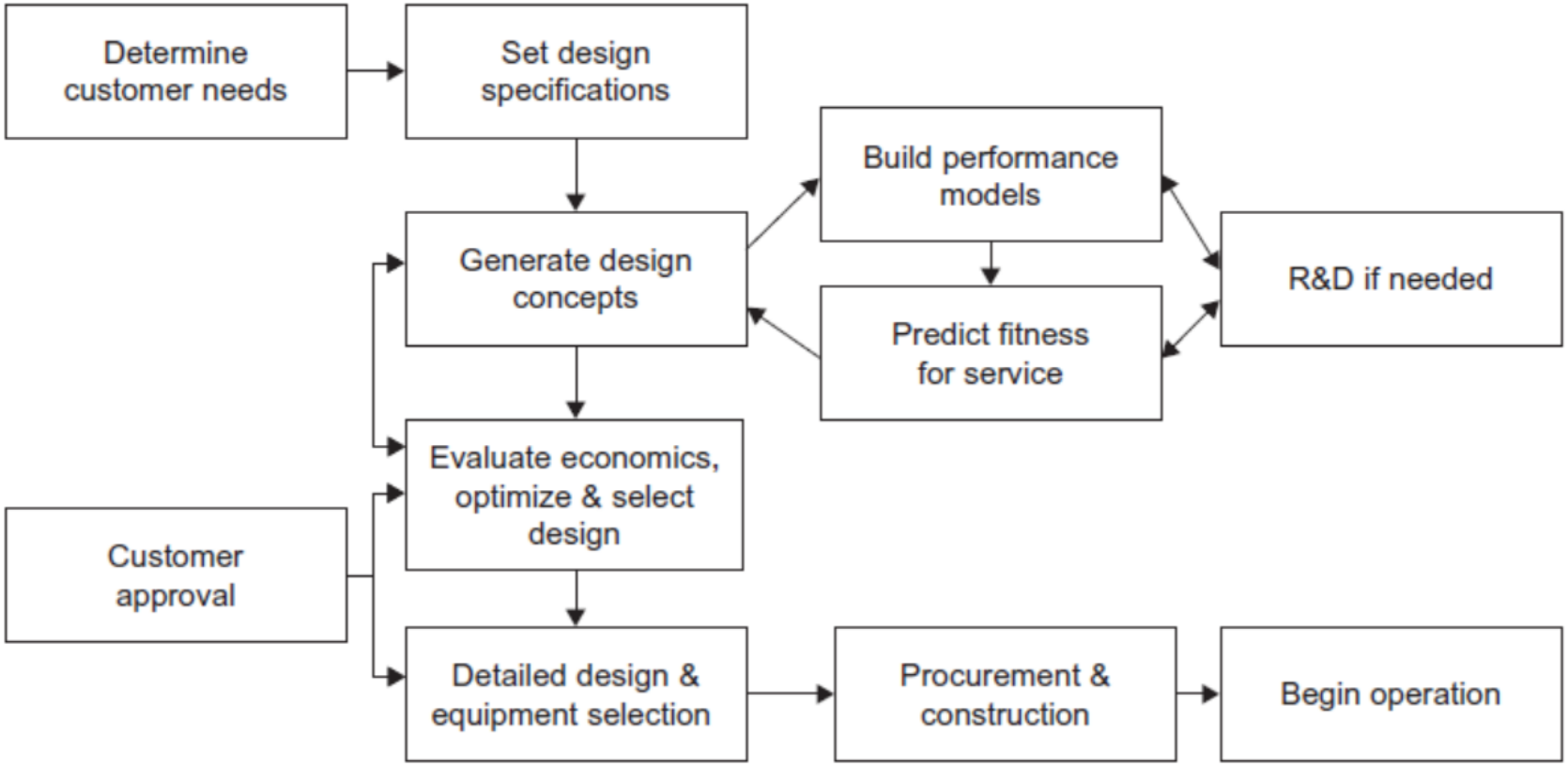
