AUBURN UNIVERSITY

Date: 08/01/2014 *(MM/DD/YYYY)*

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 7460/7466

3. Effective Term: Fall 2015

4. Course Title: Adanced Perturbation Methods

Abbreviated Title (30 characters or less): Adv Perturbation Methods

5. Requested Action:

- ○ Renumber a Course — Current Course Number:
- ◉ Add a Course — Proposed Course Number:
- ○ Revise a Course — Type of Revision:

6. Course Credit:

Maximum Hours (Repeatability): 3

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

Total Credit Hours: 3

7. Grading Type: ◉ Regular (ABCDF) ○ Satisfactory/Unsatisfactory (S/U) ○ Audit

8. Prerequisites/Corequisites:

Use "P:" to indicate a prerequisite, "C:" to indicate a corequisite, and "P/C:" to indicate a prerequisite with concurrency.

P AERO/MATH 6460, or departmental approval.

9. Restrictions: *List specific restriction in space above.* ☒ College ☐ Major ☐ Standing ☐ Degree

10. Course Description:

(20 Words or Less; exactly as it should appear in the Bulletin)

Solutions of nonlinear problems and integrals using WKB, Rayleigh-Janzen, Generalized Scales, Latta, van der Pol, Watson, Laplace, Adomian, Homotopy, Padé, Liouville-Green and Bürmann transformations.

11. May Count Either: AERO 7460/6 **or** MATH 7460/6 *(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 (e.g.: minor, major, etc.)	Program Title (e.g.: MS in Chemistry, Performance Option, Minor in Art)	Requirement or Elective? (required or optional?)
Graduate	Master in Aerospace Engineering	Elective
Graduate	Ph.D in Aerospace Engineering	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 the analytical techniques are the systematic methods of perturbation theory, where a problem is linearized and solved approximately in terms of small or large parameters or coordinates. These mathematical techniques constitute an essential component of a student's "toolbox" for reducing the complexity of mathematical problems before solving them. This course is a continuation of AERO/MATH 5460/6460.

(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 the use of several specialized asymptotic techniques
2. obtain perturbation solutions to complex physical settings involving small or large parameters;
3. understand how to model oscillatory problems;
4. obtain perturbation solutions for partial differential equations;
5. obtain perturbation solutions for problems exhibiting a nonlinear scaling structure;
6. obtain perturbation solutions for representative compressible flow problems.

(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:

Textbook: Carl M. Bender, and Steven A. Orszag, Advanced Mathematical Methods for Scientists and Engineers I: Asymptotic Methods and Perturbation Theory, Springer, 2010.
References:
1. Milton Van Dyke, Perturbation Methods in Fluid Mechanics, Annotated Edition, Parabolic Press, Inc., Stanford, CA, 1975.
2. Bhimsen K. Shivamoggi, Perturbation Methods for Differential Equations, Birkhäuser, Boston, 2002.
3. Carl M. Bender, and Steven A. Orszag, Advanced Mathematical Methods for Scientists and Engineers, McGraw-Hill, Inc., 1978.
4. Shijun Liao, Beyond Perturbation: Introduction to the Homotopy Analysis Method, 1st ed., Chapman & Hall/CRC Press, Boca Raton, FL, 2003.
5. Ali Hassan Nayfeh, Introduction to Perturbation Techniques, Wiley Classics Library Edition, John Wiley & Sons, Inc., 1981.
6. Ali Hassan Nayfeh, Perturbation Methods, John Wiley & Sons, Inc., 1973.
7. James A. Murdock, Perturbation Theory and Methods, John Wiley & Sons, Inc., 1991.
8. Jerry Kevorkian, and Julian D. Cole, Multiple Scale and Singular Perturbation Methods, Springer-Verlag, Inc., 1996.
9. A. Aziz, and T. Y. Na, Perturbation Methods in Heat Transfer, Hemisphere Publishing Corp., 1984.
Lecture Topics:
Week 1: The (Wentzel, Kramers, and Brillouin) WKB Method
Week 2: The WKB Method with Multiple Distinguished Limits
Week 3: The Liouville-Green Transformation
Week 4: The Latta Method of Composite Expansions

