The University of Arizona

GUIDELINES
FOR
GRADUATE CERTIFICATE APPROVAL

Initiating college, department, or committee:

__________________________
Graduate Interdisciplinary Program (GIDP) in Statistics

Title of this proposal: __________________ Graduate Certificate in Statistics

Unit Administrator: (name and title) __J. Bruce Walsh, GIDP Chair

Signature: __________________ Date: __________________

College Dean: __________________ Date: __________________
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College Dean: __________________ Date: __________________
(Signature)
*In some situations signatures of more than one dean or department head may be required. If the program changes have a commitment of resources from other than the initiating unit, the signature of the collaborating department/committee head and collaborating college dean is also required. If you have any questions, please contact Sandra Gonzales, CCIT 337, 621-1847.
I. Certificate Name and Description:

- Name of the certificate. Graduate Certificate in Statistics

- Managing department college, department, and oversight committee membership.
  Graduate College: Graduate Interdisciplinary Program (GIDP) in Statistics.
  Oversight Committee is the Statistics GIDP Recruiting & Admissions Committee, appointments to which will be made by the GIDP Chair in Fall 2007. (The Committee is currently unstaffed since the GIDP has not yet admitted any students.)

- Specify whether the certificate is affiliated with an existing degree program or is a stand-alone certificate.

II. Certificate Requirements – Any changes to the originally approved certificate must be approved by the Graduate College.

- List the certificate requirements, including number of credit hours required and any special requirements for completion.
  Minimum 12 units of graduate-level courses, including 3 units of MATH 566--Theory of Statistics and a minimum of 9 units from a set list of elective courses (below). Students undertaking study for and progression towards completion of the Certificate must satisfy all policies and procedures for official University of Arizona graduate certificate programs.

- List current and new courses needed to meet certificate requirements. New courses should be designated as such and include a proposed catalog description. No less than 50% must be taken for a regular letter grade.

Required: 3 units of MATH 566 -- Theory of Statistics

Required: a minimum of 9 units taken for a letter grade from any of the following 25 options (no course may be taken more than once):

1. EPID 513 -- Statistical Genetics for Quantitative Measures (cross-listed as ANS 513 and as GENE 513)

2. AREC 517 -- Introductory Mathematical Statistics for Economists (cross-listed as ECON 517),

3. AREC 518 -- Introduction to Econometrics (cross-listed as ECON 518),

4. AREC 549 -- Applied Econometric Analysis (cross-listed as ECON 549)

5. AREC 559 -- Advanced Applied Econometrics, or ECON 522A -- Econometrics

6. EPID 676 -- Advanced Topics in Biostatistics (also listed as CPH 676; same offering unit)

7. EPID 684A -- Theory of Linear Models (also listed as CPH 684A; same offering unit)

New course. Proposed catalog description: This course serves as an introduction to estimation and hypothesis testing for general linear statistical models. Emphasis is placed on both the underlying
theory and practical problems that are encountered in using these models. Beginning with a review of matrix algebra, the course continues with a discussion of the general linear univariate model, and the general linear multivariate model. Distribution theory, estimation and hypothesis testing are addressed, along with sample size determination. Prerequisites: CPH 576A, CPH 576B.

8. EPID 684B -- General Linear and Mixed Effects Models (also listed as CPH 684B; same offering unit)
New course. Proposed catalog description: This course introduces basic concepts of linear algebra that are essential for understanding more advanced statistical modeling methodology. This knowledge is used to understand the General Linear Model (GLM) which includes ordinary linear regression, ANOVA, and other special applications and modern methods for the analysis of repeated measures, correlated outcomes and longitudinal data, including the unbalanced and incomplete data sets characteristic of biomedical research. Topics include an introduction to matrices for statistics, general linear models, analysis of correlated data, random effects models, and generalized linear mixed models. Prerequisites: CPH 684A.

9. EPID 684C -- Generalized Linear Modeling (also listed as CPH 684C; same offering unit)
New course. Proposed catalog description: This course serves as an introduction to Generalized Linear Models (GLMs) and Generalized Linear Mixed Models (GLMMs). GLMs introduces a unifying theory that combines the areas of linear models used for non-Gaussian data types including binary, count, and ordinal data. GLMMs extend the GLMs by the addition of random effects, thus increasing their usage to include analysis of correlated data. Applications include analysis of prospective or longitudinal data sets, which can have incomplete data or data collected at unequal time intervals. Prerequisites: CPH 684A and CPH 684B.