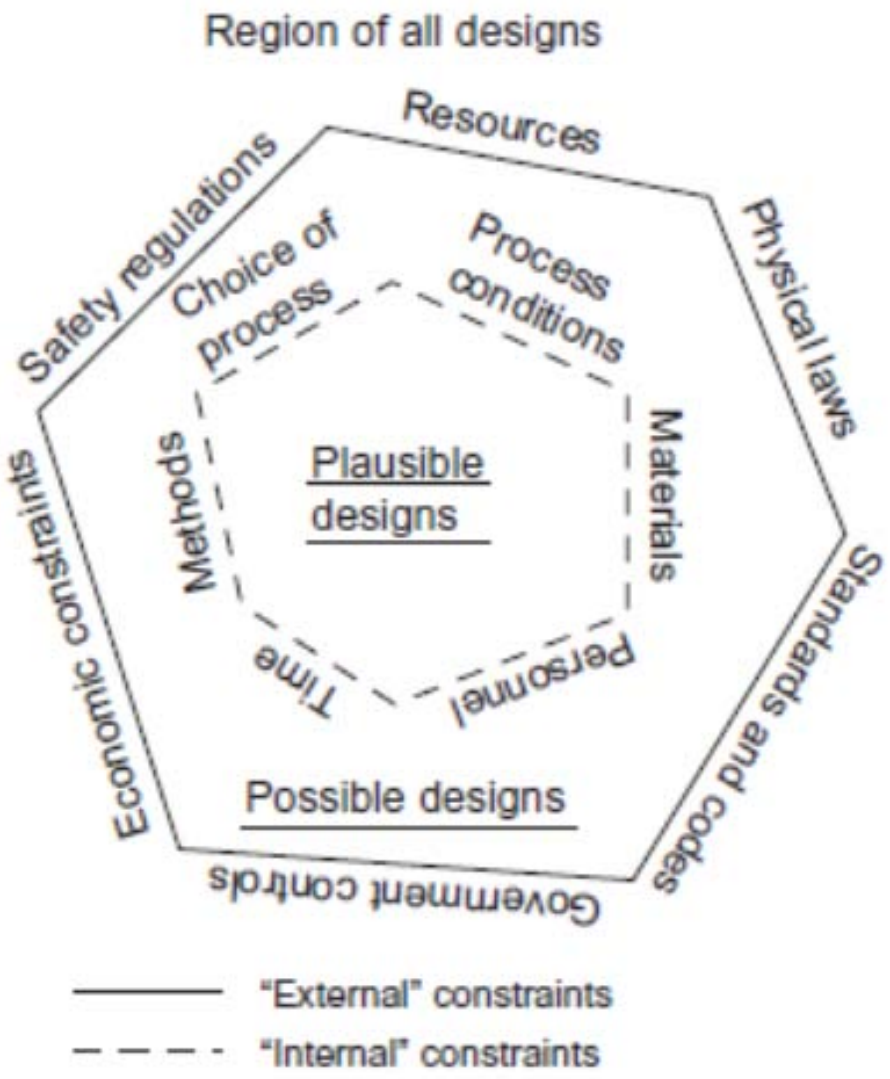


