Discipline Specific Elective (DSE) Course 3g: Bayesian Inference

Structure 1: PG Curricular Structure with only Course Work
Structure 2: PG Curricular Structure with Course Work + Research

Course Title & Code	Credits	Credit Distribution of the Course			Eligibility Criteria	Prerequisite of the course (if any)
		Lecture (45 Hours)	Tutorial (00 Hours)	Practical (30 Hours)		
DSE 3g: Bayesian Inference	**4**	**3**	**1**	**0**	**NIL**	**NIL**

Course Objectives:

- To provide the understanding of the fundamentals of Bayesian inference including concept of subjectivity and priors.
- Examine some simple Bayesian models and linear regression in a Bayesian framework.

Course Learning Outcomes: After successful completion of this course, student will be able to:

- Treat "evidence" as value of observations and prescribe methods to deal rationally with it.
- Equip students with skills to carry out and interpret posterior and pre-posterior data based modeling and analyses.
- Compute probability that the theory in question could produce the observed data.
- Examine some simple Bayesian models and linear regression in a Bayesian framework.

Unit I (12 Hours)

Review of Basic Probability Concepts. Comparing Likelihood and Bayesian Approaches, Concept of Inverse Probability and Bayes Theorem. Classes of Prior Distributions. Conjugate Families for One Parameter Exponential Family Models, Models admitting sufficient statistics of fixed dimension.

Unit II (12 Hours)

Generalized Maximum Likelihood Estimate. Types of Loss Functions. Bayes estimation under various loss functions. Posterior Risk. Bayesian interval estimation: Credible intervals, HPD intervals, Comparison with classical confidence intervals. Situation specific case studies to conduct posterior analysis.

Unit III (11 Hours)

Prior and posterior odds. Bayes factor. Lindley's Paradox. Various types of testing hypothesis problems.

Unit IV (10 Hours)

Predictive density function, Regression Models.

Tutorial:

Tutorial sessions will include at least one activity such as group discussion/presentation/ problem solving exercise based on the material covered in the lectures along with scholastic work related to the conceptual understanding of the subject.

Essential Readings:

1. Bernando, J.M. and Smith, A.F.M. (2000). *Bayesian Theory*, John Wiley & Sons.
2. Leonard, T. and Hsu, J.S.J. (1999). *Bayesian Methods, Cambridge University Press*.
3. Box, G.E.P. and Tiao, G.C. (1973). *Bayesian Inference in Statistical Analysis*, Addison & Wesley.

Suggested Readings:

1. Aitchison, J. and Dunsmore, I.R. (1975). *Statistical Prediction Analysis*, Cambridge University Press.
2. Berger, J. O., Bernardo, J. M. and Sun, D. (2023). *Objective Bayesian Inference*, World Scientific Publishing.
3. DeGroot, M.H. (1970). *Optimal Statistical Decisions*, McGraw Hill.
4. Kruschke, John. "Doing Bayesian data analysis: A tutorial with R, JAGS, and Stan." (2014).
5. Lee, P. M. (1997). *Bayesian Statistics: An Introduction*, Arnold Press.
6. Robert, C.P. (2001). *The Bayesian Choice: A Decision Theoretic Motivation* (2^{nd} Ed.), Springer Verlag.