Week 5: TAKEHOME EXAM I, The Method of Averaging (van der Pol's Method, Krylov-Bogoliubov's Method)
Week 6: The Asymptotic Expansion of Integrals (Watson's Lemma)
Week 7: The Laplace Method
Week 8: The Rayleigh Janzen Expansion
Week 9: TAKEHOME EXAM II, The Adomian Decomposition Method (ADM)
Week 10: The Homotopy Analysis Method (HAM)
Week 11: The Pade Approximation Method
Week 12: The Expansion of Functions in Infinite Series
Week 13: Applications to Compressible Flow Behavior
Week 14: Applications to Compressible Flow Behavior
Week 15: Project Presentations
Week 16: TAKEHOME FINAL EXAM

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

18. Assignments / Projects:

Homework: 30% contributes to all learning objectives
EXAM I: 15% contributes to all learning objectives
EXAM II: 15% contributes to all learning objectives
FINAL EXAM: 20% contributes to all learning objectives
Project: 20% contributes to all learning objectives
The course instructor will work with the Engineering Graduate Outreach Program office to conduct lectures in a video studio classroom. Engineering Outreach will deliver video content to distance learning students. The instructor will use Canvas to communicate with students, provide learning materials, and post assignments and grades. Engineering Outreach will arrange exam proctoring services.

(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: 30%
Exams (2@15%): 30%
Final Exam: 20%
Project: 20%
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:

This course requires the student to have a strong foundation in basic perturbation methods through completion of the AERO 6460 course. Students are required to read and comprehend current research material in this field via peer-reviewed journal articles.

(Include a brief statement explaining how the course meets graduate educational standards (i.e.: rigorous standards for evaluation, development of critical thinking and analytical skills, etc.))

(Included below are standard statements regarding course policies. If necessary, a statement may be altered to reflect the academic policies of individual faculty members and/or the academic unit or department, provided that there is no conflict with the Student Policy eHandbook, Faculty Handbook, or any existing university policy.)

POLICY STATEMENTS

Attendance: Although attendance is not required, students are expected to attend all classes, and will be held responsible for any content covered in the event of an absence.

Excused Absences: Students are granted excused absences from class for the following reasons: illness of the student or serious illness of a member of the student's immediate family, the death of a member of the student's immediate family, trips for student organizations sponsored by an academic unit, trips for university classes, trips for participation in intercollegiate athletic events, subpoena for a court appearance, and religious holidays. Students who wish to have an excused absence from class for any other reason must contact the instructor in advance of the absence to request permission. The instructor will weigh the merits of the request, and render a decision. When feasible, the student must notify the instructor prior to the occurrence of any excused absences, but in no case shall such notification occur more than one week after the absence. Appropriate documentation for all excused absences is required. Please consult the **Student Policy eHandbook** for more information on excused absences.

Make-Up Policy: Arrangement to make up a missed major examination (e.g.:hour exams, mid-term exams) due to properly authorized excused absences must be initiated by the student within one week of the end of the period of the excused absence(s). Except in unusual circumstances, such as the continued absence of the student or the advent of university holidays, a make-up exam will take place within two weeks of the date that the student initiates arrangements for it. Except in extraordinary circumstances, no make-up exams will be arranged during the last three days before the final exam period begins.

Academic Honesty Policy: All portions of the Auburn University student academic honesty code (Title XII) found in the **Student Policy eHandbook** will apply to university courses. All academic honesty violations or alleged violations of the SGA Code of Laws will be reported to the Office of the Provost, which will then refer the case to the Academic Honesty Committee.

Disability Accommodations: Students who need accommodations are asked to electronically submit their approved accommodations through AU Access and to arrange a meeting during office hours the first week of classes, or as soon as possible if accommodations are needed immediately. If you have a conflict with my office hours, an alternate time can be arranged. To set up this meeting, please contact me by e-mail. If you have not established accommodations through the Office of Accessibility, but need accommodations, make an appointment with the Office of Accessibility, 1228 Haley Center, 844-2096 (V/TT).

Approvals

Joe Majdalani — Department Chair / Head — Date: 1/13/15

Steve R. Dahl — College / School Curriculum Committee — Date: 1/22/15

College / School Dean — Date: 1/22/15

Dean of the Graduate School *(for Graduate Courses)* — Date

Assoc. Provost for Undergraduate Studies *(for Undergraduate Courses)* — Date

Contact Person:	Steve Gross	**Telephone:**	4-6846
E-Mail Address:	grossrs@auburn.edu	**Fax:**	