AUBURN UNIVERSITY

Date: 08/26/2014 *(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 7150/7156

3. Effective Term: Fall 2015

4. Course Title: Compressible Fluid Dynamics

Abbreviated Title (30 characters or less): Compressible Fluid Dynamics

5. Requested Action:

- ○ Renumber a Course — Current Course Number:
- ◉ Add a Course — Proposed Course Number:
- ○ Revise a Course — 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
3	Lectures	Weekly	3	25

Maximum Hours (Repeatability): 3

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.

Pr AERO 4140 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)

An introduction to the fundamentals of compressible fluid dynamics. Application of conservation of mass, momentum and energy for compressible flows.

11. May Count Either: AERO 7150 **or** AERO 7156 *(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	MS in Aerospace Engineering	Elective
Graduate	PhD 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:

Most flows of practical interest in aerospace engineering are inherently compressible. This course is designed to teach the fundamental physics that govern compressible flows including normal shocks, oblique shocks, Quasi-one-dimensional compressible flow, unsteady wave motion, linearized compressible flow, conical flow and the method of characteristics. The principles taught in this course are essential for graduate students to be able to stay current with modern research methods employed to characterize compressible flows. They also need an understanding the design and operation of modern wind tunnels and other test facilities.

(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. Know the basic compressible flow equations
2. Understand and solve problems involving basic compressible flow phenomena including normal shocks, oblique shocks and expansion fans
3. Solve problems involving unsteady wave motion such as those found in shock tubes
4. Understand how to form solutions to non-linear flow problems through linearization of the compressible flow problems
5. Apply the method of characteristics to obtain 2D velocity fields for supersonic nozzles and other geometries

(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: J. D. Anderson, Jr., Modern Compressible Flow, 3rd Edition, McGraw Hill, 2004.
Course content (Week/Topic):
1. Fundamental Equations of Compressible Fluid Dynamics
2. Normal Shock Waves
3. Oblique Shock Waves and Expansion Fans, Shock-Expansion Theory
4. Quasi-one-dimensional Flow, Nozzles/Diffusers
5. Unsteady Wave Motion
6. Unsteady Wave Motion
7. Shock Tubes, Exam #1
8. Velocity Potential Equations
9. Linearized Flow; Compressibility Corrections
10. Conical Flow
11. Method of Characteristics
12. Method of Characteristics
13 Method of Characteristics, Exam #2
14. Compressible Turbulence
15. Presentations
Final Exam

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

18. Assignments / Projects:

The course will consists of traditional homework assignments, exams and a course project as follows.
Exam 1 – 25%
Exam 2 – 25%
Project (Paper and Presentation) – 25%
Final Exam – 25%
Homework: Homework will be assigned regularly and is expected to be completed in a timely manner; however, homework will not be collected or graded. Select problems will be solved in class based on student feedback. A random homework problem will be collected with each Exam and will

count as one of the exam problems.
Paper/Presentation: Each student will be expected to write a paper and give a presentation on a select advance topic related to compressible fluid dynamics. The complete subject of compressible fluid dynamics cannot be covered in a single course, particularly as one considers the many applications and various geometries in which compressible flows exists. As part of this course, each student will complete a project (paper and presentation) on an advanced subject related to compressible fluid dynamics.
The purpose of this project is:
1) To provide the student with a deeper understanding of a topic related to compressible fluid dynamics not covered in the regular course material.
2) To develop students' technical writing and presentation skills.
3) To provide the class with a broader overview of topics related to compressible fluid dynamics through in-class presentations.
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:

Exam 1 – 25%
Exam 2 – 25%
Project (Paper and Presentation) – 25%
Final Exam – 25%
90-100% A
80-89% B
70-79% C
60-69% D
<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:

Compressible fluid dynamics is primarily covered in Aerodynamics II at the undergraduate level. This courses provide a much more in-depth and rigorous treatment of compressible fluid dynamics than is found in the undergraduate curriculum. In addition to a more rigorous mathematical treatment of the basic subject matter, including alternate forms of deriving the fundamental equations, the graduate level course covers additional topics not found in the undergraduate curriculum. These include unsteady wave motion, shock tubes, linearized methods, conical shock solutions, compressible turbulence and the method of characteristics. In addition, the course project provides an additional area of study not found at the undergraduate level.

(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	1/13/15 Date
Steve R. Dahl College / School Curriculum Committee	1/22/15 Date
College / School Dean	1/22/15 Date
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:**	