CHE 381A: PROCESS DYNAMICS AND CONTROL

COURSE OUTLINE

PART A: PROCESS CONTROL THEORY

Process Dynamics
     Response types
     Mathematical models
          First principles models
          Linearization
     Solving linearized ODEs
          Time domain
          Laplace domain
     Block diagrams for process systems

The Concept of Feedback Control
     Closed loop characteristic equation and stability
     The PID control algorithm and tuning methods (including process identification)

Laplace domain analysis of feedback systems

Frequency domain analysis of feedback systems

Advanced Control Structures
     Feedforward, Ratio, Cascade, valve positioning, override

Multivariable Systems
     Interaction between control loops: RGA, Niederlinski index
     Decentralized Control: BLT tuning procedure
     Decoupling: Steady state, Dynamic, Partial

Advanced control algorithms
     Smith predictor
     Model predictive control

PART B: CONTROL OF CHEMICAL PROCESSES

Control of Common Unit Operations
     Distillation Columns, reactors and miscellaneous units

Plantwide Control
     Effect of Recycle: Nonlinearity and dynamic interaction
     Heuristics for regulatory control structure synthesis
     Economic optimal operation considerations
     Case studies
          CSTR + recycle, Cumene process, HDA process

WEIGHTAGE

Simulation lab and reports		10%
Quizzes (surprise or announced)		20%
Mid Semester Exam	01	20%
Computer Simulation Exam	01	10%
End Semester Exam	01	40%
TOTAL		**100%**
BONUS (over and above 100%)	Up to	**20%**

BONUS is over and above the 100% marks allocation above. Thus, in theory, it is possible for a student to score 120 out of 100. Bonus may be earned as follows.

1. Solving one complete difficult simulation problem. The challenge problems shall be made available before mid-sem exam. If done properly (with a professional report and brief video lecture), up to 20% bonus shall be awarded.

2. All students are required to submit 5 fully solved **original** problems for the course (i.e. including a lucid exposition of the solution). **This is mandatory.** The first two of these problems are to be submitted by Feb 14 (one week before mid sems) based on material covered till then. The next 3 problems are to be submitted by April 24 (week before end sems) based on the remaining covered subject material. Properly solved submitted problems shall be made available to all students before the mid sem and end sem exams. Some of these problems (or their variants) may also be on the exam. In case such solved problems are not submitted by the due date, **1% marks shall be deducted** from the aggregate earned marks. For every solved problem that is deemed worthy of being used in an examination or quiz, student earns 2%. In this way a student can earn up to 10% bonus for the 5 submitted solved problems.

3. A student may submit a brief video lecture (size no more than 50 MB; duration no more than 15 minutes) clearly describing and solving one or more of the submitted problems. For every such top-notch professionally done video, student earns 2% bonus. A student may thus earn up to 10% bonus for 5 solved problem videos.

In any case, the bonus earned shall not exceed 20%.

Grading shall be relative.

NOTES

- All submissions (exams, simulation labs, quizzes, solved problems etc) must be on time. NO EXCEPTIONS. Late submission will result in 0 marks being awarded.
- All submissions must strictly follow submission instructions to be communicated separately. Non-compliance with submission instructions will result in severe penalties.
- Simulation lab involves extensive programming in MATLAB-SIMULINK
- Open notes exams and quizzes
- F grades if copied reports, cheating in exams etc (i.e. unfair means).
- Explanations for acts of omission and commission (e.g. cheating, late submissions etc) shall not be entertained. E.g., in case two reports appear copied beyond reasonable doubt, both shall get an F grade regardless of who copied from whom.

- I grade if any lab report remains not submitted by the time classes end. I grade shall automatically convert to F if submission is not made by the last date for grade submission in academic calendar.
- For the online semester, announced policies (including course component weightages) are subject to change due to unforeseen occurrences such as widespread cheating etc.

SPECIFIC TO ONLINE SEMESTER

- It is your responsibility to ensure proper net access and electronic infrastructure (laptop/PC, webcam, appropriate software etc)
- You are expected to have Matlab-Simulink installed on your laptop/PC. IITK has a campus-wide license, which is linked to your CC user ID. The license, once installed, allows running Matlab/Simulink from remote locations. For details, please visit https://www.iitk.ac.in/ccnew/index.php/matlab-campus-wide-license-at-iit-kanpur and follow the instructions.
- Course will run in asynchronous mode. If necessary, one may switch to live sessions.
- Every week, you may submit your queries regarding the course material in the appropriate online forum. These queries shall be collated and appropriately addressed.
- You shall be required to sign and submit an "**Ethical Conduct Honor Code**" declaration. **This is mandatory. Failure to do so shall result in deregistration.**
- All quizzes will be proctored online. For proctoring, please ensure you have a webcam properly installed. **The webcam proctoring is mandatory** and your submission shall be graded only if proctored through a webcam (no webcam proctoring implies zero credit). At the time of examination/quiz etc, the webcam must be positioned such that the available writing area and both hands are clearly visible at all times. Reported transgressions will result in severe penalties up to an F grade or compulsory deregistration. On these matters, there shall be no discussion whatsoever.
- It is possible that despite all efforts, widespread cheating is evident in quizzes or exams. Should that be the case, community punishment may have to be resorted to (e.g. 0 to the entire class for the particular quiz/examination, one reduced grade to the entire class, no A grades awarded or other such variations).

The underlying assumption in any system is fair and ethical behavior by everyone. In that case, the system functions smoothly and serves the purpose it is meant to. On the other hand, unethical and unfair practices cannot be predicted/foreseen and severely compromise the system's efficacy, to the extent of making the system seem totally arbitrary. The announced course policies assume ethical behavior on everyone's part and apply only if this assumption holds. The policies may have to be changed dynamically from time to time in case of unethical practices. These changes may or may not be announced (fully or partially) as miscreants will always find a way to bypass the intent behind announced policy alterations. The element of surprise shall be a two-way street.

TEXT BOOKS

- "Essentials of Process Control", ML Luyben and WL Luyben, McGraw Hill, 2000.

- "Process Dynamics and Control", DE Seborg, T Edgar, DA Mellichamp, FJ Doyle, Wiley, 2013.

ETHICAL CONDUCT HONOR CODE DECLARATION

I, _____ (Roll No _____), enrolled in ChE381A do hereby solemnly pledge on my honor, to a conduct of complete integrity, honesty and sincerity in all aspects of the course. I fully understand that plagiarism, cheating and its facilitation etc during an assessment or in assignments, constitute serious violations of the academic honor code and can result in severe penalties including but not limited to an F grade in the course with formal SSAC disciplinary proceedings.

Date

Place   Signature