DEPARTMENT OF INSTRUMENTATION & CONTROL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

COURSE PLAN – Part I			
Session	**January – April, 2019**		
Course Title	**Control Systems II**	**Section**	**B**
Course Code	**ICPC 24**	**Credits**	**3**
Course Type	**CORE**		
Pre-requisites	**ICPC 21 Control Systems I**		
Faculty	**Dr. Ramakalyan Ayyagari**	**Mobile No.** **Email**	**+919443923485** **rkalyn@nitt.edu**
CC Chairperson	**Dr Geetha C**		
Other Course Teacher(s)/Tutor(s)	--		

Syllabus (approved by the Senate)

- State-space Models – Review of vectors and matrices, Canonical Models from Differential Equations and Transfer Functions, Interconnection of subsystems.
- Analysis of Linear State Equations – First order scalar differential equations, System modes and modal decomposition, State Transition Matrix, Time-varying matrix case.
- Lyapunov's stability theory for Linear Systems – Equilibrium points and stability concepts, Stability definitions, Linear system stability, The Direct method of Lyapunov, Use of Lyapunov's method in feedback design.
- Controllability & Observability – Definitions, Controllability/Observability Criteria, Design of state feedback control systems, Full-order and Reduced-order Observer Design, Kalman canonical forms, Stabilizability & Detectability.
- Digital Control Systems, Closed-loop Feedback Sampled-Data Systems, Stability Analysis, Implementation of Digital Controllers. One detailed case study of modern control theory.

COURSE OBJECTIVES

1. To introduce the system's internal states and develop a framework for the state space representation of dynamical systems.
2. To teach tools and techniques suitable for large-scale linear system analysis.
3. To orient the student towards the computational procedures involved in the controller design for large-scale of systems.

MAPPING OF COs with POs

Course Outcomes	Programme Outcomes (PO)
1. In units I & II, mathematical ideas from Linear Algebra will be reinforced with a bent on the modeling and analysis of dynamical systems of arbitrarily high orders.	1, 3, 4, 5
2. In unit III & IV, students will be exposed to the ideas of controllability, observability and state feedback controller design quintessential to modern control systems.	1, 3, 4, 5
3. In unit V, students are taken up to higher levels of control problems, such as nonlinear systems, optimal control, and network control systems, as well as the computational aspects of the feedback control design problem.	1, 3, 4, 5, & 12

COURSE PLAN – Part II

COURSE OVERVIEW

This course is a sequel to ICPC 021Control Systems I. However, this course deals with methods pertaining to systems particularly of very high order. Appropriately called Modern Control, this course has rigorous algebraic techniques creating a framework that accommodates linear as well as other classes, such as nonlinear systems. The course concludes with windows opened to advanced topics.

COURSE TEACHING AND LEARNING ACTIVITIES

Classes	Week(s)	Topic(s)	Delivery
1 – 3	Jan 7 – 11	Introduction to the course	Board/ PPT
4 – 12	Jan 21 – 25 Jan 28 – Feb 1 Feb 4 – 8	**Unit 1:** Introduction to State-space, Examples – RC/RLC circuits & Suspension System, Models & Linear Algebra, Canonical Forms – CCF & OCF, Physics based and Data based (Least squares) Modeling – Importance of initial conditions, Discrete-Time systems, A note on sampling, Stability of LTIL State-space models	Board/ PPT
13 – 18	Feb 11 – 15 Feb 18 – 22	**Unit 2:** Solution of the state equation, Diagonal canonical form, e^A and A^n, Properties, Laplace Transformation, A note on computing	Board/ PPT
19 – 27	Feb 25 – Mar 1 Mar 4 – 8 Mar 11 – 15	**Unit 3:** Controllability – Definition & Criteria, Controller design – CCF based & general, State feedback with bias, Handling steady-state errors	Board/ PPT
28 - 33	Mar 18 – 22 Mar 25 – 29	**Unit 4:** Observability – Definition & Criteria, Observer design – OCF based & general, Reduced order observers, Complete state feedback, A note on Kalman Filtering	Board/ PPT
34 – 40	Apr 1 – 5 Apr 8 – 12	**Unit 5:** Some Advanced Topics – Nonlinear control, Optimal control, Computational Techniques, Cooperative Control	Board/ PPT

COURSE ASSESSMENT METHODS

S.No.	Mode of Assessment	Date	Duration	% Weightage
1.	Assessment – 1 (written)	Feb 22	60 minutes	20%
2.	Assessment – 2 (written)	Mar 29	60 minutes	20%
3.	Assessment – 3 Individual Assignments	Submission on or before April 12		20%
4.	Assessment – 4 (written)	Apr 29	120 minutes	40%
*	Compensatory Assessment	Apr 24	60 minutes	20%
*	Re-assessment, if any	May 6	180 minutes	100%

ESSENTIAL READINGS:

1. W.L. Brogan, "Modern Control Theory," 3/e, Prentice Hall, 3rd edition, 1990. Cheaper (less than INR 200/-) Indian edition is available.
2. G. Strang, Introduction to Linear Algebra, 5/e, SIAM, 2016. Video lectures on YouTube are available.
3. Get MATLAB installed (from the CSG) on your laptops and visit National Institute of Technology MATLAB Academy access portal for free courses using MATLAB

COURSE EXIT SURVEY

Feedback from the students during the class committee meetings
Feedback after Assessment 1 for mid-course correction
Feedback before End-term examination through a questionnaire, for improvements in future.

COURSE POLICY (including plagiarism, academic honesty, attendance, etc.)

Attendance: A uniform attendance policy as specified below shall be followed:

- At least 75% attendance during the class-work 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

Grading: Grading would be relative, with class-average (out of 100) shall be the benchmark – average and above shall get S, A, and B grades, and below average shall get C, D, E, and F.

- As per the recommendation of the senate, passing minimum for your batch is fixed as:

(Class Maximum/3) or (Class Average/2) whichever is lower

Academic Honesty:

- All the assessments, including the programming project in this course must be strictly individual work. However, collaboration by individuals is encouraged at the level of ideas.
- Feel free to ask each other questions, or brainstorm on solutions, or work together on a board. However, be careful about copying the actual solution. This sort of collaboration at the level of artifacts is permitted if explicitly acknowledged, but this is usually self-defeating.
- The principle behind the collaboration rule is simple:
  - I want you to learn as much as possible; you may learn from me or from each other.
- The goal of artifacts is simply to demonstrate what you have learned. So, I'm happy to have you share ideas, but if you want your own points you have to internalize the ideas and then craft them into an artifact by yourself, without any direct assistance from anyone else, and without relying on any idea taken from others (whether at this institute or from the web).

Academic Dishonesty: For purposes of this class, academic dishonesty is defined as follows:

- Any attempt to pass off work on a test that didn't come straight out of your own head.
- Any collaboration on artifacts in which the collaborating parties do not clearly explain exactly who did what, at turn-in time.
- Any activity that has the effect of significantly impairing the ability of another student to learn. Examples here might include destroying the work of others, interfering with their access to resources, or deliberately providing them with misleading information.

Further, the recommendation of the Senate with reference to Academic Dishonesty is as follows:

- 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.

ADDITIONAL COURSE INFORMATION
All the students are urged to be interactive during the classes. Further, the students are suggested to make a google group for faster dissemination of PPTs, discussions on projects etc. They are free to interact with me over email any time, and if needed meet me in person with prior appointment.
FOR SENATE'S CONSIDERATION

9/1/19		9/1/19
Dr. Ramakalyan Ayyagari Course Faculty	Dr. Geetha C CC-Chairperson	Dr. B. Vasuki HOD