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

COURSE PLAN – PART I

Name of the programme and specialization	**M.Tech. Industrial Automation (II Semester, 2020-22 batch)**		
Course Title	**Network Control Systems**		
Course Code	**IC 622**	No. of Credits	**3**
Course Type	✓ **Elective course** ~~Core Course~~		
Pre-requisite(s)	NIL		
Session	**January 2021**	Section	
Name of Faculty	**Dr. Ramakalyan Ayyagari**	Department	**ICE Dept**
Official Email	**rkalyn@nitt.edu**	Telephone No.	**+91.944.392.3485**

Syllabus (approved in the BoS)

Network Models - graphs, random graphs, random geometric graphs, state-dependent graphs, switching networks

Decentralized Control - limited computational, communications, and controls resources in networked control systems

Multi-Agent Robotics - formation control, sensor and actuation models

Mobile Sensor Networks - coverage control, voronoi-based cooperation strategies

Mobile communications networks - connectivity maintenance

Course Objectives

1. To provide an introduction to multi-agent dynamical systems, including their analysis
2. To study the fundamental phenomena over interconnneted network systems, including consensus and disagreement.
3. To complement the theoretical results with numerical examples of network control systems.
4. To provide several key examples from social networks, ecology, etc.

Mapping of COs with POs

Course Outcomes	Program Objectives
1. In unit I core mathematical ideas from Graph theory will be presented with a bent on control theory and applications	1,2
2. In units II & III, from a network perspective, ideas such as structural controllability will be explored. In particular, agreement protocols for consensus/rendezvous and leader-follower topologies will be discussed	1,2,4,5,8
3. In unit IV, students are taken up to practical applications such as formations in mobile robotics	1,2,4,5,8
4. In unit V, more general ideas, such as social networks and games over networks, shall be learnt and case studies will be shown	1,2,4,5,8,12

COURSE PLAN – Part II

Course Overview

This course is tailored to be accessible to the advanced undergraduate students, and provides an introduction to the analysis and design of dynamic multiagent networks. The focus is on graph theoretic methods for the analysis and synthesis of the networks, and the student is exposed to the essential set of tools for networked systems, viewing networks as systems, and making them amenable to control-theoretic analysis and automatic synthesis, capturing to what extent the behavior of networks can be influenced by exogenous inputs.

Course Teaching & Learning Activities			
Classes	**Week/Contact Hours**	**Topic**	**Mode of Delivery**
1 – 3	Feb 1 – 5	Introduction to the course	MS Teams
4 – 6	Feb 8 – 12	Review of Graph Theory, Control Principles of Complex Systems	MS Teams
7 – 9	Feb 15 – 19		MS Teams
10 – 12	Feb 22 - 26		MS Teams
13 – 15	Mar 1 – 5	Structural Controllability, Edge and Node classification, Controllable subspace and Control centrality, Agreement protocols	MS Teams
16 – 18	Mar 8 – 12		MS Teams
19 – 21	Mar 15 – 19		MS Teams
22 – 24	Mar 22 - 26		MS Teams
25 – 27	Mar 27 – Apr 2	Formation control, Mobile robotics	MS Teams
28 – 30	Apr 5 – 9		MS Teams
31 – 33	Apr 12 – 16		MS Teams
34 – 36	Apr 19 – 23	Social Networks, Advanced topics	MS Teams
37 – 39	Apr 26 – 30		MS Teams
40 – 42	May 3 – 7	Course conclusion	MS Teams

Course Assessment Methods

S.No.	Mode of Assessment	Date	Duration	% Weightage
1	Written Test	25th February 2021	1 hour	15%
2	Assignment submission	13th March 2021	open	25%
3	Written test	25th March 2021	1 hour	15%
4	Seminar	28th Arpil 2021	open	15%
CPA	Compensation Assessment*	23rd April 2021	1 hour	15%
5	Final Assessment: Written test	18th May 2021	2 hours	30%

- **Evaluation will be completed by May 30th**
- **Students can access their answer scripts, for the unlikely event of re-grading, on May 30th**

RESULTS WILL BE SUBMITTED TO THE PAC AS PER SCHEDULE

Essential Readings:

1. M Mesbahi & M Egerstedt, *Graph Theoretic Methods in Multiagent Networks*, Princeton Univ. Press, 2010.
2. Y-Y Liu, A-L Barabási, "Control Principles of Complex Systems," *Reviews of Modern Physics*, Vol. 88, pp. 1-58, 2016.
3. R Olfati-Saber, J A Fax, R M Murray, "Consensus and Cooperation in Networked Multi-Agent Systems," *Proceedings of the IEEE*, Vol. 95, No. 1, pp. 215-233, 2007.
4. F. Bullo et. al., *Distributed Control of Robotic Networks*, Princeton Univ. Press, 2009.

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.
- 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 (M.10.2 & M.10.3),

- **A minimum of 30 % should be scored in the final assessment for a pass.**
- **The passing minimum shall be MAX{35% or Average/2}**
- **The award of "S" grade in the course is restricted to a maximum of 10% of the total number of students.**

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.

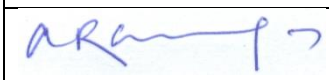
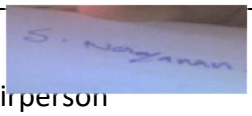
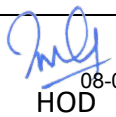
Further, the recommendation of the Senate with reference to Academic Dishonesty is as follows:

- 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

08-02-2021

Course Faculty	CC-Chairperson	HOD
(Dr. Ramakalyan Ayyagari)	(Dr. S. Narayanan)	(Dr. G. Uma)