FIGURE 1.2

The design process.

Towler, G., and Sinnott, R., "Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design", Second Edition, Butterworth-Heinemann, Oxford, 2013 (TP155 Tow 2013).

Constraints in Process Design



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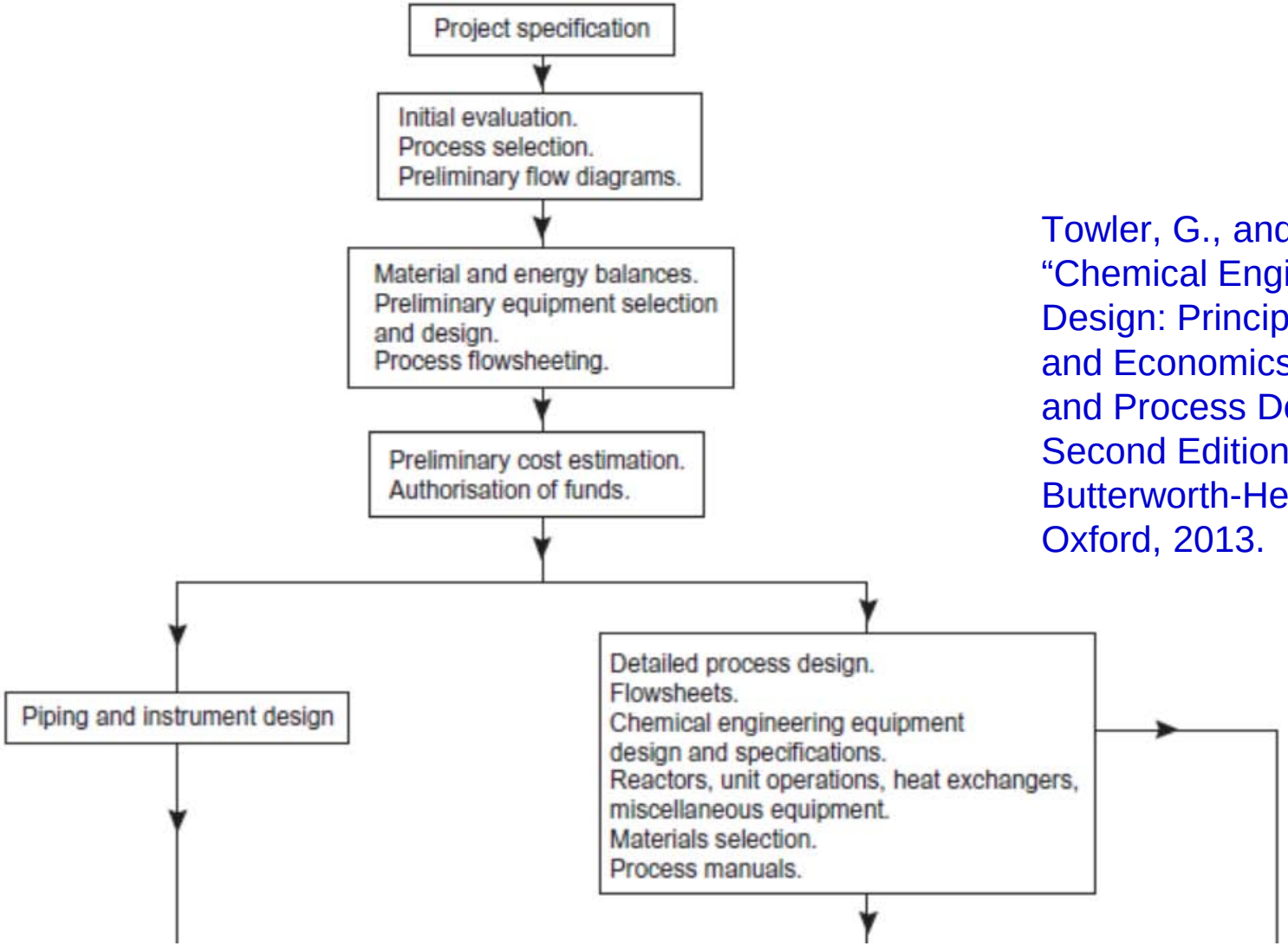
Steps in Process Design



