***Statistics and data analysis*** (Prof. G. Botter, University of Padova - frontal lessons, 30 h)

**PROBABILITY**
Continuous and discrete random variables. Pdf's of continuous and discrete random variables and estimate of pdf's from samples. Exceedance probability, sample estimates of exceedance probability, exceedance prob. vs pdf. Moments of a pdf: mean, variance, CV, skewness. Moment Generating function (MGF). Estimate of moments from samples and biases. Analytical models for single random variables (exponential, gamma, Gaussian, Poisson, Gumbel). Joint probability density functions. Marginal pdf's. Conditional pdf's. Bayes' rule and statistical independence. Moments of joint pdf's and joint MGF. Covariance e correlations. Analytical models for multivariate pdf's: multivariate Gaussian distributions.

**STOCHASTIC PROCESSES**
Definitions and examples. Moments of a stochastic process. Hierarchy of the distribution functions. Markov processes. Consistency conditions for Markov processes. Chapman Kolmogorov equation. Examples: Wiener-Levy process and independent increments processes. Stationary and homogeneous processes. Markov and stationary processes: Ornstein-Ulhenbeck. Markov Chains. Autoregressive processes AR(1).

**PARAMETR ESTIMATE of PDF'S and INPUT/OUTPUT MODELS**
Samples of random variables. Parameter estimate from a sample of a pdf. Method of moments. Method of the Maximum Likelihood. Asymptotic theory of the Maximum Likelihood. Estimate of parameters in input/output models. Graphical methods. Informal Performance metrics. Max likelihood. AR(1) correlated errors. Heteroscedasticity.

**BAYESIAN INFERENCE**
Posterior distributions of model parameters and problem statement. Information updating. Prior pdf's. Analytical model to compute posterior pdf's. Posterior moments. Bayesian Monte-Carlo methods (BMC). Importance Sampling. Markov-Cahin Monte Carlo methods (MCMC). Metropolis Hastings algorithm.