10. EPID 685 -- Statistical Consulting (also listed as CPH 685; same offering unit)

11. EPID 686 -- Survival Analysis (also listed as CPH 686; same offering unit)

12. ECOL 518 -- Spatio-temporal Ecology, or
    RNR 613 -- Applied Biostatistics

13. ECON 520 -- Quantitative Methods in Economics

14. EDP 658B -- Theory of Measurement

15. GEOS 585A -- Applied Time Series Analysis, or
    MATH 562 -- Time Series Analysis, or
    SIE 533 -- Time Series Modeling, Analysis, and Applications

16. MATH 563 -- Probability Theory

17. MATH 564 -- Theory of Probability

18. MATH 567A -- Theoretical Statistics

19. MATH 567B -- Theoretical Statistics

20. MATH 570 -- Categorical Data Analysis

21. MATH 571A -- Advanced Statistical Regression Analysis
New course. Proposed catalog description: Regression analysis including simple linear regression and multiple linear regression. Matrix formulation and analysis of variance for regression models. Residual analysis, transformations, regression diagnostics, multicollinearity, variable selection techniques, and response surfaces. Students will be expected to utilize standard statistical software packages for computational purposes. Prerequisite(s): MATH 410 or MATH 413, or equivalent; and MATH 461 or MATH 466, or equivalent.

22. MATH 571B -- Design of Experiments, or
   PSYC 507C -- Research Design & Analysis of Variance, or
   SIE 536 -- Experiment Design and Regression
MATH 571B is a new course. Proposed catalog description: Principles of designing experiments. Randomization, block designs, factorial experiments, analysis of contrasts, multiple comparisons, analysis of variance and covariance, repeated measures, variance components analysis. Students will be expected to utilize standard statistical software packages for computational purposes. Prerequisite(s): MATH 223, or equivalent; and MATH 571A.

23. MATH 574 -- Introduction to Geostatistics (cross-listed as GEOG 574)

24. SIE 522 -- Engineering Decision Making Under Uncertainty

25. SIE 531 -- Simulation Modeling and Analysis

This list of 25 options is necessarily broad, in order to give interested students maximum flexibility in choosing a Certificate curriculum that suits their individual graduate programs, and to attract a wide population of such students. However, a number of possible elective “sample tracks” of at least 9 units are possible; these include:

A. Biometry/Biological statistics, for students in biology and the life and medical sciences wishing to coordinate a program of statistical study around biometrical problems and applications:
   EPID 513, RNR 613, EPID 676; or
   RNR 613, EPID 676, EPID 686

B. Econometrics, for students in business and finance wishing to coordinate a program of statistical study around economic problems and applications:
   AREC 517, AREC 549, ECON 520; or
   AREC 518, AREC 549, AREC 559; or
   AREC 518, AREC 549, ECON 522A; or
   AREC 517, AREC 549, SIE 533; or
   AREC 517, AREC 549, MATH 562

C. Technometrics, for students in the physical and engineering sciences wishing to coordinate a program of statistical study around physical science/technical applications:
   SIE 522, SIE 531, SIE 533; or
   SIE 536, GEOS 585A, MATH 574

D. Psychometrics, for students in the social sciences and/or education wishing to coordinate a program of statistical study around quantitative problems in measurement and testing:
   EDP 658B, MATH 571A, PSYC 507C

E. Spatial/spatio-temporal statistics, for students whose data require design, analysis, and interpretation within a spatial or temporal context:
ECOL 518, MATH 571A, MATH 574, GEOS 585A; or
MATH 574, GEOS 585A, SIE 533; or
MATH 571A, MATH 574, MATH 562

F. Methodological Statistics, for Applied Mathematics majors and any advanced students in programs with heavy data-analytic needs wishing to develop expertise in the methods of statistical analysis:
MATH 571A, MATH 571B, MATH 570; or
MATH 571A, MATH 571B, MATH 562; or
MATH 571A, MATH 571B, EPID 684A; or
MATH 571A, PSYC 507C, EPID 684A; or
MATH 571A, SIE 536, EPID 684A; or
EPID 684A, EPID 684B, EPID 684C; or
EPID 685, MATH 571A, MATH 571B

G. Applied probability, for Applied Mathematics majors and any students in programs wishing to develop expertise in aspects of introductory probability and reasoning under uncertainty:
MATH 564, SIE 522, SIE 531
ECON 520, MATH 564, SIE 522

H. Theoretical Statistics, for Mathematics majors and students in other quantitative graduate programs wishing to develop expertise in the theory of probability and statistics:
MATH 564, MATH 563, MATH 567A; or
MATH 563, MATH 567A, MATH 567B

- Describe any courses that will be offered via distance learning or other distributed methods? None currently, although courses on the required or elective list that are in the future offered through distance education will be accepted for credit towards the Certificate.

- Student Learning Outcomes
  Students will obtain a firm foundation in the theory of statistical inference (via MATH 566) and also be allowed to design or select a concomitant curriculum pertinent to their own research or professional interests from a list of advanced, statistically-rigorous courses taken from across the campus’ offerings. Depending on the student’s selection of elective courses, expertise may be gained in statistical practice, theory, and/or applications in a specialized area such as biometry, econometrics, psychometrics, etc., as per the “sample tracks” illustrated above. Of course, these outcomes will differ depending on the combination of elective courses selected.

III. Student Admittance/Advising/Completion – Student must have no less than a bachelor’s degree for a post-baccalaureate, a master’s degree for a Post-Master’s certificate or be currently enrolled in a graduate level program.