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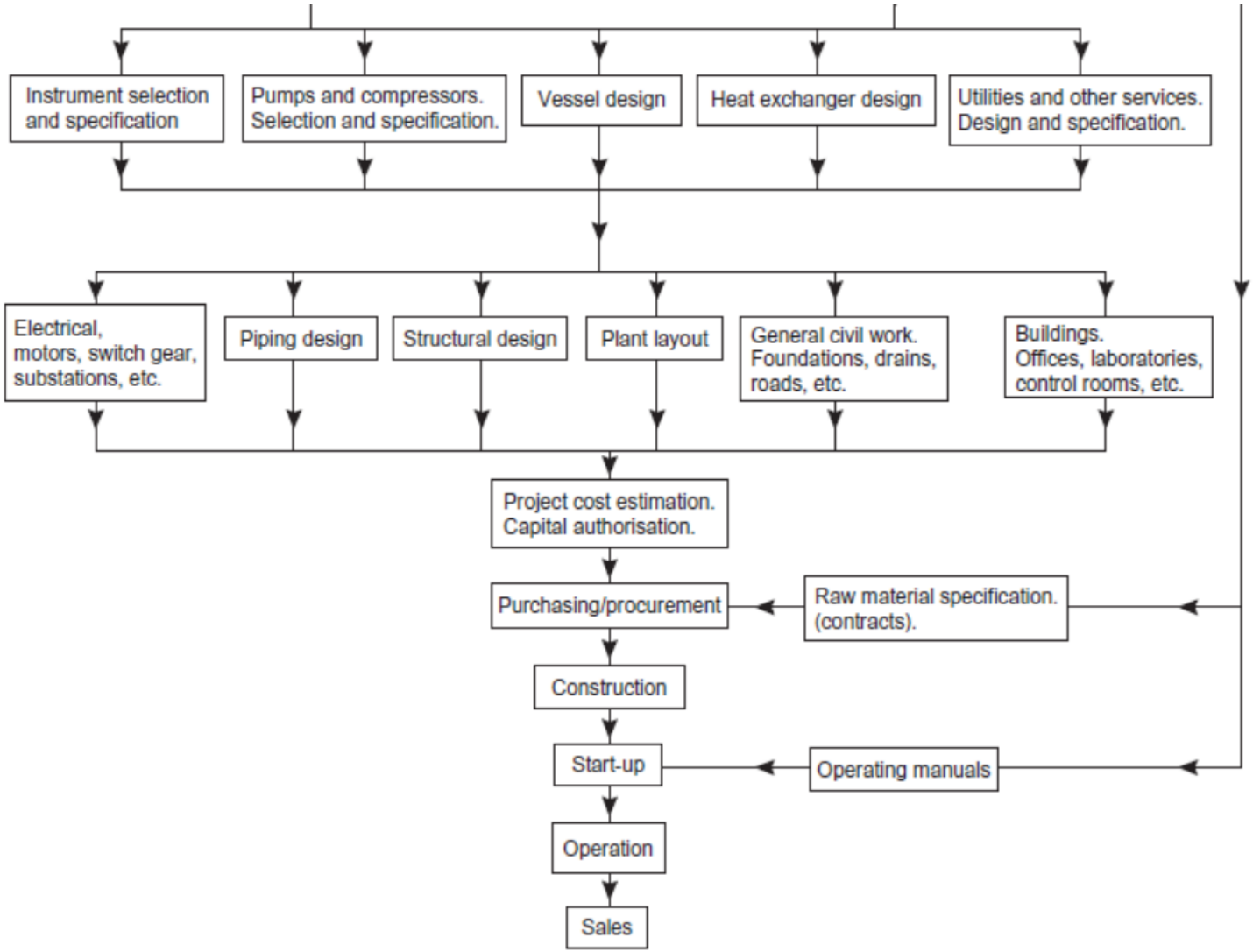
Steps in Process Design



Objectives & Outcomes

- Contributing individually, and also to the Team
- Independent Study/Learning
- Solving an open-ended design project similar to that encountered in industrial situations
- Application of fundamental chemical engineering principles and available data
- Consider process alternatives, perform simulations, sizing, HAZOP and safety analyses, and assess profitability
- Making critical design decisions in a safe, creative, critical and cost-effective manner
- Effective communication and report writing

Objectives & Outcomes

On completion of this module, students will be able to:

1. Work effectively in a team to develop a process with all members contributing individually as well as collectively with proper communication and coordination;
2. Apply chemical engineering principles and available data;
3. Make design decisions in a safe, creative, critical and cost-effective manner;
4. Design a process section in detail;
5. Present the work in formal oral and written reports.

Design Brief

Design a MTO Plant to Produce

Olefins (ethene and propene) from Methanol using a Solid Catalyst

- **Plant Capacity of 800,000, 1000,000, 1200,000 or 1400,000 tonne/year**
- **Methanol Purity of 99.6 or 99.85 wt %**
- **C_2H_4 Purity of 98.5, 99.9 wt %; C_3H_6 Purity of 94.0, 96.0 or 99.5 wt %; C_4H_8 Purity of 99.0 wt %**
- Seven Sections: (1) Reactor, (2) Water Removal, (3) De-C_1, (4) De-C_2, (5) De-C_3, (6) De-C_4 and (7) Heat Integration

Organization

- Teams of **SEVEN** students
  - Number of teams ~ 40
  - Variation in plant capacity and product purities
- Each team must have a Team Leader
- Each team member will design one of the sections

- Team & Individual Contributions
  - Each team will make a ***collective*** contribution and each team member will make an ***individual*** contribution
- Enroll by **Jan 16** via IVLE's project facility

Organization: Signing up on IVLE

- To sign up in IVLE, go to:
  - Student Workspace
  - IVLE Tools – Projects/Groups
  - Select the lowest team number (not taken up)

- Every student signs up for TWO '*projects*' under their team number:
  - "CN4123 : Team Members"
  - "CN4123 : Section N: xxxx"
    - N: section number; xxxx: name of advisor for the unit
    - E.g. "CN4123: Section 1: Kawi" for 'Reactor Section'
- Also, Team Leaders sign up for the following project:
  - "CN4123: Team Leaders"

- Incorrect signups will incur penalties

Organization

The Team Leader's role:

- facilitates meetings and positive interaction of team members
- ensures team members make the required progress and on time
- ensures adequate and fair distribution of work for the common sections
- seamlessly integrates the various sections
- ensures that team meets the deadlines

Team leader's additional contribution will be factored in during evaluation/grading.

