

PURDUE UNIVERSITY
REQUEST FOR ADDITION, EXPIRATION,
OR REVISION OF A GRADUATE COURSE
(50000-60000 LEVEL)



DEPARTMENT Civil and Mechanical Engineering EFFECTIVE SESSION Fall 2017

INSTRUCTIONS: Please check the items below which describe the purpose of this request.

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

PROPOSED: Subject Abbreviation <u>ME</u> Course Number <u>54700</u> Long Title <u>Mechatronics, Robotics, and Automation</u> Short Title _____ <small>Abbreviated title will be entered by the Office of the Registrar if omitted. (30 CHARACTERS ONLY)</small>	EXISTING: Subject Abbreviation _____ Course Number _____	TERMS OFFERED Check All That Apply: <input checked="" type="checkbox"/> Fall <input checked="" type="checkbox"/> Spring <input type="checkbox"/> Summer CAMPUS(ES) INVOLVED <input type="checkbox"/> Calumet <input type="checkbox"/> N. Central <input type="checkbox"/> Cont Ed <input type="checkbox"/> Tech Statewide <input checked="" type="checkbox"/> Ft. Wayne <input type="checkbox"/> W. Lafayette <input type="checkbox"/> Indianapolis
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CREDIT TYPE 1. Fixed Credit Cr. Hrs. <u>3</u> 2. Variable Credit Range: Minimum Cr. Hrs. _____ (Check One) To <input type="checkbox"/> Or <input type="checkbox"/> Maximum Cr. Hrs. _____ 3. Equivalent Credit: Yes <input type="checkbox"/> No <input type="checkbox"/> 4. Thesis Credit: Yes <input type="checkbox"/> No <input type="checkbox"/>	COURSE ATTRIBUTES: Check All That Apply 1. Pass/Not Pass Only <input type="checkbox"/> 2. Satisfactory/Unsatisfactory Only <input type="checkbox"/> 3. Repeatable <input type="checkbox"/> Maximum Repeatable Credit: _____ 4. Credit by Examination <input type="checkbox"/> 5. Fees <input type="checkbox"/> Coop <input type="checkbox"/> Lab <input type="checkbox"/> Rate Request <input type="checkbox"/> Include comment to explain fee _____ 6. Registration Approval Type Department <input checked="" type="checkbox"/> Instructor <input checked="" type="checkbox"/> 7. Variable Title <input type="checkbox"/> 8. Honors <input type="checkbox"/> 9. Full Time Privilege <input type="checkbox"/> 10. Off Campus Experience <input type="checkbox"/>
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Schedule Type	Minutes Per Mtg	Meetings Per Week	Weeks Offered	% of Credit Allocated	Cross-Listed Courses
Lecture	150	1	13	100	
Recitation					
Presentation					
Laboratory					
Lab Prep					
Studio					
Distance					
Clinic					
Experiential					
Research					
Ind. Study					
Pract/Observ					

COURSE DESCRIPTION (INCLUDE REQUISITES/RESTRICTIONS): (Note: If description will not fit in space provided, please create a separate document and attach to this form.)

Modern products are mostly mechatronic products, where mechanical components are integrated with electrical, electronic, and control components to fulfill high-level system functionalities. This course is designed for graduate students to (1) understand the concept of mechatronics, (2) learn design principles to integrate multidisciplinary components as a system to meet requirements of products, (3) gain the fundamental knowledge about robots and automation, (4) have hand-on skills in developing basic mechatronic products. Prereq: ME 361 or Graduate Standing

*COURSE LEARNING OUTCOMES: (Note: If course learning outcomes will not fit in space provided, please create a separate document and attach it to this form.)

A student who successfully fulfills the course requirements will have demonstrated (1) an ability to identify, select, and integrate mechatronic components to meet product requirements [a, k], (2) an ability to develop kinematic, dynamic and control models for robots [a, k], (3) an ability to use commercial software tools for modeling and simulation of mechatronic systems [a, k], (4) an ability to design, analyze, and optimize mechatronic products [a, c, e, k], and (5) an ability to write technical reports and convey engineering message efficiently [g].

