Chair: Tracy Christofero | **GC#6: Course Addition**

Request for Graduate Course Addition

1. Prepare one paper copy with all signatures and supporting material and forward to the Graduate Council Chair.
2. E-mail one identical PDF copy to the Graduate Council Chair. If attachments included, please merge into a single file.
3. ***The Graduate Council cannot process this application until it has received both the PDF copy and the signed hard copy.***

College: CITE | Dept/Division: Engineering | Alpha Designator/Number: ME 617 | (•) Graded ( ) CR/NC

Contact Person: SARDER E. SADIQUE, Ph.D., P.E. (CA) | Phone: 3046965621

NEW COURSE DATA:

New Course Title: Additive Manufacturing

Alpha Designator/Number: M E 6 1 7

Title Abbreviation: A D D I T I V E M A N U F A C T U R I N G

(Limit of 25 characters and spaces)

Course Catalog Description: (Limit of 30 words)

Additive manufacturing (AM), rapid prototyping, rapid tooling, joining processes, direct digital manufacturing to form 3D parts with applications ranging from prototyping to production in aerospace, defense, and biomedical industries.

Co-requisite(s): Not Applicable | First Term to be Offered: Fall 2015

Prerequisite(s): Graduate Status | Credit Hours: 3

Course(s) being deleted in place of this addition (*must submit course deletion form*):

Signatures: if disapproved at any level, do not sign. Return to previous signer with recommendation attached.

Dept. Chair/Division Head _____	Date _____
Registrar _____	Date _____
College Curriculum Chair _____	Date _____
Graduate Council Chair _____	Date _____

Request for Graduate Course Addition - Page 2

College: CITE | Department/Division: Engineering | Alpha Designator/Number: ME 615

Provide complete information regarding the new course addition for each topic listed below. Before routing this form, a complete syllabus also must be attached addressing the items listed on the first page of this form.

1. FACULTY: Identify by name the faculty in your department/division who may teach this course.

SARDER E. SADIQUE, Ph.D., P.E. (CA), Assistant Professor of Mechanical Engineering

2. DUPLICATION: If a question of possible duplication occurs, attach a copy of the correspondence sent to the appropriate department(s) describing the proposal. Enter "***Not Applicable***" if not applicable.

Not Applicable

3. REQUIRED COURSE: If this course will be required by another deparment(s), identify it/them by name. Enter "***Not Applicable***" if not applicable.

Not Applicable

4. AGREEMENTS: If there are any agreements required to provide clinical experiences, attach the details and the signed agreement. Enter "***Not Applicable***" if not applicable.

Not Applicable

5. ADDITIONAL RESOURCE REQUIREMENTS: If your department requires additional faculty, equipment, or specialized materials to teach this course, attach an estimate of the time and money required to secure these items. (Note: Approval of this form does not imply approval for additional resources.) Enter "***Not Applicable***" if not applicable.

Not Applicable

6. COURSE OBJECTIVES: (May be submitted as a separate document)

Submitted as a separate document in the Course Syllabus

7. COURSE OUTLINE (May be submitted as a separate document)

Submitted as a separate document in the Course Syllabus

8. SAMPLE TEXT(S) WITH AUTHOR(S) AND PUBLICATION DATES (May be submitted as a separate document)

Submitted as a separate document in the Course Syllabus

9. EXAMPLE OF INSTRUCTIONAL METHODS (Lecture, lab, internship)

Lecture/Lab

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10. EXAMPLE EVALUATION METHODS (CHAPTER, MIDTERM, FINAL, PROJECTS, ETC.)

MIDTERM, FINAL, PROJECTS, LAB

11. ADDITIONAL GRADUATE REQUIREMENTS IF LISTED AS AN UNDERGRADUATE/GRADUATE COURSE

12. PROVIDE COMPLETE BIBLIOGRAPHY (May be submitted as a separate document)

Submitted as a separate document in the Course Syllabus

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Please insert in the text box below your course summary information for the Graduate Council agenda. Please enter the information exactly in this way (including headings):

Department:
Course Number and Title:
Catalog Description:
Prerequisites:
First Term Offered:
Credit Hours:

Department: Engineering

Course Number and Title: ME 617 Additive Manufacturing

Catalog Description:
Additive manufacturing (AM), rapid prototyping, rapid tooling, joining processes, direct digital manufacturing to form 3D parts with applications ranging from prototyping to production in aerospace, defense, and biomedical industries.