Resources

- Software: Hysys, Excel, MATLAB, Visio, etc.

- Computational Facilities:
  - ChBE PC Cluster (E5 03-24, E5 03-37) available on Thursdays, Fridays and Saturdays 0800 – 1800.
  - e-ITU PC Clusters PC1 (E1 04-09), PC2 (E1 04-10) and PC3 (E2 03-06): available Thursdays and Saturdays 0900 – 1800.
  - Aspen Hysys is accessible from all the above clusters.
  - MATLAB and Visio are available in ChBE PC Cluster (E5 03-24) only

- References: RBR of Central Library

Schedule of Activities

Date	Activity (Venue: LT6)	Time
Jan 12 (week 1)	Overview of the project	1 pm
	Talk on team-work	1.45 pm
	Talk on Design & Sustainability in Practice	2 pm
Jan 19 (week 2)	Reactors and their Design Guidelines Columns and their Design Guidelines	1 – 1.45 pm 1.45 – 2.30 pm
Jan 26 (week 3)	Pump sizing and specifications Small Group Meetings (venues on next slide)	1 – 1.45 pm
Feb 9 (week 5)	Small Group Meetings (venues on next slide)	Timings on next slide
February 18-26 *Recess Week*		

Schedule of Activities

Date	Activity (Venue: LT6)	Time
Mar 2 (week 7)	Report Writing Small Group Meetings (venues on next slide)	1 pm
Mar 16 (week 9)	Small Group Meetings (venues on next slide)	
Mar 23 (week 10)	Briefing on Cost Estimation, Economic Analysis	1 pm
	Briefing on Health, Safety and Environment	1.45 pm

Sections, Advisors & Industry Talks

Section (Advisor)	Venue	Time
Reactor (Dr. Kawi)	E5 03-21	2 – 3 pm
Water Removal (Dr. Hidajat)	E5 03-23	2 – 3 pm
De-C_1 (Dr. Gautam)	E5 03-22	4 – 5 pm
De-C_2 (Dr. Lim)	E5 03-22	2 – 3 pm
De-C_3 (Dr. Karimi)	E5 03-20	2 – 3 pm
De-C_4 (Dr. Borgna)	E5 03-21	4 – 5 pm
Heat Integration (Dr. Suraj)	E5 03-23	4 – 5 pm

Industry Talks: Details of each talk will be conveyed after the confirmation from the speaker, about one week in advance. These sessions are a few for B.Eng. and B.Tech. students together, and may be on Thursday at 1 pm or on Saturday morning subject to speaker's availability.

Deliverables

Date	Deliverables	Submit to
Jan 16 (wk 2)	Team members and team leaders to complete enrollment on IVLE Penalty: 1% for failure to enroll or incorrect enrollment	IVLE
Jan 19 (wk 2)	Section selection: sign up for IVLE project.	IVLE
Feb 16 (wk 6)	Interim Report (electronic copy): Two-page report (one from each team). Suggested contents: scope, process overview, inputs/targets for each section, progress, plan, milestones. Flowsheet and stream data as additional pages.	Upload one pdf per team to **IVLE Project CN4123: Team Leaders** by 3.00 pm

Deliverables

Date	Deliverables	Submit to
March 23 (wk 10)	**Section Report - Process Development and Design** • One printed and one electronic copy • To be submitted by each student • Page limit: 35 pages (including appendices, if any)	1. Upload a SINGLE pdf into your own folder under **IVLE project: Section X: xxxx** by **12.00 pm**. 2. Submit one printed copy (double sided) to **ChBE Department Office** by **12.00 pm**.
Week 13	**Oral Presentations**: On Process Development and Design of individual sections.	Venues and dates TBA

