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**Selected Topics in Information Theory and Combinatorics (106717)**

**Instructor:** Prof. Igal Sason (office: Meyer 652, e-mail: [sason@ee.technion.ac.il](mailto:sason@ee.technion.ac.il)).

**Time and Place:** Tuesdays 10:30-12:30 (Ullman 705) and 14:30-15:30 (Ullman 102).

**Credit Points:** 3.0 academic points. A joint undergraduate-graduate course.

**Prerequisites:** Elementary (undergraduate) courses in calculus, combinatorics, linear algebra, and probability. *No prior knowledge in information theory is assumed.*

**Language:** Hebrew, unless there will be demand to give it in English.

**Grading Policy:** Semester exams: Final A (07.05.2024), and Final B (04.06.2024). Homework assignments are not for submission but are very recommended (also for the final exams).

**Course outline (Tentative)** [3 hours per week, 12 weeks - 36 hours]:

1. Shannon entropy, (conditional) mutual information, divergences and  $f$ -divergences (5 hours).
2. Han's inequality and Shearer's lemma. A combinatorial application (1 hour).
3. Channels, data-processing inequalities, chain rules, and convexity properties (3 hours).
4. AEP, and almost lossless compression for discrete memoryless sources (3 hours).
5. Differential entropy and applications in matrix theory (3 hours).
6. Information theory and problems in extremal combinatorics (6 hours).
7. Method of types, universal compression, Sanov's theorem (5 hours).
8. Submodularity, information inequalities, and combinatorial applications (4 hours).
9. Entropy rates of discrete-time stationary processes (1 hour).
10. Shannon capacity of graphs for zero-error communication (5 hours).

## REFERENCES

- [1] M. Aigner and G. M. Ziegler, *Proofs from the Book*, Springer, 6th edition, 2018.
- [2] T. M. Cover and J. A. Thomas, *Elements of Information Theory: Second Edition*, 2006.
- [3] S. Jukna, *Extremal Combinatorics with Applications in Computer Science*, 2nd Edition, Springer, 2011.