Calumet Department Head <u>Nate Van</u> Date <u>11/17/16</u>	Calumet School Dean <u>[Signature]</u> Date <u>11-7-16</u>	Calumet Director of Graduate Studies Date _____
Fort Wayne Department Head Date _____	Fort Wayne School Dean Date _____	Fort Wayne Director of Graduate Studies Date _____
Indianapolis Department Head Date _____	Indianapolis School Dean Date _____	IUPUI Associate Dean for Graduate Education Date _____
North Central Department Head Date _____	North Central School Dean Date _____	North Central Director of Graduate Studies Date _____
West Lafayette Department Head Date _____	West Lafayette College/School Dean Date _____	Date Approved by Graduate Council Date _____
Graduate Area Committee Convener Date _____	Graduate Dean Date _____	Graduate Council Secretary Date _____
		West Lafayette Registrar Date _____

Detailed Graduate Course Proposal for Academic Review

Note: The detailed course proposal is intended for academic review by the appropriate area committee of the Graduate Council. It supplements the Form 40G that is intended for administrative review of the Graduate School and Registrar.

To: Purdue University Graduate Council

From: Faculty Member: Zhuming Bi
Department: Civil and Mechanical Engineering
Campus: Indiana University Purdue University Fort Wayne (IPFW)

Date: October 10, 2016

Subject: Proposal for New Graduate Course

Contact for information if questions arise:

Name:	Zhuming Bi
Phone:	260-481-5711
Email:	biz@ipfw.edu
Address:	2101 E. Coliseum Blvd. Fort Wayne, IN, 46805

Course Number: ME-54700
Course Title: Mechatronics, Robotics and Automation
Short Title:

Course Description:

Modern products are mostly mechatronic products, where mechanical components are integrated with electrical, electronic, and control components to fulfill high-level system functionalities. Especially, robots are critical components in modern manufacturing; their roles to our societies are becoming increasingly of importance. The design, manufacture, assembly, and operation of mechatronic products require engineers to understand a wide scope of engineering knowledge and to be able to design and integrate mechanical, electric, and control subsystems. This course is designed for graduate students to (1) understand the concept of mechatronics, (2) learn design principles to integrate multidisciplinary components as a system to meet requirements of products, (3) gain the fundamental knowledge about robots and automation, (4) have hand-on skills in developing basic mechatronic products.

A. Justification for the Course

Justification of the need for the course

- Department of Civil and Mechanical Engineering at IPFW is changing its curricula of Master of Science in Engineering program to make it self-sustainable (i.e. sufficient enrollment). Existing curricula provide very limited options of courses for students to satisfy the requirements of their graduations. It is imperative to develop several new engineering courses into the curricula to attract incoming students.
- Many small- and medium sized enterprises (SMEs) are in the Northern Indiana area, and most of them have their needs of talents on design of mechatronic products. So far available courses offered at the department are mostly in the field of mechanical engineering, there is no course to teach students how knowledge and skills from different disciplines can be integrated to solve multidisciplinary design problems.
- The course will be open to junior- and senior-level undergraduates as a technical elective. Completing a capstone design project is a critical requirement of graduation. Most of capstone projects are multi-disciplinary nature; it is desirable for the department to offer this new course to prepare students for multi-disciplinary design projects.

Justification that course will be taught at a graduate level

- Modern products are becoming more and more complex, and robots are typical mechatronic products. A course on mechatronics, robotics, and automation provides an ideal introduction for students in conjunction with new literatures in mechatronic design, manufacturing processes, robotics and automation.
- In the proposed course, students will learn the design principles to integrate multidisciplinary components as a system to meet requirements products.
- Robots are of the most important manufacturing resources, and design methodologies for robots reflect the cutting-edge advancement in engineering.
- The course includes the components of independent research, and students are required to conduct their own researches to develop solutions for application-oriented product design problems.

Justification of the demand for the course

- Anticipated enrollment
 - Undergraduate 15 ~ 20
 - Graduate 5 ~ 10

Justification for online delivery

This course is planned to be offered in classroom; it will not be delivered online immediately or in the near future. It is mainly because (1) the class size is relatively small; (2) the course materials will include some customized subjects to students, which should be often revised; (3) it is not worth for the effort

converting materials suitable for online teaching.