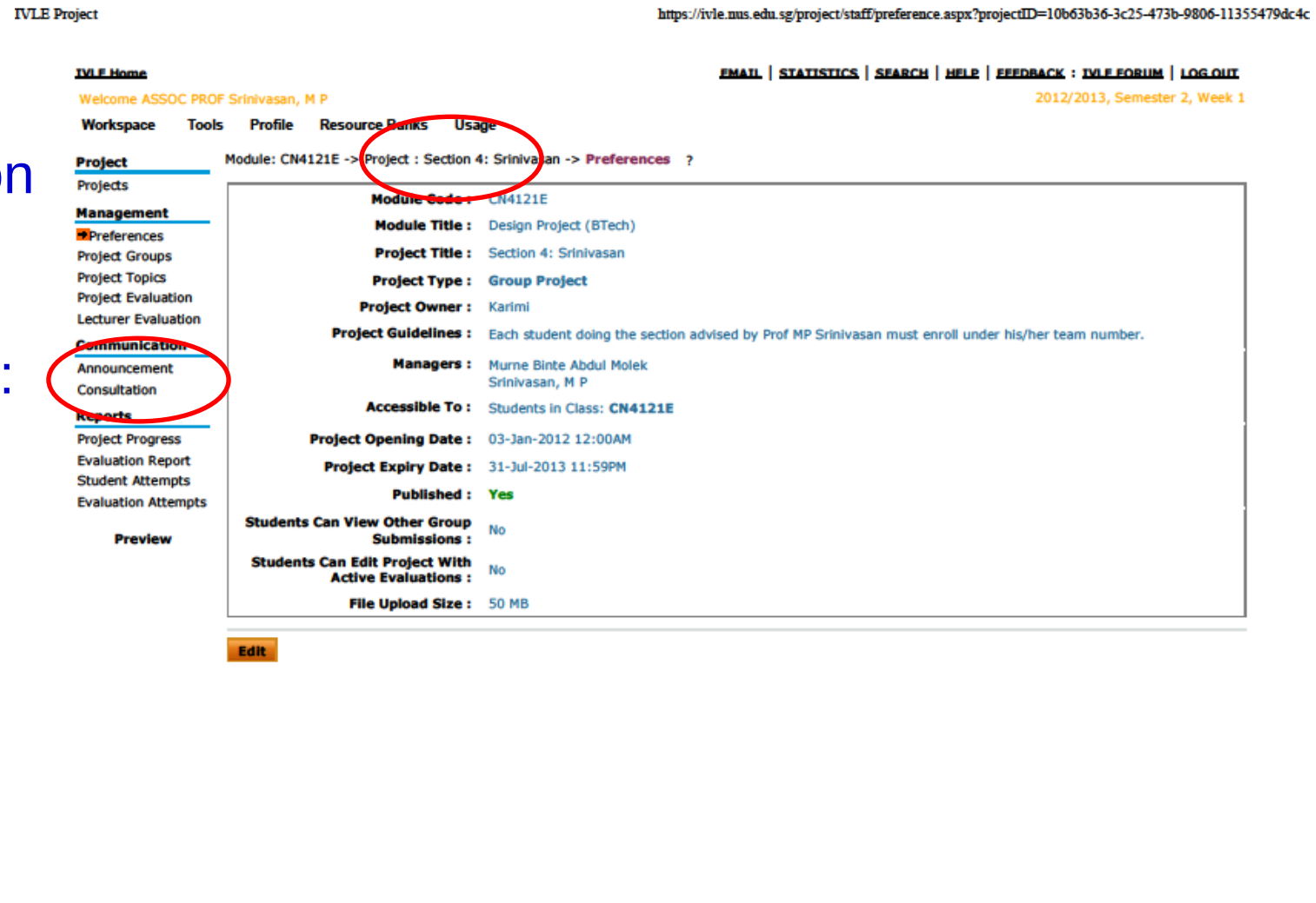
Deliverables

Date	Deliverables	Submit to
Apr 10 (wk 13)	**Team Report**: One report from each team with following Contents and Limits: • Executive Summary: 4 pages • Cost estimation & economic analysis: 20 pages • SHE: 30 pages • Sustainability: 3-5 pages • Entire report: ≤ 59 pages (excluding title page, table of contents, PFD and stream data)	Upload to IVLE (**IVLE project folder CN4123: Team leaders**) by **12.00 pm**: 1. One pdf per team. 2. One HYSYS file with complete plant simulation.
Apr 24	**Peer assessment**: Each member will assess all others in the team on their contribution to the project. This will be taken into account for grading each student's performance.	Online in IVLE

