DEPARTMENT OF CHEMICAL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

COURSE PLAN – PART I			
Name of the programme and specialization	**M.Tech.** **Chemical Engineering** **Process Control & Instrumentation**		
Course Title	**Advanced process Control**		
Course Code	**CL601**	**No. of Credits**	**3**
Course Code of Pre-requisite subject(s)			
Session	**Sept. 2021**	**Section (if, applicable)**	**NA**
Name of Faculty	**T.K.Radhakrishnan**	**Department**	**Chemical Engg.**
Email	**radha@nitt.edu**	**Telephone No.**	**2503104**
Name of Course Coordinator(s) (if, applicable)			
E-mail		**Telephone No.**	
Course Type	√ **Core course**	**Elective course**	

Syllabus (approved in BoS)

Review of Systems: Review of first and higher order systems, closed and open loop response. Response to step, impulse and sinusoidal disturbances. Transient response. Block diagrams.

Stability Analysis: Frequency response, design of control system, process identification. PI Controller tuning - Ziegler-Nichols and Cohen-Coon tuning methods, Bode and Nyquist stability criterion. Process identification.

Special Control Techniques: Advanced control techniques, cascade, ratio, feed forward, adaptive control, Smith predictor, internal model control, model based control systems.

Multivariable Control Analysis: Introduction to state-space methods, Control degrees of freedom analysis and analysis, Interaction, Bristol arrays, Niederlinski index - design of controllers, Tuning of multivariable PI controllers, Design of multivariable DMC and MPC.

Sample Data Controllers: Basic review of Z transforms, Response of discrete systems to various inputs. Open and closed loop response to step, impulse and sinusoidal inputs, closed loop response of discrete systems. Design of digital controllers. Introduction to PLC and DCS.

COURSE OBJECTIVES

Expose students to the advanced control methods used in industries and research. This course prepares the student to take up such challenges in his profession.

COURSE OUTCOMES (CO)	
Course Outcomes	**Aligned Programme Outcomes (PO)**
Upon completing the course, the student will be able to	
1. perform stability analysis and controller tuning	POs-1,2,3,4,5,8,9,11,12
2. select and design advanced controllers that need to be used for specific problems	POs-1,2,3,4,5,8,9,11,12
3. design controllers for interacting multivariable systems	POs-1,2,3,4,5,8,9,11,12
4. understand the dynamic behavior of discrete time processes and design discrete controllers	POs-1,2,3,4,5,8,9,11,12

COURSE PLAN – PART II

COURSE OVERVIEW

The Advanced Process Control course is offered in the first semester to the PG Chemical Engineering and Process Control & Instrumentation students for the understanding of principles of process control in industries.

COURSE TEACHING AND LEARNING ACTIVITIES

L. No	Week	Brief outline of the content to be delivered	Mode of Delivery	
			C & T	**PPT**
1-9	3 weeks	First order systems – Examples- level, concentration and temperature process- Response of first order systems - Higher order systems - Non-interacting and Interacting- Second order system analysis - Transient response of control systems – stability - Frequency response- Bode stability - Nyquist stability – Nichols chart - Closed loop log modulus	✓	✓
10-17	2-3 weeks	Step and pulse testing – First and second order model estimation - Relay tuning – integral error methods for tuning - Direct synthesis method for controller design - Non-minimum phase systems - inverse response - delay systems – open loop unstable systems - compensator design.	✓	✓
18-24	2 weeks	Cascade systems – Feed forward control – Ratio control – IMC – MPC.	✓	✓
25-33	2-3 weeks	Multivariable systems - State space model - Interaction – RGA - Pairing recommendation – Niederlinski index Non square systems – Singular value – SVR analysis – stability - MV Nyquist plots – BLT tuning for decentralized controller design –Decoupling.	✓	✓
34-40	2 weeks	Sampling and reconstruction of signals- aliasing- sampling period selection - Signal processing and filtering – analog and signal filter – Z transforms - Pulse transfer function- closed loop transfer function – stability – minimum variance control - design of digital controllers.	✓	✓

S.No.	Mode of Assessment	Week/Date	Duration	% Weightage
COURSE ASSESSMENT METHODS (shall range from 4 to 6)				
1	Cycle Test I	On completion of first two Units	1 Hr	25%
2	Cycle Test II	On completion of 3rd and 4th units	1 Hr	25%
3	Assignment/Viva	Covering the first four units		20%
CPA	Compensation Assessment*	After Cycle Test II	1 Hr	25%
4	Final Assessment *	After completing the syllabus	3 hrs	30%

*mandatory;

COURSE EXIT SURVEY (mention the ways in which the feedback about the course shall be assessed)

- ➢ Feedback from the students during class committee meetings
- ➢ Assessing students' performance in assessment methods
- ➢ Anonymous feedback through questionnaire

COURSE POLICY (preferred mode of correspondence with students, compensation assessment policy to be specified)

MODE OF CORRESPONDENCE (email/ phone etc)

- Most of the information will be announced in the class room
- Any other (schedule of classes/schedule of assessment/ course material/ any other information regarding the course) will be through the class representatives via mail/phone
- Queries (if any) to the faculty shall be emailed to radha@nitt.edu

COMPENSATION ASSESSMENT POLICY

- Attending all assessments are MANDATORY for every student.
- If any student is not able to attend the assessments (1,2 only) due to genuine reason, student is permitted to attend the compensation assessment (CPA).
- At any case, CPA will not be considered as an improvement test.

ATTENDANCE POLICY (A uniform attendance policy as specified below shall be followed)

- **At least 75% attendance in each course is mandatory.**

- **A maximum of 10% shall be allowed under On Duty (OD) category.**

- Students with **less than 65% of attendance** shall be prevented from writing the final assessment and **shall be awarded 'V' grade.**

ACADEMIC DISHONESTY & PLAGIARISM

- Possessing a mobile phone, carrying bits of paper, talking to other students, copying from others during an assessment will be treated as punishable dishonesty.

- Zero mark to be awarded for the offenders. For copying from another student, both students get the same penalty of zero mark.

- The departmental disciplinary committee including the course faculty member, PAC chairperson and the HoD, as members shall verify the facts of the malpractice and award the punishment if the student is found guilty. The report shall be submitted to the Academic office.
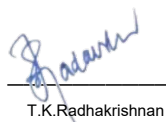
  The above policy against academic dishonesty shall be applicable for all the programmes.

ADDITIONAL INFORMATION

The faculty can be contacted in person/phone for clarifications by the student at a mutually convenient time.

FOR APPROVAL

Course Faculty _____

T.K.Radhakrishnan

CC-Chairperson _Dr Kartikeya Shukla_ **HOD** _____

Guidelines:

a) The number of assessments for a course shall range from 4 to 6.

b) **Every course shall have a final assessment on the entire syllabus with at least 30% weightage.**

c) **One compensation assessment for absentees in assessments (other than final assessment) is mandatory. Only genuine cases of absence shall be considered.**

d) **The passing minimum shall be as per the regulations.**

B.Tech. Admitted in				P.G.
2018	**2017**	**2016**	**2015**	
35% or class average/2 whichever is greater.		Peak/3 or class average/2 whichever is lower		40%

e) **Attendance policy and the policy on academic dishonesty & plagiarism by students are uniform for all the courses.**

f) **Absolute grading policy shall be incorporated if the number of students per course is less than 10.**

g) Necessary care shall be taken to ensure that the course plan is reasonable and is objective.