B. Learning Outcomes and Methods of Assessment

Learning Outcomes	Assessment Methods
A student from class will be able to identify, select, and integrate mechatronic components to meet product requirements [a, k]	<ul style="list-style-type: none"> • Homeworks • Exams
A student from class will be able to develop kinematic, dynamic and control models for robots [a, k]	<ul style="list-style-type: none"> • Homeworks • Exams
A student from class will be able to use commercial software tools for modeling and simulation of mechatronic systems [a, k]	<ul style="list-style-type: none"> • Labs • Lab reports
A student from class will be able to design, analysis, and optimize mechatronic products [a, c, e, k]	<ul style="list-style-type: none"> • Team projects • Exams
A student from class will be able to write technical reports and convey engineering message effectively [g]	<ul style="list-style-type: none"> • Presentations • Reports

Final Grading Criteria

Describing the criteria that will be used to assess students and how the final grade will be determined. Add and delete rows as needed.

Assessment Methods (should match method types in the previous table)	Weight Toward Final Course Grade
Exams	40%
Papers and Projects	20%
Home Works	20%
Lab Reports	20%

Methods of Instruction

Weeks	Method of Instruction	Contribution to Outcomes
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10	Lecture	Teach students to (1) identify, select, and integrate mechatronic components to meet product requirements; (2) develop kinematic, dynamic and control models for robots.
2	Laboratory	Teach students to use commercial software tools for modeling and simulation of mechatronic systems
2	Independent Study	Train students to design, analyze, and optimize mechatronic products
1	Presentation	Train students to write technical reports and present engineering design solutions efficiently

C. Prerequisite(s)

- Graduate standing, or
- ME-361 Kinematics and Dynamics of Machinery

D. Course Instructor(s)

Name	Rank	School, dept., or center	Graduate Faculty or expected date
Zhuming Bi	Associate Professor	Civil and Mechanical Engineering	Yes

Zhuming Bi is an Associate Professor at Department of Civil and Mechanical Engineering (CME). I joined the department in 2009. His research areas are in Intelligent Manufacturing, Enterprise Information Systems, and Robotics & Automation. He holds the dual Ph.D. degrees in Mechanical Engineering from University of Saskatchewan, Canada (2002) and Harbin Institute of Technology, China (1994), respectively. He has had several opportunities to work at three leading institutions in robotics and automation including National Research Council in Canada (2003-2007), Northern Ireland Technology Centre in UK (2008-2009), and National Institute of Standards and Technology in USA (2016). He has worked in these research areas for over 22 years since he got his first Ph.D. degree in 1994. He has around 100 publications in peer-reviewed journals in robotics and automation.

E. Course Schedule or Outline

Week	Topic(s)	Activity (optional)
1	• Introduction of mechatronics	• Lecture
2	• Mechanical components and motion systems	• Lecture
3	• Power and driving systems	• Lecture
4	• Sensing, numerical control, and programming	• Lecture
5	• Modeling and Simulation	• Lab
6	• System integration	• Lab
7	• Introduction of robotics	• Lecture
8	• Robotic kinematics	• Lecture
9	Semester break	
10	• Robotics dynamics	• Lecture
11	• Robotic control	• Lecture
12	• Robotics in production systems	• Lecture
13	• Human and robot interaction	• Lecture
14	• Independent study on robotic design	• Design project
15	• Independent study on robotic design	• Design project
16	• Comprehensive Exam	

F. Reading List (including course text)

Primary Reading List

- “Fundamentals of Mechatronics,” Musa Jouaneh, Cengage Learning, 2011.

Secondary Reading List

- “Mechatronics: a Foundation Course”, Clarence de Silva, CRC Press, 2010.
- “Mechatronics Systems Fundamentals”, Rolf Isermann, Springer, 2005.
- Mechatronics,” Sabri Cetinkunt, Wiley, 2006.

G. Library Resources

Name of journal, proceedings, book, video, or other acquisition	Already in Libraries?
IEEE/ASME Transactions on Mechatronics	Yes
IEEE Transactions on Robotics	Yes
IEEE Transactions on Automated Manufacturing	Yes

Engineering	
ASME Journal of Mechanisms and Robotics	Yes
Mechanism and Machine Theory	Yes
Robotics and Computer Integrated Manufacturing	Yes

H. Course Syllabus

ME54700: Mechatronics, Robotics and Automation

Lectures: 3 Credit Hours. one meeting per week, 150 minutes per meeting
ME-361 Kinematics and Dynamics of Machinery or Graduate
Pre-requisites: Standing

