Proposal Form For Addition And Revision Of Courses

1. Proposing College / School: Samuel Ginn College of Engineering
   Department: Aerospace Engineering

2. Course Prefix and Number: AERO/MATH 5460

3. Effective Term: Fall 2015

4. Course Title: Perturbation Methods
   Abbreviated Title (30 characters or less): Perturbation Methods

5. Requested Action:
   - ☑ Rename a Course
   - ☑ Add a Course
   - ☑ Revise a Course
   - ☑ Current Course Number:
   - ☑ Proposed Course Number:
   - ☑ Type of Revision:

6. Course Credit:
   Contact/Group Hours | Scheduled Type (e.g.: Lab, Lecture, Practicum, Directed Study) | Weekly or Per Term? | Credit Hours | Anticipated Enrollment
                        |                                             |                      |              |                    |
   Maximum Hours (Repeatability): 3 | Lecture | 3 | 3 | 25

   Total Credit Hours: 3

7. Grading Type:
   - ☑ Regular (ABCDF)
   - ☑ Satisfactory/Unsatisfactory (S/U)
   - ☑ Audit

8. Prerequisites/Corequisites:
   - P MATH 2660 or instructor's consent

9. Restrictions: List specific restriction in space above.
   - ☑ College
   - ☐ Major
   - ☐ Standing
   - ☐ Degree

10. Course Description:
    Analytical solutions of nonlinear problems, ODEs, PDEs, multiple scales, and transcendental equations in engineering, mathematics, and physics using both regular and singular perturbation methods.

11. May Count Either:
    - aero/math 5460
    - aero/math 6460 (Indicate if this particular course cannot be counted for credit in addition to another)

12. Affected Program(s):
    (Respond "N/A" if not included in any program; attach memorandum if more space is required)
    - Program Type: Major
    - Program Title: Bachelor of Aerospace Engineering
    - Requirement or Elective? (required or optional?): Elective

13. Overlapping or Duplication of Other Units' Offerings:
    (If course is included in any other degree program, is used as an elective frequently by other unit(s), or is in an area similar to that covered by another college/school, attach correspondence with relevant unit)
    - ☑ Applicable
    - ☐ Not Applicable
14. Justification:

The MATH department has agreed to cross-list this course with AERO. (see attachment)

Many of the problems facing physicists, engineers, and applied mathematicians involve difficulties in solving nonlinear equations, transcendental equations, differential equations with variable coefficients, and nonlinear boundary conditions. Solutions to such problems are usually approximated using numerical techniques, analytical techniques, and combinations thereof. Foremost among analytical techniques are the systematic methods of perturbation theory, where a problem is linearized and solved approximately in terms of a small or a large parameter or coordinate. These mathematical techniques constitute an essential component of a student's "toolbox" for reducing the complexity of mathematical problems before solving them.

(Include a concise, yet adequate rationale for the addition/revision of the course, citing accreditation, assessments (faculty, graduate, and/or external) where applicable)

15. Resources:

No additional resources are required.

(Indicate whether existing resources such as library materials, classroom/laboratory space, and faculty appointments are adequate to support the proposed addition/revision; if additional resources are required, indicate how such needs will be met, referencing the appropriate level of authorization -- i.e.: Dean -- where necessary; if no additional resources or shifting of resources will be necessary, respond "Not Applicable")

16. Student Learning Outcomes:

1. understand when and how perturbation methods can be applied;
2. obtain regular perturbation solutions to algebraic equations involving small or large parameters;
3. construct perturbation solutions to linear and nonlinear boundary value problems for ordinary differential equations (ODEs);
4. identify singular perturbation problems and apply one of the strained-coordinate methods;
5. understand how solutions to initial value problems may depend on slow and fast scales and apply matched asymptotic and multiple scale methods to such problems.

The first four learning outcomes pertain to both undergraduate and graduate students. The last learning outcome is expected of the graduate students and is part of the Graduate Project (see grading info)

(State in measurable terms (reflective of course level) what students should be able to do when they have completed this course)

17. Course Content Outline:


References:
Objectives: The purpose of this course is to introduce students to asymptotic methods used in the construction of analytical approximations to transcendental equations and differential equations.

Lecture Topics:
Week 1: Introduction, examples, High-order polynomial
Week 2: High-order polynomial, Landau Orders — Gauge Functions,
Week 3: Non-dimensionalizing Equations, Regular Perturbations — Von Karman’s Eqn., Regular Perturbations — Slab Problem.
Week 4: Regular Perturbations — Method of Ansatz
Week 5: Regular Perturbations — Laplace’s Eqn., Regular Perturbations — Flow Past Cylinder
Week 6: Singular Perturbations — Nonlinear Spring
Week 7: Strained Coordinates — Lindstedt
Week 8: EXAM I, Post-Exam/Catching Up
Week 9: Strained Coordinates — PLK BCs
Week 10: Strained Coordinates — Pritulo, Boundary Layer Theory — Prandtl’s Matching Principle
Week 11: Inner Approximation — Erdelyi, Van Dyke’s Matching Principle
Week 12: EXAM II, Post-Exam/Catching UP
Week 13: Matched-Asymptotic Expansions
Week 14: Matched-Asymptotic Expansions, Multiple Scales
Week 15: Multiple Scales
Week 16: FINAL EXAM (undergraduate), Project Due (graduate)

(Provide a comprehensive, week-by-week breakdown of course content, including assignment due dates)

18. Assignments / Projects:
Homework: 20% contributes to all learning objectives
Test I: 25% contributes to learning objectives #1 and #2
Test II: 25% contributes to learning objectives #3 and #4
Undergraduate students — Final Exam: 30% - contributes to all learning objectives
Graduate students — Final Project: 30% — contributes to all learning objectives, but with special emphasis on Learning Outcome #5
The Final Project for the graduate students will involve the solution of a problem related to the individual student's area of interest within engineering, physics or mathematics using the methods developed in the course. This Final Project for the graduate students will replace an in-class final exam. The undergraduate students will not complete a project, but will have to complete an in-class final exam.

(List all quizzes, projects, reports, activities and other components of the course grade — including a brief description of each assignment that clarifies its contribution to the course’s learning objectives)

19. Rubric and Grading Scale:
Assessment Contribution to Course Grade
Homework: 20%
Exams (2@25%): 50%
Final Exam/Project: 30%
Course Grading Scale:
90-100% - A
80-89% - B
70-79% - C
60-69% - D
Below 60% - F

(List all components of the course grade — including attendance and/or participation if relevant — with point totals for each; indicate point totals and ranges or percentages for grading scale; for S/U grading, detail performance expectations for a passing grade)

20. Justification for Graduate Credit:
The Final Project is a requirement of all graduate students enrolled in the course, but is not a requirement for the undergraduate students. The Final Project will require the graduate students to select a problem for analysis using perturbation methods that will require a higher degree of critical thinking than would be expected of the undergraduate students.
Approvals

Department Chair / Head

College / School Curriculum Committee

College / School Dean

Dean of the Graduate School (for Graduate Courses)

Assoc. Provost for Undergraduate Studies (for Undergraduate Courses)

Date

Date

Date

Date

Date

Contact Person: Steve Gross

E-Mail Address: grossrs@auburn.edu

Telephone: 4-6846

Fax: 