# INFORMATION THEORY

**PROF. HIMANSHU TYAGI**
Department of Electrical Engineering
IISc Bangalore

**TYPE OF COURSE** : New | Elective | UG/PG
**COURSE DURATION** : 12 weeks (20 Jul' 20 - 9 Oct' 20)
**EXAM DATE** : 18 Oct 2020

**PRE-REQUISITES :** Undergraduate level probability (sets and events, probability distributions, probability density functions, probability mass functions, random variables, expected value, variance, popular probability laws, Markov inequality, Chebyshev inequality, central limit theorem, law of large numbers)

**INTENDED AUDIENCE :** Senior undergraduate and graduate students interested in probability, statistics ,communication, theoretical computer science, machine learning, quantum information and statistical physics

**INDUSTRIES APPLICABLE TO :** Not Available

**COURSE OUTLINE :**
This is a graduate level introductory course in Information Theory where we will introduce the mathematical notion of information and justify it by various operational meanings. This basic theory builds on probability theory and allows us to quantitatively measure the uncertainty and randomness in a random variable as well as information revealed on observing its value. We will encounter quantities such as entropy, mutual information, total variation distance, and KL divergence and explain how they play a role in important problems in communication, statistics, and computer science.
Information theory was originally invented as a mathematical theory of communication, but has since found applications in many areas ranging from physics to biology. In fact, any field where people want to evaluate how much information about an unknown is revealed by a particular experiment, information theory can help. In this course, we will lay down the foundations of this fundamental field.

**ABOUT INSTRUCTOR :**

Prof. Himanshu Tyagi is an Assistant Professor of Indian Institute of Sciences.

**COURSE PLAN :**

**Week 1**: Introduction to entropy as a measure of uncertainty and randomness

**Week 2:** Binary hypothesis testing: bayes optimal binary hypothesis testing and total variation distance, Neyman-Pearson formulation, Stein & lemma and KL divergence

**Week 3**: Measures of information and their properties: Chain rule and additivity, concavity, and variational formulae

**Week 4:**Data processing inequality, Pinsker's inequality, and Fano's inequality

**Week 5:** Data compression: variable length source coding theorems and entropy

**Week 6:** Human code, Shannon-Fano-Elias code, arithmetic code, hash tables

**Week 7**: Universal compression

**Week 8**: Channel coding: Channel capacity theorem, sphere packing bound, maximal code construction

**Week 9:** Random coding and ML decoding

**Week 10**: LDPC and Polar codes

**Week 11:** Quantization

**Week 12**: Minmax lower bounds in statistics