IVLE upload locations

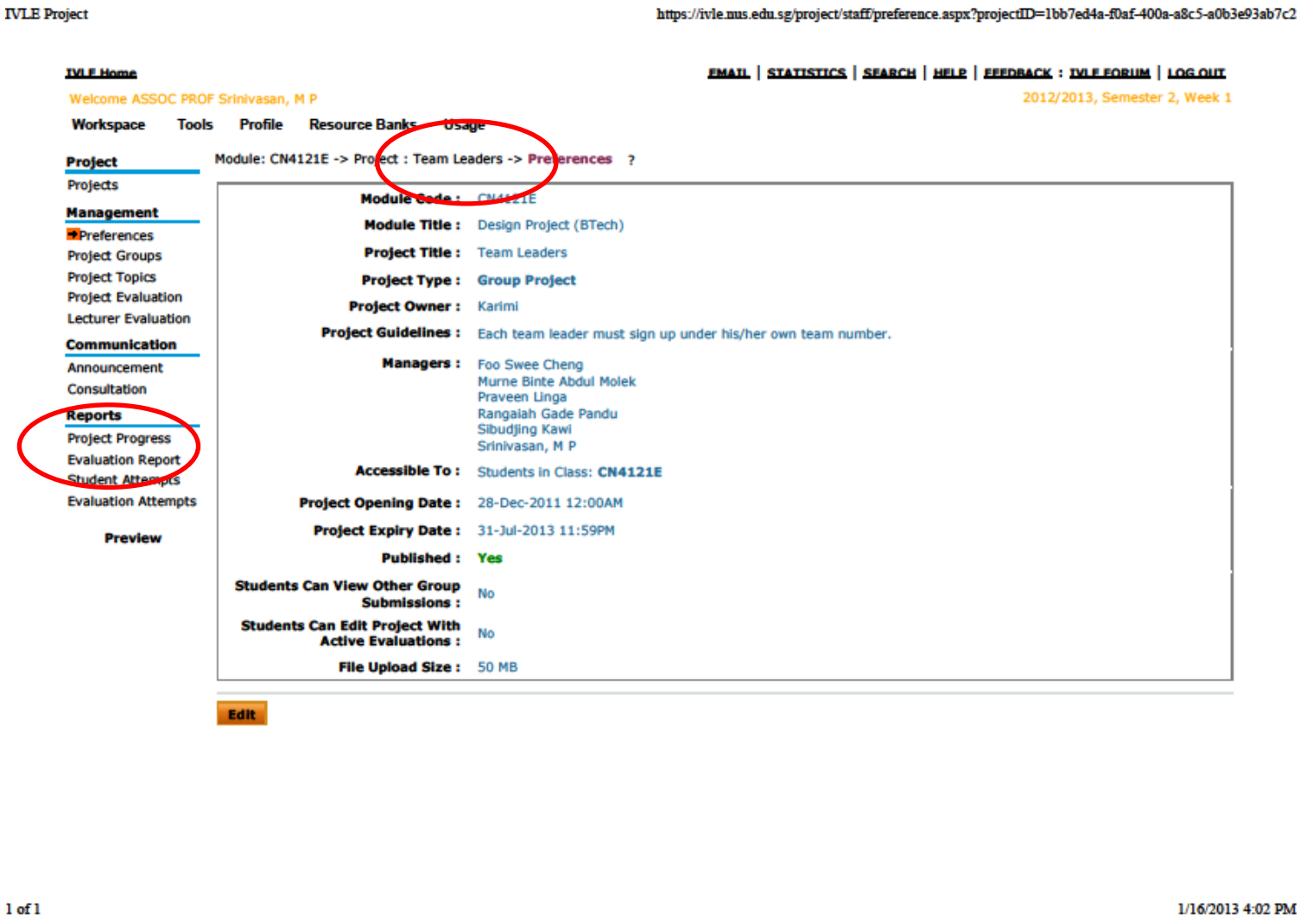
For Section Reports:

Section x: xxx



IVLE upload locations

For Team Reports



Penalties

- Failure to enroll/incorrect enrollment: 1%
- Late Submission: 2% per day of delay
- Excess pages: 0.5% for every 2 pages
- Incorrect formatting: 2%

