Office of the Registrar
FORM 40G REV. 1/07

PURDUE UNIVERSITY
REQUEST FOR ADDITION, EXPIRATION, OR REVISION OF A GRADUATE COURSE
(500-600 LEVEL)

EFD 21-09
Graduate Council Doc. No. 10-16e

DEPARTMENT Mechanical Engineering EFFECTIVE SESSION Spring 2011

INSTRUCTIONS: Pl~~Mechanical Engineering~~ ~~Fall 2009~~

- [x] 1. New course with supporting documents (complete proposal form)
- [ ] 2. Add existing course offered at another campus
- [ ] 3. Expiration of a course
- [ ] 4. Change in course number
- [ ] 5. Change in course title
- [ ] 6. Change in course credit/type
- [ ] 7. Change in course attributes
- [ ] 8. Change in instructional hours
- [ ] 9. Change in course description
- [ ] 10. Change in course requisites
- [ ] 11. Change in semesters offered
- [ ] 12. Transfer from one department to another

PROPOSED:		EXISTING:	
Subject Abbreviation	ME	Subject Abbreviation	
Course Number	ME 592 00	Course Number	

Long Title: Fundamentals of Particle Image Velocimetry

Short Title: Fund of PIV
Abbreviated title will be entered by the Office of the Registrar if omitted. (22 CHARACTERS ONLY)
~~Fundamentals of Particle Image Velocimetry~~

TERMS OFFERED (Check All That Apply)
- [ ] Summer
- [ ] Fall
- [x] Spring

CAMPUS(ES) INVOLVED
- [ ] Calumet
- [ ] Cont Ed
- [ ] Ft. Wayne
- [ ] Indianapolis
- [ ] N. Central
- [ ] Tech Statewide
- [x] W. Lafayette

1. Fixed Credit: Cr. Hrs. 1
2. Variable Credit Range:
   Minimum Cr. Hrs
   (Check One) To [ ] Or [ ]
   Maximum Cr. Hrs
3. Equivalent Credit: Yes [ ] [X]
4. Thesis Credit: Yes [ ] No [X]

1. Pass/Not Pass Only [ ]
2. Satisfactory/Unsatisfactory Only [ ]
3. Repeatable [ ]
   Maximum Repeatable Credit:
4. Credit by Examination [ ]
   ~~nator Required~~ [ ]
   ~~al Fees~~ [ ]

7. Registration Approval Type
   Department [ ] Instructor [ ]
8. Variable Title
9. Remedial
10. Honors
11. Full Time Privilege
12. Off Campus Experience

Instructional Type	Min Per Mtg	Max Per Week	Weeks Offered	% of Credit Allocated	Delivery Method (Asyn. Or Syn.)	Delivery Medium (Audio, Internet, Live, Text-Based, Video)
Lecture	50	1	16		Syn	~~Live~~
Recitation						
Presentation						
Laboratory						
Lab Prep						
Studio						
Distance						
Clinic						
Experiential						
Research						
Ind. Study						
Pract/Observ						

Cross-Listed Courses

COURSE DESCRIPTION (INCLUDE REQUISITES):

ME 592 00 Fundamentals of Particle Image Velocimetry, Sem. 2, Class 1, cr. 1. Prerequisite: ME 30900

Measurement of fluids in motion using the particle image velocimetry technique and related techniques through computer programming, laboratory experiments, and independent research in experimental fluids journals.

Professor Wereley.

