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 7420/7426

3. Effective Term: Fall 2015

4. Course Title: Particle Image Velocimetry

Abbreviated Title (30 characters or less):

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	Lectures	Weekly	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.

AERO 7120 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 particle image velocimetry and it variations including conventional planar PIV, stereo-PIV and tomo-PIV.

11. May Count Either: AERO 7420 **or** AERO 7426 *(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:

Particle image velocimetry (PIV) is the predominant experimental method for measurement of 2D and 3D fluid velocity fields in laboratories throughout the world including several at Auburn University. Understanding the fundamental concepts and principles of this method are essential for proper application of the technique and interpretation/analysis of results obtained with the technique. In addition, the development of advanced instrumentation and measurement techniques based on PIV principles is and will continue to be an active area of research. Establishment of such a course will provide students with the knowledge necessary to work in and advance this field.

(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 fundamentals of light scattering from particles and the formation of particle images
2. Be able to develop and apply direct and Fourier based cross-correlation algorithms for the analysis of particle image pairs.
3. Quantify uncertainty associated with calculation of particle displacements at various image noise levels.
4. Perform particle image velocimetry experiments
5. Analyze particle image velocimetry results
6. Identify various sources of error and uncertainty in PIV experiments

(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: Particle Image Velocimetry
Cambridge Aerospace Series, 2011
Authors: Ronald J. Adrian, Jerry Westerweel
Course content (Week/Topic):
1. Introduction & Brief History; Components of a basic PIV measurement system; Overview of PIV variants
2. Particles – particle slip, light scattering and statistical considerations
3. Imaging – geometric imaging, diffraction, illumination
4. Imaging – recording, discretization, noise sources
5. Synthetic image generation
6. Image Processing – Cross correlation & peak detection
7. Image Processing – Advanced Algorithms
8. Data Postprocessing – Validation & replacement
9. Data Postprocessing – Derivatives and statistics
10. Stereo-PIV
11. Micro-PIV
12. Tomo-PIV
13. Student Oral Presentations
14. Student Oral Presentations
15. Student Oral Presentations
Oral Presentations are substituted for Final Exam

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

18. Assignments / Projects:

In addition to lectures and regular reading assignments, the course will primarily consists of in-depth, hands-on homework assignments that stress practical implementation of concepts discussed in class. In addition, each student will be expected to write a paper and give an oral presentation on a select advanced topic related to particle image velocimetry. The purpose of the project is:
1) To provide the student with a deeper understanding of a topic related to

PIV 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 PIV through in-class presentations.
HW Projects 60 %
Research Paper/Presentation 40 %
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:

HW Projects 60 %
Research Paper/Presentation 40 %
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:

PIV is a routinely used measurement in fluid dynamics research and provides the base measurement for many discoveries and advancements in the broad field of fluid dynamics. It is not covered at the undergraduate or graduate level in any discipline. These experimental PIV techniques allow the student to establish the validity of mathematical models for flow behavior introduced in the prerequisite course AERO 7120: Dynamics of Viscous Fluids.

(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. Dr 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:**	