- Are there prerequisites or standardized tests required for admission? Students must have earned at least a bachelor’s degree from an accredited institution of higher learning. No standardized tests are required.

- Is concurrent enrollment in a degree program allowed, required? Concurrent enrollment is allowed, but not required.
Is there a University credit requirement? *University credit is the term used to identify all credit offered by The University of Arizona with the exception of correspondence and Special Examination for Credit.*

None for admission.

Will transfer credit from other institutions be accepted? How many credit hours maximum? (May not exceed 6)

No transfer of credit will be allowed; however, coursework taken previously at another institution may be used to satisfy prerequisites for any of the courses in the Graduate Certificate, at the discretion of the course instructor or department.

What provisions are included for student advising?

Accepted students will meet with the Chair of the GIDP in Statistics or an alternate advisor from the GIDP designated by the Chair to plan a program of study suited to their professional needs. Upon admission, students plan their program with this advisor to devise a suitable set of electives to meet their individual graduate program needs.

May a student change from a certificate to a degree program? What are the provisions?

Yes, as desired. Students desiring admission the M.S. or Ph.D. program in Statistics must meet all existing requirements for admission to those programs at the time admission is requested.

**IV. Certificate and Student Outcomes**

Provide a plan and frequency for assessing the intended certificate outcomes both for students and the certificate.

Students earning the Certificate will be surveyed at the conclusion of their graduate studies to determine if the courses they selected to complete the Certificate served as important components of their Statistics education and training. One- and three-year follow-up assessments will be conducted. These will be web-based, but with active contact from the GIDP staff to target 90% return on the one-year and upwards of 80% on the three-year response. Feedback from these surveys will be forwarded to the GIDP curriculum committee for appropriate action.

**V. Student Demand - Is there sufficient student demand for the certificate?**

What is the anticipated student enrollment for this certificate?

Anticipated enrollment is 5-20 students over the next 3-5 years.

Will there be any collaboration with other departments or universities to maximize resources?

Yes. Due to the interdisciplinary nature of the Certificate and of the larger GIDP, a wide variety of departments and programs from multiple UA colleges will collaborate in providing courses for the Certificate.

Program demand/need. *Will the certificate serve a community need, preparation for professional certification exams, degree program recruitment, employability enhancement, or other.*

The Certificate will serve to provide necessary training for graduate students in other graduate programs who require more than introductory knowledge in statistical theory and applications, and also offer the opportunity for supplementary training for students in areas where statistics plays a key role. The Certificate will help define a curriculum of study that accomplishes advanced learning and training in the theory, application, and practice of modern Statistics, and that should be
recognized/certified as such. Indeed, the potential market for this Certificate extends beyond registered UA graduate students, to working professionals and other members of the State’s populace who wish to enhance their graduate training/quantitative literacy in modern statistical methods, helping to fulfill the Institution’s land-grant mission. The GIDP provides the appropriate venue to coordinate, rationalize, and utilize pertinent courses towards this goal and, at the same time, provide a focus of interest for current faculty concerned with statistically oriented teaching and training.

VI. Expected Faculty and Resource Requirements

- List the name, rank, highest degree and estimate of level of involvement of all current faculty who will participate in the program.
  J. Bruce Walsh, GIDP Chair, Ph.D., or his successor as GIDP Chair, will provide the majority of effort/involvement for managing the Certificate. Other faculty associated with the Certificate are restricted to those who will teach the required and elective courses through the auspices of their home departments, or core GIDP faculty assigned to advise entering students in the Chair’s stead.

- Describe additional faculty needed for the first three years of the certificate. No additional faculty are required to begin offering the Certificate. Certain courses selected for inclusion in the Certificate's elective list are under development; any needs the sponsoring department has for offering these courses are the responsibility of that department.

- Give the present numbers of FTE students and FTE faculty in the department or unit in which the certificate is offered. No students are currently enrolled in the Statistics GIDP, since the GIDP was only organized in 2006. We anticipate enrolling between 5-20 students over the next 3 years, admitting the first cohort in Fall 2007. Also, since the unit is a GIDP, it has no FTE faculty lines. However, over 30 full-time faculty members currently list affiliation with the GIDP.

- Give the proposed numbers of FTE students and FTE faculty for the next three years in the department or unit in which the certificate is offered. Since the GIDP was only organized in 2006, we anticipate enrolling between 5-20 students (not including students applying for the proposed Graduate Certificate) over the next 3 years, admitting the first cohort in Fall 2007. Also, since the unit is a GIDP, it has no FTE faculty lines. However, we expect the over 30 full-time faculty members currently listing affiliation with the GIDP to continue their membership for the next 3 years and beyond.

- Provide a copy of the current department budget and note any impact the approval of the certificate could have on department resources. The GIDP does not currently operate under its own budget, past the limited administrative supplement received from the Office of Graduate Interdisciplinary Programs. The new Certificate will have essentially no additional budgetary impact on the GIDP.

**NOTE:** Implementation of any graduate certificate requires approval by the appropriate university committees prior to announcement and implementation.

**Effective:** 4/2006