Calumet Department Head	Date	Calumet School Dean	Date	Calumet Undergrad Curriculm Committee	Date
Fort Wayne Department Head	Date	Fort Wayne School Dean	Date	Fort Wayne Chancellor	Date
				V. R. Capra	3/3/2010
Indianapolis Department Head	Date	Indianapolis School Dean	Date	Undergrad Curriculm Committee	Date
				APPROVED	2/17/11
North Central Department Head	Date	North Central Chancellor	Date	Date Approved by Graduate Council	
E. Daniel Hirleman	12/12/2008			Tina L. Payne	2/18/11
West Lafayette Department Head	Date	West Lafayette College/School Dean	Date	Graduate Council Secretary	Date
T.A. Wenshon	2/17/2011				3/10/11
Graduate Area Committee Convener	Date	Graduate Dean	Date	West Lafayette Registrar	Date

OFFICE OF THE REGISTRAR

3/11/11

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PURDUE UNIVERSITY
REQUEST FOR ADDITION, EXPIRATION,
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(500-600 LEVEL)

EFD 2-1-09

DEPARTMENT: Mechanical Engineering

EFFECTIVE SESSION: Fall 2009

INSTRUCTIONS: Pl

- [x] 1. New course with supporting documents (complete proposal form)
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PROPOSED:		EXISTING:	
Subject Abbreviation	ME	Subject Abbreviation	
Course Number	ME 592	Course Number	
Long Title			
Short Title	Fund of PIV		

Abbreviated title will be entered by the Office of the Registrar if omitted. (22 CHARACTERS ONLY)

Fundamentals of Particle Image Velocimetry

TERMS OFFERED
Check All That Apply:
[ ] Summer [ ] Fall [x] Spring

CAMPUS(ES) INVOLVED
[ ] Calumet [ ] N. Central
[ ] Cont Ed [ ] Tech Statewide
[ ] Ft Wayne [x] W. Lafayette
[ ] Indianapolis

1. Fixed Credit: Cr. Hrs. 1
2. Variable Credit Range:
   Minimum Cr. Hrs
   (Check One) To [ ] Or [ ]
   Maximum Cr. Hrs
3. Equivalent Credit: Yes [ ] No [ ]
4. Thesis Credit: Yes [ ] No [ ]

1. Pass/Not Pass Only [ ]
2. Satisfactory/Unsatisfactory Only [ ]
3. Repeatable [ ]
   Maximum Repeatable Credit:
4. Credit by Examination [ ]
   nator Required [ ]
   ic Special Fees [ ]

7. Registration Approval Type
   Department [ ] Instructor [ ]
8. Variable Title [ ]
9. Remedial [ ]
10. Honors [ ]
11. Full Time Privilege [ ]
12. Off Campus Experience [ ]

Instructional Type	Min Per Mtg	Weeks	Times Offered	% of Credit Allocated	Delivery Method (Asyn. Or Syn.)	Delivery Medium (Audio, Internet, Live, Text-Based, Video)
Lecture	50	1	16		Syn	e
Recitation						
Presentation						
Laboratory						
Lab Prep						
Studio						
stance						
Clinic						
Experiential						
Research						
Ind. Study						
Pract/Observ						

Cross-Listed Courses

COURSE DESCRIPTION (INCLUDE REQUISITES):

ME 592 Fundamentals of Particle Image Velocimetry, Sem. 2, Class 1, cr. 1. Prerequisite: ME 309

Measurement of fluids in motion using the particle image velocimetry technique and related techniques through computer programming, laboratory experiments, and independent research in experimental fluids journals.

Calumet Department Head	Date	Calumet School Dean	Date	Calumet Undergrad Curriculm Committee	Date
Fort Wayne Department Head	Date	Fort Wayne School Dean	Date	Fort Wayne Chancellor	Date
				R. Cipra	3/3/2010
Indianapolis Department Head	Date	Indianapolis School Dean	Date	Undergrad Curriculm Committee	Date
North Central Department Head	Date	North Central Chancellor	Date	Date Approved by Graduate Council	
Daniel Hirleman	12/12/2008		5/12/2010		
West Lafayette Department Head	Date	West Lafayette College/School Dean	Date	Graduate Council Secretary	Date
Graduate Area Committee Convener	Date	Graduate Dean	Date	West Lafayette Registrar	Date

OFFICE OF THE REGISTRAR

TO: The Engineering Faculty

FROM: The Faculty of the School of Mechanical Engineering

RE: New Course – ME 592 Fundamentals of Particle Image Velocimetry

The Faculty of the School of Mechanical Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

ME 592 Fundamentals of Particle Image Velocimetry
Sem. 2, Class 1, cr. 1
Prerequisite: ME 309

Measurement of fluids in motion using the particle image velocimetry technique and related techniques through computer programming, laboratory experiments, and independent reading of experimental fluids journals.