Prerequisites: Graduate Status

First Term Offered: Fall 2016

Credit Hours: 3

Course Title/Number	**Additive Manufacturing - ME 617**
Semester/Year	
Days/Time	
Location	
Instructor	Sarder E. Sadique, Ph.D., P.E.(CA)
Office	Weisberg Engineering Lab Room 109 (previously lab general office) Division of Engineering College of Information Technology and Engineering Marshall University Huntington, WV 25755
Phone	304-696-5621
E-Mail	sadique@marshall.edu
Office/Hours	
University Policies	By enrolling in this course, you agree to the University Policies listed below. Please read the full text of each policy be going to www.marshall.edu/academic-affairs and clicking on "Marshall University Policies." Or, you can access the policies directly by going to http://www.marshall.edu/academic-affairs/?page_id=802 Academic Dishonesty/ Excused Absence Policy for Undergraduates/ Computing Services Acceptable Use/ Inclement Weather/ Dead Week/ Students with Disabilities/ Academic Forgiveness/ Academic Probation and Suspension/ Academic Rights and Responsibilities of Students/ Affirmative Action/ Sexual Harassment

Catalog Course Description:

Additive manufacturing (AM), rapid prototyping, rapid tooling, joining processes, direct digital manufacturing to form 3D parts with applications ranging from prototyping to production in aerospace, defense, and biomedical industries.

Course Prerequisites:

Graduate Status

Required Text:

Course Textbook:

Additive Manufacturing Technologies by Brent Stucker, David Rosen, and Ian Gibson, Springer: 2010; ISBN 978-1-4419-1120-9.

Lecture notes will be given before classes.

References:

- Manufacturing Processes and Systems, Phillip F. Ostwald Jairo Munoz. ISBN 0-471-04741-4.
- Bourell, Leu, and Rosen, *Roadmap for Additive Manufacturing*, NSF Workshop report, 2009.
- Gibson, Rosen, Stucker, *Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing*. Springer, 2009.
- Hopkinson, Hague, Dickens, *Rapid Manufacturing: An Industrial Revolution for the Digital Age*. Wiley, 2005.
- Gibson, *Advanced Manufacturing Technologies for Medical Applications*. Wiley, 2005.

- S. Kalpakjian, and S. R. Schmid, *Manufacturing Engineering and Technology*, *7*th Edition, Pearson Prentice Hall, Singapore, 2013, ISBN-10: 0133128741.

Course Objectives:

At the successful completion of this course, the students should be able to:

- Use commercial software for digitizing free-form geometry.
- Capture digital data from a difficult to design object and make a manufactured model.
- Create the design of an object suitable for additive manufacturing processes.
- Compare traditional versus next generation manufacturing.
- Define and apply criterion for selecting appropriate additive manufacturing process for any given application.
- Investigate application domain of additive manufacturing like aerospace, defense, biomedical etc.
- Learn important process parameters for bio-manufacturing and determine a suitable additive technique for bio-manufacturing.

Class/Laboratory Schedule

- Class: 3 hrs

Grade Policy:

The grading for the class will be determined using the following weights:

Assignments	30%
Literature review project	20%
Technology survey project	15%
Development project	25%
Participation	10%
Total Score	100%

Problem Assignments: Students will be given ~2 weeks for each assignment, which will consist of solving problems that correspond to the materials covered in class.

Literature review project: The objective of the literature review projects is to help the students to learn how to identify and read literatures. Students will discuss the review topic with the professor. The project will be done with a presentation and a review report.

Technology survey project: The objective of the technology survey project is to help the students to understand potential applications and opportunities in various fields. Students will discuss the survey topic with the professor. The project will be done with a presentation and a survey report.

Development project: The objective of the development project is to help the students to gain hands-on experience of solving a problem related to 3D printing. Students will discuss the problem with the professor. The project will be done with a demonstration, a presentation, and a technical report.

Participation: Active participation in the class discussion is required and will be taken into account.

Letter Grade Scale*:

90 - 100 --------- A
80 - 89 ---------- B
70 - 79 ---------- C
60 - 69 ---------- D

0 - 59 ---------- F

* *The instructor does reserve the right to slightly curve or scale the grades based on class groupings/performance.*

Tests/Exams:

Makeup exams will be given only due to **extraordinary circumstances**, and only if the instructor is notified **prior** to the exam and the instructor judges it to be an acceptable excuse. Academic dishonesty (cheating) on any exam will result in a grade of zero for that exam. A second infraction will result in a course grade of F and possible University sanctions.

Grading Policy of Tests/Exams:

Three tests and a final exam will be given during the course of the semester. Exams will be closed book and closed notes. No makeup exams will be given with the exception of unusual circumstances (institutional excuse, severe injuries, family emergencies, group activities etc.).

