I. **Course Description**

This course introduces hierarchical Bayesian statistical methods that enable investigators to combine information from similar experiments, account for complex spatial, temporal, and other correlations, and also incorporate prior information or expert knowledge (when available) into a statistical analysis. This course explains the theory behind Bayesian methods and their practical implementation, and also compares them with classical (frequentist) methods. The course emphasizes data analysis via modern computer simulation methods using WinBUGS and R (free statistical software) that are introduced and used in the course.

II. **Course Prerequisites**

Stat 5101-02 or PubH 7405-7406 or instructor's consent. If you are unsure about your qualifications for the course, please contact one of the instructors.

III. **Course Goals and Objectives**

Upon successful completion of the course, students will be able to independently formulate Bayesian hierarchical models for analyzing complex datasets arising from non-trivial statistical designs and experiments requiring such modeling. They will also be able to implement these models using statistical software, and write comprehensive reports for their analysis.
IV. Methods of Instruction and Work Expectations

Methods of instruction will be through in-class lectures and presentations, and also through hands-on practice with the WinBUGS and R software in the SPH Computer Lab (Mayo C381).

V. Course Text and Readings

The required text for the course will be the beta-test version of *Bayesian Methods for Data Analysis, 3rd edition* by Bradley P. Carlin and Thomas A. Louis. This will be passed out along with the syllabus on the first day of class at no cost to the student.

VI. Course Outline/Weekly Schedule

Week 1 (1/22): Preliminaries; Overview and basics of Bayesian Inference
Week 2 (1/29): Introduction to the R computing environment and language; Basic Bayesian Computing
Week 3 (2/5): Theory of Bayesian linear models; Bayesian linear models in R
Week 4 (2/12): Introduction to WinBUGS and Hierarchical Modeling
Week 5 (2/19): Bayesian Computing; Markov chain Monte Carlo (MCMC) methods; packages in R
Week 6 (2/26): Review; First Midterm Exam (in-class)
Week 7 (3/4): Bayesian Model Criticism and Selection
Week 8 (3/11): Empirical Bayes methods: point and interval estimates, frequentist comparisons
Week 9 (3/25): Bayesian designs for clinical trials
Week 10 (4/1): Hierarchical longitudinal and time-series models
Week 11 (4/8): Bayesian survival analysis and frailty models
Week 12 (4/15): Review; Second Midterm Exam (take-home)
Week 13 (4/22): Spatial and spatiotemporal models
Week 14 (4/29): Bayesian nonparametric regression
Week 15 (5/6): Bayesian inference for high-dimensional problems; case studies in Bayesian statistics

VII. Evaluation and Grading

Your final grade will be based upon homework assignments (30%), two midterms (15 and 25%, respectively), and a written final project at the end of the course (30%). For data analysis problems, your write-up must be a careful report of your models, methods, interpretations, and conclusions -- as if you were making a final report to a supervisor who has statistical training, but doesn't want to get bogged down in the details. Include the relevant parts of your computer output as a technical appendix, or "cut and paste" them into your report, labeling all plots, variables, and so forth. You need not get too carried away -- always substitute prose for output where possible. The final project involves preparing a short (say, 10-page) paper on some subtopic of interest to you. Once you have identified a topic of interest, we may suggest a paper or two for you to read as a starting point. This should in turn suggest several interesting project possibilities: extending an analytical result, simulating the performance of some procedure, undertaking a challenging data analysis, etc.

We take a very dim view of unexcused late assignments, especially in a class like this where most of the work is "take-home." As a general rule, prior notification is essential to our accepting a late paper of any kind. If illness or travel is going to cause you to miss a deadline, don't surprise us -- call or send an e-mail message (as crazed modern academics, we check our voice messages and e-mails constantly).

Incomplete Grade

A grade of incomplete "I" shall be assigned at the discretion of the instructor when, due to extraordinary circumstances, the student was prevented from completing the work of the course on time. The assignment of an incomplete requires a written agreement between the instructor and student specifying the time and
manner in which the student will complete the course requirements. In no event may any such written agreement allow a period of longer than one year to complete the course requirements.

University of Minnesota Uniform Grading and Transcript Policy
A link to the policy can be found at onestop.umn.edu.

VIII. Other Course Information and Policies

Grade Option Change (if applicable)
For full-semester courses, students may change their grad option, if applicable, through the second week of the semester. Grade option change deadlines for other terms (i.e. summer and half-semester) can be found at onestop.umn.edu.

Course Withdrawal
Students should refer to the Refund and Drop/Add Deadlines for the particular term at onestop.umn.edu for information and deadlines for withdrawing from a course. As a courtesy, students should notify their instructor and, if applicable, advisor of their intent to withdraw.

Students wishing to withdraw from a course after the noted final deadline for a particular term must contact the School of Public Health Student Services Center at sph-ssc@umn.edu for further information.

Student Conduct, Scholastic Dishonesty and Sexual Harassment Policies
Students are responsible for knowing the University of Minnesota, Board of Regents’ policy on Student Conduct and Sexual Harassment found at www.umn.edu/regents/polindex.html.

Students are responsible for maintaining scholastic honesty in their work at all times. Students engaged in scholastic dishonesty will be penalized, and offenses will be reported to the Office of Student Academic Integrity (OSAI, www.osai.umn.edu).

The University’s Student Conduct Code defines scholastic dishonesty as “plagiarizing; cheating on assignments or examinations; engaging in unauthorized collaboration on academic work; taking, acquiring, or using test materials without faculty permission; submitting false or incomplete records of academic achievement; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement; or altering, forging, or misusing a University academic record; or fabricating or falsifying of data, research procedures, or data analysis.”

Plagiarism is an important element of this policy. It is defined as the presentation of another's writing or ideas as your own. Serious, intentional plagiarism will result in a grade of "F" or "N" for the entire course. For more information on this policy and for a helpful discussion of preventing plagiarism, please consult University policies and procedures regarding academic integrity: http://writing.umn.edu/tww/plagiarism/.

Students are urged to be careful that they properly attribute and cite others' work in their own writing. For guidelines for correctly citing sources, go to http://tutorial.lib.umn.edu/ and click on “Citing Sources”.

In addition, original work is expected in this course. It is unacceptable to hand in assignments for this course for which you receive credit in another course unless by prior agreement with the instructor. Building on a line of work begun in another course or leading to a thesis, dissertation, or final project is acceptable.

If you have any questions, consult the instructor.

Disability Statement
It is University policy to provide, on a flexible and individualized basis, reasonable accommodations to students who have a documented disability (e.g., physical, learning, psychiatric, vision, hearing, or systemic) that may affect their ability to participate in course activities or to meet course requirements. Students with disabilities are encouraged to contact Disability Services to have a confidential discussion of their individual needs for accommodations. Disability Services is located in Suite180 McNamara Alumni Center, 200 Oak Street. Staff can be reached by calling 612/626-1333 (voice or TTY).