CS711: Introduction to Game Theory and Mechanism Design

1. **Objectives:** This course is an introduction to game theory and mechanism design. The goal is to equip students with a general purpose tool to analyze strategic behavior in multi-agent interaction. Though primarily a topic of economic flavor, it has significant applications in the decision process of a multi-agent environment like sponsored advertisements, crowdsourcing, social media, internet-based trade, and several settings of social choice and welfare. This course is a backend of such applications and discusses the mathematical details of analyzing and designing strategic interactions.
2. **Departments which may be interested:** CSE, ECO, MTH, EE, IME
3. **Pre-requisites:** Familiarity with formal mathematical reasoning, probability theory, calculus, basics of computational complexity, and (soft constraint) familiarity with computer programming.
4. **Course Contents:**

   A tentative list of topics are as follows.

- **Non-cooperative game theory**
  - Quantitative models of strategic interaction: rationality, intelligence, common knowledge
  - Complete information simultaneous move games – normal form representation
    - Ideas of equilibria: domination of strategies, Nash equilibrium
    - Existence results for mixed and pure Nash equilibrium
    - Correlated equilibrium.
  - Complete information sequential move games – extensive form representation
    - Perfect and imperfect information extensive form games
    - Equilibria concepts – subgame perfect equilibrium, perfect Bayesian equilibrium, analogies with pure and mixed Nash equilibrium
  - Incomplete information games
    - Bayesian games
    - Equilibria concepts tied to the belief system
    - Nash and Bayesian equilibria in incomplete information games
- **Introduction to mechanism design**
  - Incomplete information to player types
  - Social welfare function, Arrow's impossibility result
  - Social choice function, Gibbard-Satterthwaite result
  - Domain restriction
  - Single-peaked preferences
  - Task allocation domain

- Quasi-linear preferences

- **Some real world applications of mechanism design**

5. **Evaluation Components & Policies:** [COVID19 special] One midterm home assignment and one course project (weightage 45% each). Solutions should be typeset in LaTeX and emailed before the deadline. Both components of the evaluation is a group activity. Please form groups of at most 5 people and inform before the end of second week of the course. The grade will be equal for all members of a group. This is not an optimal choice – but in absence of any better remote proctoring mechanism, this is the current best.

   There will be a 10% weight on answering the lecture questions on Mookit. Some of these evaluation components may be changed and new evaluation may be added on a need basis.

6. **Lecture schedule & venue:** Weekly videos will be posted.

7. **Discussion time:** Mondays 2-3 PM (Mookit meetings). Treat this session as a clarification session of the lecture content, and not a problem solving session (as it is impossible to do in an hour). For the problem solving, I suggest posting them on Piazza.

8. **Course webpage:** https://swaprava.wordpress.com/cs711-fall-2020

9. **Teacher**: Swaprava Nath. **Office hours:** via email: swaprava@cse.iitk.ac.in with subject including [CS711]

10. **Teaching assistants:**

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11. **Course Policies:**

    Honesty practices according to the policy laid down by the CSE department will be followed. For details, see: https://www.cse.iitk.ac.in/pages/AntiCheatingPolicy.html. This applies particularly for the take-home assignments. Collaboration is very much encouraged, but you should mention each collaborators' name in the assignments – this does not affect your score in any way – but the solutions you write must be self-written.

12. **Books & References:**

    No specific one. The following books could be helpful.

    1. **"Game Theory"** — Michael Maschler, Eilon Solan, Shmuel Zamir (few copies of this book are available in the library)

2. **“Multiagent Systems”** — Y. Shoham and K. Leyton Brown, Cambridge University Press, online copy available
3. **“Game Theory and Mechanism Design”** — Y. Narahari, World Scientific and IISc Press – Indian edition available