CALIFORNIA POLYTECHNIC STATE UNIVERSITY
San Luis Obispo, California

STAT 415 – Bayesian Reasoning and Methods **Fall 2017**

1. Catalog Description

STAT 415 Bayesian Statistical Reasoning (4)
Bayes' theorem, prior and posterior distributions, likelihood functions, Markov Chain Monte Carlo (MCMC) methods, hierarchical modeling, Bayesian data analysis, comparison of Bayesian and classical (frequentist) approaches. Prerequisite: one of the following: IME 326, STAT 252, STAT 302, STAT 312, STAT 313, or STAT 513; and one of the following: STAT 305, STAT 350, or STAT 425. Recommended: STAT 331.

2. Required Background and/or Experience

IME 326, STAT 252, STAT 302, STAT 312, STAT 313, or STAT 513; and one of the following: STAT 305, STAT 350, or STAT 425

3. Learning Objectives

The student should be able to:

a. Demonstrate how conditional probability and Bayes' theorem relate to the analysis of data via the Bayesian paradigm
b. Apply, implement, and interpret a Bayesian approach to relevant statistical problems
c. Apply simulation methods in Bayesian data analysis
d. Compare Bayesian and classical (frequentist) approaches of data analysis.

4. Text and References

Text: Kruschke, J., *Doing Bayesian Data Analysis,* 2nd ed., Academic Press, 2015.
References: Albert, J. *Bayesian Computation with R.*
Downey, A., *Think Bayes*.
Gelman, A. et al., *Bayesian Data Analysis*.
Hoff, P. *A First Course in Bayesian Statistical Methods.*
McElreath, R. *Statistical Rethinking: A Bayesian Course with Examples in R and Stan.*

5. Minimum Student Materials

Calculator and access to R or equivalent software for student use in preparing assignments and taking exams.

6. Minimum University Facilities

Access to R or equivalent software in the classroom, data projection capability, and chalkboard for instructional use.

7. Expanded Description of Content and Method

Content: *Number of Lectures*

1) Review of basic concepts of probability 4

Interpretations of probability, conditional probability, Bayes' theorem, probability distributions, expected value, variance, simulation, introduction to R or comparable software

2) Introduction to Bayesian inference 7

Models and parameters, prior and posterior distributions, likelihood functions, Bayes' rule for distributions, inference for a population proportion, credible intervals, choice of prior

3) Methods for approximating posterior distributions 5

Introduction to random walks and Markov chains, Metropolis algorithm, Gibbs sampling, introduction to JAGS or comparable software, evaluating performance of MCMC methods

4) Hierarchical modeling 6

Formulating and fitting hierarchical models, model comparison, model averaging, prediction

5) Bayesian approaches to hypothesis testing 4

Bayes factor, region of practical equivalence, power, sequential testing

6) Selected topics in Bayesian data analysis 10

Bayesian analysis of generalized linear models and special cases; Bayesian analogs of one- and two-sample t procedures, ANOVA, linear regression, chi-square procedures; comparison of Bayesian and classical (frequentist) approaches; reporting results of Bayesian analysis

Total 36

8. Method of Evaluating Outcome

Daily problem assignments, computer-based projects, scheduled tests, and a final examination.