Reason: This course has been taught three times on an experimental basis with the following enrollments: spring 2002 - 25 students , spring 2005 – 22 students, and spring 2008 - 17 students. This course provides students with fundamental knowledge and experience on how to measure fluid motion using the particle image velocimetry (PIV) technique. As such this course is a valuable source for developing skills in this technique for students utilizing PIV in their research.

James D. Jones

James D. Jones, Associate Head/Professor
School of Mechanical Engineering

APPROVED FOR THE FACULTY
OF THE SCHOOLS OF ENGINEERING
BY THE ENGINEERING
CURRICULUM COMMITTEE

ECC Minutes #11

Date 12/14/09

Chairman ECC R. Cipra

ME 592
FUNDAMENTALS OF PARTICLE IMAGE VELOCIMETRY

Course Outcomes

1. To learn the principles of *quantitative* flow visualization.
2. To study the physical phenomena underlying particle image velocimetry.
3. To understand the limitations of this flow measurement technique.
4. To explore advanced topics in particle image velocimetry.

Introduction (2 wks)

1. Historical background
2. Principles of operation
3. Recent developments

Tracer particles (2 wks)

1. Fluid/Particle dynamics
2. Light scattering behavior
3. particle generation and supply

Light sources (1 wk)

1. lasers
2. white light sources

Image Recording (2 wks)

1. Photographic recording
2. Digital imaging
3. Sources of error in imaging

Mathematical Background (3 wks)

1. Particle image locations
2. Image intensity field
3. auto/cross correlation

Advanced Topics (5 wks)

1. Adaptive window shifting
2. image correction
3. simultaneous temperature/velocity measurements
4. holographic and other 3D techniques
5. bio applications
6. micro applications

COURSE NUMBER: ME 592

COURSE TITLE: Fundamentals of Particle Image Velocimetry

REQUIRED COURSE OR ELECTIVE COURSE: Elective

TERMS OFFERED: Spring

TEXTBOOK/REQUIRED MATERIAL: Raffel, Willert, Kompenhans, Particle *Image Velocimetry*, Springer-Verlag, 1998.

PRE-REQUISITES: ME 309 Fluid Mechanics

COORDINATING FACULTY: S. Wereley

COURSE DESCRIPTION: Measurement of fluids in motion using the particle image velocimetry technique and related techniques through computer programming, laboratory experiments, and independent reading of experimental fluids journals.

ASSESSMENTS TOOLS:

1. Weekly homework assignments.
1. One laboratory report.
2. One final oral report.

PROFESSIONAL COMPONENT:

1. Engineering Topics: Engineering Science – __ credit (80%)
   Engineering Design – __ credit (20%)

COURSE OUTCOMES:

1. Understand the various *scientific principles* underlying the particle image velocimetry technique – fluid dynamics, particle dynamics, optics, etc.
2. Gain an in-dept understanding of the *PIV technique* including its advantages over competing techniques, its limitations, and its future potential.
3. An ability to analyze a particular flow and determine the *optimal parameter space* for investigating that flow: particle size, time between exposures, imaging format, magnification, etc.
4. Exposure to several of the *commercial particle image velocimetry packages* in addition to writing their own basic software.

NATURE OF DESIGN CONTENT: The class has a project for the final deliverable. Students must design the experiment necessary for this project. The design can be either a computational design or actual hardware.

RELATED ME PROGRAM OUTCOMES: N/A

COMPUTER USAGE: The students will need to use Matlab or a programming language (C/C++, VisualBasic, Fortran, etc.) to write basic particle image velocimetry computer programs.

