IIT Mandi
Proposal for a New Course

Course number   : MA-529
Course Name   : Statistical Inference
Credit Distribution : 3-1-0-4
Intended for   : M.Sc./M.S./PhD/ B.Tech
Prerequisite   : MA-524 (Probability and Statistics)
Mutual Exclusion : NA

1. Preamble:

In this one semester course, we will review the basic concepts of statistical inference. The course aims at providing in-depth understanding about the theory of estimation and testing of hypotheses. Statistical inference is about analyzing and drawing conclusions from the data. In particular, we will focus on the so-called parametric model. We will assume that the data is from certain family of distributions (e.g., a Normal distribution) and the goal is to make inference about the underlying unknown parameter/s (e.g., the mean and/or variance of Normal) using the data. For a parametric model, there are three common tasks in statistical inference – estimating the underlying parameter/s, providing a confidence interval for the underlying parameter/s, and testing if the underlying parameter/s satisfy certain conditions. In parametric inference, there are two major approaches – the frequentist approach and the Bayesian approach. Concepts of both the theoretical set-ups will be discussed and practical problems will be discussed in detail. This course will serve as a foundation course for students working on Machine Learning. Candidates need to have a general knowledge of probability, data collection, and descriptive statistics to understand the content without any difficulty.

2. Course Modules with quantitative lecture hours:

Module 1: Random sample, Statistics, Order statistics, Sampling distributions, Parametric point estimation, Estimator, Unbiasedness, Sufficiency, Minimal sufficiency, Factorization theorem, Rao-Blackwell theorem, Completeness, Lehmann-Scheffe theorem, UMVUE, Basu's Theorem, Lower bounds for the variance of an estimator, Frechet-Rao-Cramer, Bhattacharya, Chapman- Robbins-Keifer inequalities.

(16 Hours)

Module 2: Consistency, Efficiency, Method of moments and method of maximum likelihood, Bayes estimators and Minimax Procedure, Invariance, Best equivariant estimators.

(10 Hours)

Module 3: Tests of hypothesis, Simple and composite hypothesis, Types of error, Neyman-Pearson Lemma, Families with monotone likelihood ratio, UMP, UMP unbiased and UMP invariant tests, Likelihood ratio tests- applications to one sample and two sample problems, Chi-square tests, Bayes tests, Methods for finding confidence intervals, shortest length confidence intervals, Bayesian confidence interval.

(16 Hours)

3. Text books:

1. Main Text Book: Statistical Inference, George Casella and Roger L. Berger, Duxbury Press, second edition 2001.

2. An Introduction to Probability and Statistics, Vijay K Rohatgi and A. K. Md. Ehsanes Saleh, John Wiley, second edition, 2001.

4. References:

1. A. M. Mood, F. A. Graybill and D. C. Boes, Introduction to the theory of Statistics, McGraw Hill Education, 3rd edition (2017)
2. J. Shao, Mathematical Statistics, Springer, (1998).
3. E. L. Lehmann, G. Casella, Theory of Point Estimation, Springer, (2006).
4. E. L. Lehmann, J. P. Romano, Testing of Statistical Hypothesis, Springer, (2006)

5. Similarity with the existing courses:
   (Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course code	Similarity content	Approx.% of content
1.	Interval estimation + Testing of hypothesis	MA-524	2 hours	~4.76%