i. **Course title: Bayesian Methods for Data Analysis**

ii. **Area to which the course belongs:** Production and Quantitative Methods

iii. **Term in which the course is to be offered: Term 6**

iv. **Instructor** : Karthik Sriram

v. **Course credits:** 1 credit (20 Sessions)

vi. **Introduction:**

> In many decision making situations, data may be limited or even if available may not be fully relevant to the problem at hand. In such situations, systematically incorporating expert opinions or prior information about the context along with data becomes important. This course introduces basic principles and methods in Bayesian data analysis. The ideas will be introduced by using a number of practical examples. Although the focus will be practical application of concepts, adequate theory will be discussed to help meaningfully formulate and solve problems.   Practical exercises will be mostly done in R and Excel. R software and the supporting GUI, can be freely downloaded from https://cran.r-project.org/ and https://www.rstudio.com

vii. **Objective:**

> The aim will be to provide a firm basic understanding of Bayesian methods to be able to apply to practical data analysis problems.

viii. **Pedagogy:**

> Lectures and practical exercises.

ix. **Evaluation Scheme:**

> **Quizzes 40% , Class Preparation 10%, Assignments 50%**

Course Books/Reference Materials:

> Study material with specific chapters and readings will be provided to the students

References

1. William M. Bolstad, Introduction to Bayesian Statistics (Second Edition), Wiley.
2. Jeff Gill, Bayesian Methods: A Social and Behavioral Sciences Approach (Third Edition), CRC Press.
3. Andrew Gelman et al: Bayesian Data Analysis (Third Edition), CRC Press.
4. Anthony O' Hagan et al, Uncertain Judgements: Eliciting Experts' Probabilities, Wiley.

x. Session Plan*:

Session	Topic	Chapter reference	Other Readings / Exercise	Course material page
1	Introduction to Bayesian thinking - Conditional Probability and the importance of prior information in some decision problems	Gill Ch 1	"Search for the wreckage of Air France Flight 447": Statistical Science (2014)	pg 1-36. pg 199-210
2	The Beta-Binomial Model (for estimating proportions): Understanding the posterior distribution	Bolstad Ch 8	Example on "Estimating probability of female birth in European populations" : Sections 2.1 -2.4 of Gelman et al Ch 2	pg 211-229
3	The Beta-Binomial Model: Informative and Non Informative Priors	Bolstad Ch 8		pg 287-297
4	The Beta-Binomial Model: Eliciting informative priors for proportions based on expert opinions	O'Hagan et al Ch 6, section 6.3		pg 321-332
5	Bayesian Estimation in Normal Populations: Known Variance	Bolstad ch 11	Ex 11.1 , 11.4 in Bolstad Ch 11	pg 247-270
6	Bayesian Estimation in Normal Populations: Known Mean, Unknown Variance			
7	Bayesian Estimation in Normal Populations: Unknown Mean, Unknown Variance			
8	Bayesian Estimation in Normal Populations: Prior Elicitation	Gill Ch 4 (Sections 4.5.2.1 and 4.5.2.2)	Example 4.1 on "election campaign spending" in Gill Ch 4	pg 58-61

Session	Topic	Chapter reference	Other Readings / Exercise	Course material page reference
9	Bayesian Analysis in Linear Regression Model	Gill Ch 5 (Sections 5.1,5.2)	Gill Ex 5.1, "Election on Palm beach county", Ex 5.3 "A Model of Education Effects"	pg 85-101
10	Bayesian Analysis in Linear Regression Models	Gill Ch 5 (Sections 5.1,5.2)		
11	**Quiz 1 + Recap of ideas**			
12	Bayesian analaysis with general distributions: e.g. Poisson-Gamma	Bolstad Ch 10		pg 231-246
13	Bayesian Testing and Bayes Factors	Gill Ch 7 (Sections 7.1 to 7.3)	Gill Ex 7.1 "French Labor strikes data"	pg 115-139
14	Bayesian Testing and Bayes Factors	Gill Ch 7 (Sections 7.1 to 7.3)		
15	Markov Chain Monte Carlo: Introduction	Gill Ch 1 (Sec 1.7)		pg 24-33
16	MCMC: Gibbs Sampler	Gill Ch 10 (Section 10.3)	Gill Ex 10.3: Change point analysis of Military Fatalities in Afghanistan	pg 165-175
17	MCMC: Gibbs Sampler			
18	Robust Bayesian analysis	Bolstad: Ch 16		pg 271-286
19	Robust Bayesian analysis			
20	**Quiz 2 + Wind up**			

*Specific readings or exercises may be altered by the instructor.

xi.   Pre-requisites & Eligibility:

Good knowledge of Probability and Statistics concepts at the level discussed in the first year PGP course.

Desirable: Mathematics at graduation level and familiarity with computer programming.