Approval: 4th Senate Meeting

Course Name : Network Information Theory
Course Number : EE-609
Credits : 3-0-0-3
Prerequisites : IC210, EE-304, Advanced Communication Theory
Intended for : 4th year B.Tech. (CS+EE) and research students
Distribution : Elective for CS and EE
Semester : Even/Odd

Preamble: The proposed course is an advanced-level course, primarily for the research students in the SCEE. It can also be one of the advanced elective for B.Tech. students, who have some exposure to Information Theory, that is currently provided in EE discipline core course EE-304 and another proposed elective course "Advanced Communication Theory".

Objective: The objective of the course is to introduce some of the fundamental problems addressed in Network Information Theory as well as the basic tools and techniques usually used in this discipline.

Syllabus:

1. Network information flow problem, Max-flow Min-cut Theorem, Point-to-Point Information Theory versus Network Information Theory. Brief overview of Point-to-Point Information Theory. (7 contact hours)
2. Multiple access channels: Definition, Bounds on and single letter characterization of the capacity region, Time sharing, Gaussian MAC, extensions to more than two senders. (5 contact hours)
3. Broadcast channels (Degraded and General): Definitions, Bounds on the capacity region, Superposition coding inner bound, Gaussian broadcast channel, Marton's inner bound (also with common message), Outer bounds, Inner bounds for more than two receivers. (5 contact hours)
4. Channels with state: Definition, Compound channel, Arbitrarily varying channel, Channels with random state, ISI channels, Dirty paper writing. (5 contact hours)
5. Distributed source coding: Slepian-Wolf Theorem, Duality between Slepian-Wolf Theorem and MAC, Achievability schemes, Various generalizations (DSC with side-information, with helper, etc.). (5 contact hours)
6. Relay channels: Definition, Cutset upper bounds, Gaussian relay channel, Performance of various achievability schemes (Decode-and-forward, Compress-and-forward, Compute-and- forward, Quantize-map-and-forward, Amplify-and-Forward, etc.). (5 contact hours)
7. Interference channels: Definition, Coding schemes, Gaussian IC, Han-Kobayashi inner bound, Deterministic approximation of the Gaussian IC. (5 contact hours)
8. General multiterminal networks: Gaussian networks, Capacity scaling-laws, Gupta-Kumar Network. (5 contact hours)

References:

1. R. G. Gallager, *Information Theory and Reliable Communication*, Wiley, 1968.
2. A. El Gamal and Y.-H. Kim, *Network Information Theory*, Cambridge Univ. Press, January 2012.
3. I. Csiszár and J. Körner, *Information Theory: Coding Theorems for Discrete Memoryless Systems*, Cambridge Univ. Press, August 2011.
4. Related research papers.