COURSE STRUCTURE/SCHEDULE:

1. Lecture – 1 day per week at 50 minutes.

PREPARED BY: S. Wereley

DATE: March 26, 2007

Supporting Document for a New Graduate Course

Purdue University Graduate Council

For Reviewer's comments only
(Select One)
Choose an item.

From: Faculty Member: Steven T. Wereley
Department: Mechanical Engineering
Campus: West Lafayette

Reviewer:
Click here to enter text.

Date: 3/15/2010

Comments:
Click here to enter text.

Subject: Proposal for New Graduate Course- Documentation Required by the Graduate Council to Accompany Registrar's Form 40G

Contact for information if questions arise:

Name: James D. Jones
Phone Number: 494-5691
E-mail: jonesjd@purdue.edu
Campus Address: 1288 ME/ME room 222

Course Subject Abbreviation and Number: ME 59200

Course Title: Fundamentals of Particle Image Velocimetry

A. Justification for the Course:

- This course has been taught three times on an experimental basis with the following enrollments: spring 2002 – 25 students, spring 2005 – 22 students, and spring 2008 – 17 students. This course provides students with fundamental knowledge and experience on how to measure fluid motion using the particle image velocimetry (PIV) technique. As such this course is a valuable source for developing skills in this technique for students utilizing PIV in their research.
- The proposed ME 59200 is a one-credit course on the fundamentals of particle image velocimetry (PIV). Because of the advanced nature of this measurement technique, this course is designed for entry-level graduate students, although some undergraduate students may take the course. Enrollment is anticipated to be 15-20 students per year, mostly graduate students.

B. Learning Outcomes and Methods of Evaluation or Assessment:

- 1) Understand the various scientific principles underlying the particle image velocimetry technique – fluid dynamics, particle dynamics, optics, etc. 2) Gain an in-depth understanding of the PIV technique including its advantages over competing techniques, its limitations, and its future potential. 3) An ability to analyze a particular flow and determine the optimal parameter space for investigating that

flow: particle size, time between exposures, imaging format, magnification, etc. 4) Exposure to several of the commercial particle image velocimetry packages in addition to writing their own basic software.

- Weekly homework assignments, one laboratory report and one final oral report.
- Engineering Topics: Engineering Science - ___ credit (80%) & Engineering Design - ___ credit (20%)
  - **Criteria:**

☐	Exams and Quizzes	☒	Papers and Projects
☒	Homework	☒	Laboratory Exercises
☐	Attendance and Class Participation	☐	Extra Credit Policies

- This course is taught by lecture and covers the program outcomes described in the program map.
  - **Method of Instruction:**

☒	Lecture	☐	Recitation
☐	Presentation	☐	Laboratory
☐	Lab Prep	☐	Studio
☐	Distance	☐	Clinic
☐	Experimental	☐	Research
☐	Ind. Study	☐	Pract/Observe
☐	Seminar		

C. Prerequisite(s):

- ME 30900 – Fluid Mechanics
- The students will need to use Matlab or a programming language (C/C++, Visual Basic, Fortran, etc.) to write basic particle image velocimetry computer programs.

D. Course Instructor(s):

- Steven T. Wereley, Associate Professor of Mechanical Engineering
- Is the instructor currently a member of the Graduate Faculty? ☒ Yes ☐ No Click here to enter text.
  (If the answer is no, indicate when it is expected that a request will be submitted.)

E. Course Outline:

- Introduction (2 weeks), Tracer particles (2 weeks). Light sources (1 week), Image recording (2 weeks), Mathematical background (3 weeks), and Advanced topics (5 weeks).

F. Reading List (include course text):

- "Particle Image Velocimetry" by Raffel, Willert, Kompenhans, Spring-Verlag, 1998.
- No textbook required.

G. Library Resources:

- No resources needed.