Assessment

- Based on
  - Interim and final reports
  - Oral presentations
  - Peer evaluation

- Contributions to final grade :
  - Section Report, oral presentation: 60% (individual contributions)
  - Interim Report, and Team Report along with peer evaluation: 40% (team contributions)

- Incentive for Team Leader:
  - Can earn additional credit (up to 2 marks)
  - Based on peer evaluation of the Team Leader by his/her team members

Scope of Design – Section Report

- Alternatives for raw materials, process conditions, reaction pathways, catalysts, separations etc.
- Energy/resource conservation, material recycle/reuse/ treatment
- Synthesis and evaluation of alternate configurations
- Identification of best process based on above analyses
- Criteria: feasibility, safety, cost effectiveness, reliability, etc.
- Discussion on alternative technologies
- Complete simulation model and PFD
- Table of process stream data

Scope of Design

Sections for Process Development and Design and the respective advisors:

- Reactor Section (Dr. Kawi)
- Water Removal Section (Dr. Hidajat)
- De-C_1 Section (Dr. Gautam)
- De-C_2 Section (Dr. Lim)
- De-C_3 Section (Dr. Karimi)
- De-C_4 Section (Dr. Borgna)
- Heat Integration Section (Dr. Suraj)

Each of the above sections will be the responsibility of one member of each team.

Scope of Design – Team Report

- ***Executive Summary***
  - Main features of proposed design
- ***Safety, Health and Environment***
  - Hazard identification, HAZOP studies
  - Plant layout, operational safety, treatment and disposal of effluent, product life cycle, personnel protection
- ***Cost Estimation and Economic Analysis***
  - Equipment schedule (including vessels, pumps, etc.)
  - Cost estimation and economic analysis
  - Discussion on profitability
- ***Sustainability***
  - Sustainability assessment using suitable biomass in a location (chosen by the team) different from that given.
  - Qualitative discussions about economic, environmental and societal aspects – no cost calculations needed.

Challenges in the Project

- **Open-Ended**
  - DO NOT look for an answer for every little detail; make reasonable assumptions and justify
- **Breadth and Depth of Knowledge are needed**
  - Chemistry, Mathematics, Numerical Methods
  - Mass & Energy Balances, Thermodynamics, Fluid Mechanics, Heat Transfer, Mass Transfer
  - Separation Processes, Fluid-Solid Systems, Reaction Engineering

Challenges in the Project

- Several Alternatives
  - Selection based on Cost and Experience: Rules of Thumb (Heuristics)
- Success requires Trials
- Co-operation and Persistence
- Novel Ideas and Approaches

Communications

Advisors–Teams relationship is similar to that between Clients and Vendors

- Vendors to Suggest Alternatives & Reasons
- Formal and Technical Communications

Communication lines

- Between advisors and all members
- Between advisors and team leaders
- Among team members including leader

Suggested Schedule

- Weeks 1 – 2
  - Process alternatives
  - Comparative evaluation
  - Responsibilities of team members
- Weeks 3 – 4
  - Process, Components, Properties
  - Process Flowsheet, Mass & Energy Balances, Operating Conditions
  - Identification of units/clusters for detailed ChE design
- Weeks 5 – 8
  - Process Development and Detailed Design of Individual Sections

Suggested Schedule

- Weeks 9 – 10
  - Preparation of Section Report
- Weeks 11 – 13
  - Equipment Schedule & Economic Analysis
  - Safety Health & Environment
  - Sustainability
  - Preparation of Team report
  - Oral Presentation
- Week 15
  - Peer Assessment
- Weeks 15 – 16
  - Examinations for other Modules

Teamwork – Progress & Monitoring

- **Each Team to Meet and Discuss Regularly**
  - **Say, once a week**
  - **TA to observe 1-2 meetings of each team**

- **Minutes of the Meetings**
  - **Attendance, Decisions Made, Action Items etc.**
  - **Minutes Template on IVLE**

- **Upload Meeting Minutes into IVLE (CN4123 → Project → Team Leaders → Choose Your Team → Files → Document)**
  - **By Friday, 17th February (Tnn-A.doc) and**
  - **By Friday, 14th April (Tnn-B.doc)**

Questions & Answers

- Question 1
- Question 2

- Question 3
- Question 4

- Question 5
- Question 6