Instructor: Dr. Zhuming Bi
Email: biz@jpfw.edu
Office: ET321H
Phone: 260-481-5711
Office Hours: TBD

Course Description: Modern products are mostly mechatronic products, where mechanical components are integrated with electrical, electronic, and control components to fulfill high-level system functionalities. Especially, robots are critical components in modern manufacturing and their roles to our societies are becoming increasingly of importance. The design, manufacture, assembly, and operation of mechatronic products require engineers to understand a wide scope of engineering knowledge and to be able to design and integrate mechanical, electric, and control subsystems. This course is designed for graduate students to (1) understand the concept of mechatronics, (2) learn design principles to integrate multidisciplinary components as a system to meet requirements of products, (3) gain the fundamental knowledge about robots and automation, (4) have hand-on skills in developing basic mechatronic products.

Course Objectives: This course serves as an introduction course on mechatronics, robotics, and automation. Students from this course are expected to (1) appreciate the importance of mechatronics, robots and automation in modern manufacturing, (2) be familiar with the classification of mechatronic components and their roles in products, (3) master the theory and methodologies in design, analysis, optimization of mechatronic systems, in particular, robots for manufacturing automation, (4) gain some hand-on skill of design, manufacture, and control of typical mechatronic products via design projects.

Textbook (Optional) and References:

- [1] "Fundamentals of Mechatronics," Musa Jouaneh, Cengage Learning, 2011.
"Mechatronics," Sabri Cetinkunt, Wiley, 2006.
- [2] "Mechatronics: a Foundation Course", Clarence de Silva, CRC Press, 2010.

[3] "Mechatronics Systems Fundamentals", Rolf Isermann, Springer, 2005.

Grading Policy:

Homeworks:	20%
Mid-Exams:	20%
Lab Reports:	20%
Final Exam:	20%
Project(s):	20%
Letter Grades:	A 90-100%; B 80-89%; C 70-79%; D 60-69%; F 0-59%

Course Policy:

- 1) Consult the student handbook for information pertaining to academic honesty, the grade appeal process, or grievance policies.
- 2) You are expected to use your IPFW account to send and receive email related to this course. Please send email only from your IPFW email account.
- 3) During computer labs, computers are to be used only for material related to this class. No internet surfing unless the instructor requests, no game playing, absolutely no chatting!
- 4) Eating and drinking are not allowed in classroom or lab. If you do carry a drink, it should have a lid and please be careful.
- 5) As a courtesy to the instructor and other students, do not be late for class and turn off your cell phone.
- 6) No late homework or in-class exercise submission.
- 7) Students with a disability should contact the SSD office at Walb 113 (481-6657) for a description of services available.

Course Contents:

- [1]. Introduction of Mechatronics
- [2]. Mechanical Components and Motion Systems
- [3]. Power and Driving Systems
- [4]. Sensing, Numerical Control, and Programming
- [5]. Modeling and Simulation
- [6]. System Integration
- [7]. Introduction of Robotics
- [8]. Fundamental of Kinematics and Dynamics
- [9]. Robotic Programming and Control
- [10]. Robots in Production Systems
- [11]. Human and Robot Interaction
- [12]. Independent study on mechatronic design

Course Outcomes:

A student who successfully fulfills the course requirements will have demonstrated:

- [1]. An ability to identify, select, and integrate mechatronic components to meet product requirements [a, k]
- [2]. An ability to develop kinematic, dynamic and control models for robots [a, k]

- [3]. An ability to use commercial software tools for modeling and simulation of mechatronic systems [a, k]
- [4]. An ability to design, analyze, and optimize mechatronic products [a, c, e, k]
- [5]. An ability to write technical reports and present engineering design solutions efficiently [g]

ABET Program Outcomes:

- a. an ability to apply knowledge of mathematics, science, engineering
- b. an ability to design and conduct experiments, as well as to analyze and interpret data
- c. an ability to design a system, component, or process to meet desired needs
- d. an ability to function on multi-disciplinary teams
- e. an ability to identify, formulate, and solve engineering problems
- f. an understanding of professional and ethical responsibility
- g. an ability to communicate effectively
- h. the broad education necessary to understand the impact of engineering solutions in a global and societal
- i. a recognition of the need for, and an ability to engage in life-long learning
- j. a knowledge of contemporary issues
- k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