H. Example of a Course Syllabus:

Date	Class #	Subject	Reading
11-Jan	1	Introduction	Chapter 1
18-Jan	2	Demonstrations	
25-Jan	3	Tracer particles, illumination	Chapter 2
1-Feb	4	Particle imaging	Chapter 2
8-Feb	5	Statistics of PIV	Chapter 3
15-Feb	6	Recording techniques	Chapter 4
22-Feb	7	Eval Techniques I, corr, peak fitting	Chapter 5, papers
1-Mar	8	Eval Techniques II, corr tracking, padding	Chapter 5, papers
8-Mar	9	Eval Techniques III, corr avg, CDIC	Chapter 5, papers
22-Mar	10	Image processing, particle ident, part tracking	papers
29-Mar	11	Data validation, correction, statistics	papers
5-Apr	12	Resolution, uncertainty	papers
12-Apr	13	Advanced Topics, stereo, holo, temp	papers
19-Apr	14	Applications	
26-Apr	15	Reports	
Final	16	Reports	

Supporting Document for a New Graduate Course

To: Purdue University Graduate Council

From: Faculty Member: Anil K. Bajaj
Department: Mechanical Engineering
Campus: Mechanical Engineering

Date: 3/16/2010

Subject: Proposal for New Graduate Course- Documentation Required by the Graduate Council to Accompany Registrar's Form 40G

For Reviewer's comments only (Select One)
Choose an item.
Reviewer: Click here to enter text.
Comments: Click here to enter text.

Contact for information if questions arise:

Name:	James D. Jones
Phone Number:	494-5691
E-mail:	jonesjd@purdue.edu
Campus Address:	1288 ME / ME room 222

Course Subject Abbreviation and Number: ME 69100

Course Title: Mechanical Engineering Graduate Seminar

A. Justification for the Course:

- This course has been taught four times on an experimental basis with the following enrollments: fall 2004 – 63 students, fall 2005 – 110 students, fall 2006 – 140 students, and fall 2007 – 163 students. This course provides new graduate students with a broad understanding of the field of Mechanical Engineering and an appreciation of various interdisciplinary research efforts.
- ME 69100 is a new Mechanical Engineering Graduate Seminar course. As such it is designed exclusively for new graduate students. No undergraduates wil be taking this course. Anticipated enrollment will typically be 100-150 graduate students.

B. Learning Outcomes and Methods of Evaluation or Assessment:

- 1) Develop an understanding of the field of Mechanical Engineering in its widest possible applications.
  2) Develop an appreciation of the various interdisciplinary research efforst being pursued where Mechanical Engineering has the potential to provide leadership.
- 1. Attendance 2. Every student is required to attend at least 10 of the seminars of the fourteen scheduled during a semester. 3. Some substitution of seminars in the series by high-level technical seminars across campus is permitted.

- Engineering Topics: Engineering Science – 0 credits (0%)
    - **Criteria:**

☐	Exams and Quizzes	☐	Papers and Projects
☐	Homework	☐	Laboratory Exercises
☒	Attendance and Class Participation	☐	Extra Credit Policies

- This course is taught by lecture and covers the program outcomes described in the program map.
    - **Method of Instruction:**

☒	Lecture	☐	Recitation
☐	Presentation	☐	Laboratory
☐	Lab Prep	☐	Studio
☐	Distance	☐	Clinic
☐	Experimental	☐	Research
☐	Ind. Study	☐	Pract/Observe
☐	Seminar		

Prerequisite(s):

- Graduate standing, MS or PhD student in Mechanical Engineering
- None

D. Course Instructor(s):

- Anil K. Bajaj, Associate Head for Graduate Education & Research and Professor of Mechanical Engineering
- Is the instructor currently a member of the Graduate Faculty? ☒ Yes ☐ No Click here to enter text.
  (If the answer is no, indicate when it is expected that a request will be submitted.)

E. Course Outline:

- Typical Schedule (15 weeks)

F. Reading List (include course text):

- No textbook required.
- No textbook required.

G. Library Resources:

- No resources needed.

H. Example of a Course Syllabus:

- The course syllabus changes from semester to semester depending on guest speakers. The guest speakers range from industry to faculty from around the country to talk about their research and experiences. The graduate students must attend 10 seminars during the semester and this is tracked by swiping their PUID card at the beginning of the seminar.