Topics to be Covered*:

Lecture	Topic	Chapter
1	Introduction to unit - Overview, Basic principles, Research topic discussion	
2	Reverse Engineering: Introduction, From Scanner to Model validation	
3	Traditional manufacturing vs Additive manufacturing	
4	Additive Manufacturing Process Plan: Building Strategies & Post Processing	
5	Development of Additive Manufacturing Technology	
6	3D content editing - Design opportunities and CAD systems for AM	
7	Extrusion Based Additive Manufacturing Process	
8	Additive processes beyond layers - Hybrid processes	
9	Photo-polymer vat Additive Manufacturing Process	
10	Powder bed fusion and material jetting Additive Manufacturing Process	
11	Gear manufacture and Gear Measurement	
12	Issues with additive manufacturing	
13	Rapid tooling and indirect processes	
14	Additive manufacturing in medical applications	
15	Material issues - Heterogeneous & Functional materials	
16	3D Bio-manufacturing	
17	Process and quality control in additive manufacturing - Accuracy, repeatability, Process viability and sensors	
18	Zero skill manufacturing	
19	Fabrication speed and improvements	
20	Advanced Research in Laser Theory in Manufacturing Processes	
21	Vat Photopolymerization - 3D Systems/Stereolithography, Envision Technology, Direct digital manufacturing (DDM)	

* *The above schedule, policies, and assignments in this course are subject to change in the event of extenuating circumstances or by mutual agreement between the instructor and the students i.e. Schedule may be revised if necessary. Students will be notified if this is the case.*

Attendance Policy:
The attendance policy will follow University's excused absence policy. You are expected to attend all classes. However, the instructor accepts your absence for one session provided that an advance notice will be given, unless this is an excused absence such as institutional excuse, severe injuries, family emergencies, group activities etc.

Learning Outcomes:

Course Outcome - student will:	**Implementation Method**	**Evaluation Method**	**Program Outcomes**
Provide a comprehensive overview of AM technologies including descriptions of related technologies including design and AM-specific software and post-processing/part finishing approaches.	• Lectures • In-class examples • Project/CAD solutions • Homework assignments	• Homework Assignments • Exam, Quiz • Project/CAD	c2, e1, k3
Describe various additive manufacturing processes.	• Lectures • In-class examples • Project/CAD solutions • Homework assignments	• Homework Assignments • Exam, Quiz • Project/CAD	c2, e1, k3
Explain the capabilities, limitations, and basic principles of alternative AM technologies.	• Lectures • In-class examples • Project/CAD solutions • Homework assignments	• Homework Assignments • Exam, Quiz • Project/CAD	c2, e1, k3
Evaluate and select appropriate AM technologies for specific applications.	• Lectures • In-class examples • Project/CAD solutions • Homework assignments	• Homework Assignments • Exam, Quiz • Project/CAD	a2, c2, e1
Demonstrate the use of selected laser based manufacturing machines. Explain the theory behind laser manufacturing processes.	• Lectures • In-class examples • Project/CAD solutions • Homework assignments	• Homework Assignments • Exam, Quiz • Project/CAD	a2, c2, e1
Discuss the wide variety of new and emerging applications like micro-scale AM, medical applications, direct printing of electronics and Direct Digital Manufacturing of end-use components.	• Lectures • In-class examples • Project/CAD solutions • Homework assignments	• Homework Assignments • Exam, Quiz • Project/CAD	a2, c2, e1
Define: 3D Printing, Stereolithography, Selective Laser Sintering and various metal deformation technologies.	• Lectures • In-class examples	• Homework Assignments • Exam, Quiz	a2, c2, e1

	• Project/CAD solutions • Homework assignments	• Project/CAD	
Explain product prototyping. Apply AM techniques to a challenging rapid manufacturing application.	• Lectures • In-class examples • Project/CAD solutions • Homework assignments	• Homework Assignments • Exam, Quiz • Project/CAD	a2, c2, k3
Identify, explain, and prioritize some of the important research challenges in AM.	• Lectures • In-class examples • Project/CAD solutions • Homework assignments	• Homework Assignments • Exam, Quiz • Project/CAD	a2, c2, k3

PROGRAM LEARNING OUTCOMES (ABET)

Item No.	Outcome
a-2	Complete an engineering assignment that involves the use of calculus and scientific principles (e.g., chemistry or physics)
c-2	Complete a design with clearly defined objectives, engineering standards, and realistic constraints. Present a design in a professional manner
e-1	Formulate and solve an engineering problem with given data and constraints using applicable standards for a problem already identified. Present the results in a professional manner
k-3	Ability to use the techniques, skills and modern engineering tools necessary for engineering practice: Use of a modern engineering too for a design

Additional Academic Policies:

Marshall University policies pertaining to Academic Dishonesty, Excused Absences, University Computing Services Acceptable Use, Inclement Weather, Dead Week, Students with Disabilities, Academic Dismissal, Academic Forgiveness, Academic Probation and Suspension, Academic Rights and Responsibilities of Students, Affirmative Action, and Sexual Harassment can be found at: http://www.marshall.edu/academic-affairs/?page_id =802.