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 17-09

Graduate Council Doc. No. 10-16a

DEPARTMENT Mechanical Engineering EFFECTIVE SESSION Spring 2011

INSTRUCTIONS: Ple ~~Mechanical Engineering~~ ~~Fall 2009~~ ~~Spring 2011~~

- [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	50300	Course Number	

Long Title Micro-and-Nano-Scale Energy Transfer Processes

Short Title Energy Transfer Processes
Abbreviated title will be entered by the Office of the Registrar if omitted. (22 CHARACTERS ONLY)

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

~~Mico-and-Nano-Scale Energy Transfer Processes~~

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

2. Satisfactory/Unsatisfactory Only
3. Repeatable
   Maximum Repeatable Credit:
4. Credit by Examination
5. Designator Required
   Fees

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

Instructional Type	Minutes Per	Meetings Per	Weeks	% of Credit Allocated	Delivery Method (Asyn. Or Syn.)	Delivery Medium (Audio, Internet, Live, Text-Based, Video)
Lecture	50	3	16		Syn	Live
Recitation						
Presentation						
Laboratory						
Lab Prep						
Studio						
Distance						
Clinic						
Experiential						
Research						
Ind. Study						
Pract/Observ						

Cross-Listed Courses

2011 FEB 22 AM 9:56

COURSE DESCRIPTION (INCLUDE REQUISITES):

ME 503 Micro-and Nano-Scale Energy Transfer Processes, Sem. 2 (alternate years), Class 3, cr. 3.
00 Prerequisite: Graduate Standing

Transport of energy in natural and fabricated micro- and nano-scale structures. Physical nature of energy transport by three carriers – electrons, phonons, and photons. Bulk material properties (e.g., thermal/electrical conductivity) are derived from statistical particle transport theories. Effects of spatial confinement on bulk properties are quantified. Contemporary interdisciplinary engineering applications.
Professor Fisher.

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
				x R. Cipra	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	
x E. Daniel Hoffman	12/12/2008	x	5/12/2010	Tina L. Payne	2/18/11
West Lafayette Department Head	Date	West Lafayette College/School Dean	Date	Graduate Council Secretary	Date
T.A. Wenstan	2/17/2011				3/4/11
Graduate Area Committee Convener	Date	Graduate Dean	Date	West Lafayette Registrar	Date

OFFICE OF THE REGISTRAR

3/1/11

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FORM 40G REV. 1/07

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

EFD 17-09

DEPARTMENT: Mechanical Engineering

EFFECTIVE SESSION: Fall 2009

INSTRUCTIONS: Ple

- [x] 1. New course with supporting documents (complete proposal form)
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- [ ] 10. Change in course requisites
- [ ] 11. Change in semesters offered
- [ ] 12. Transfer from one department to another

PROPOSED:
Subject Abbreviation: ME
Course Number: 503

EXISTING:
Subject Abbreviation:
Course Number:

Long Title: Mico-and-Nano-Scale Energy Transfer Processes

Short Title: Energy Transfer Proc.
Abbreviated title will be entered by the Office of the Registrar if omitted. (22 CHARACTERS ONLY)

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: 3
2. Variable Credit Range:
   Minimum Cr. Hrs
   (Check One) To [ ] Or [ ]
   Maximum Cr. Hrs
3. Equivalent Credit: Yes [ ] No [ ]
4. Thesis Credit: Yes [ ]
2. Satisfactory/Unsatisfactory Only [ ]
3. Repeatable [ ]
   Maximum Repeatable Credit:
4. Credit by Examination [ ]
5. Designator Required [ ]
Fees [ ]
Department [ ] Instructor [ ]
8. Variable Title [ ]
9. Remedial [ ]
10. Honors [ ]
11. Full Time Privilege [ ]
12. Off Campus Experience [ ]

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

Cross-Listed Courses

COURSE DESCRIPTION (INCLUDE REQUISITES):

ME 503 Micro-and Nano-Scale Energy Transfer Processes, Sem. 2 (alternate years), Class 3, cr. 3.
Prerequisite: Graduate Standing

Transport of energy in natural and fabricated micro- and nano-scale structures. Physical nature of energy transport by three carriers – electrons, phonons, and photons. Bulk material properties (e.g., thermal/electrical conductivity) are derived from statistical particle transport theories. Effects of spatial confinement on bulk properties are quantified. Contemporary interdisciplinary engineering applications.

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
				X 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	
E. Daniel Hoberman	2/12/2008				
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 503 Micro- and Nano-scale Energy Transfer Processes

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 503 Micro-and Nano-Scale Energy Transfer Processes
Sem. 2 (alternate years), Class 3, cr. 3
Prerequisite: Graduate Standing

Transport of energy in natural and fabricated micro- and nano-scale structures. Physical nature of energy transport by three carriers – electrons, phonons, and photons. Bulk material properties (e.g., thermal/electrical conductivity) are derived from statistical particle transport theories. Effects of spatial confinement on bulk properties are quantified. Contemporary interdisciplinary engineering applications.

Reason: This course has been taught two times on an experimental basis with the following enrollments: spring 2003 - 23 students , spring 2005 – 17 students, and spring 2007 - 12 students. This course provides students with the basic theory of solid-state physics, continuum physical properties, and energy transport in modern small-scale materials and devices.

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 503
MICRO- AND NANO-SCALE ENERGY TRANSFER PROCESSES

Course Outcomes

Students in this course will:

1. Gain an understanding of the fundamental elements of *solid-state physics*.
2. Develop skills to derive *continuum physical properties* from sub-continuum principles.
3. Apply statistical and physical principles to describe *energy transport in modern small-scale materials* and *devices*.

1. Microstructure of Solids (1 wk)

1. Atomic bonds
2. Crystalline, polycrystalline, amorphous materials
3. Bravais lattice, reciprocal lattice, Miller indices

2. Vibrations in Solids (3 wks)

1. Crystal vibrations, dispersion relations
2. Quantization and phonons
3. Phonon branches and modes
4. Lattice specific heat
5. Phonon scattering and heat conduction

3. Electrons in Solids (2.5 wks)

1. Electron structure and quantization
2. Free electron theory of metals
3. Fermi-Dirac statistics
4. Band structures of metals, semiconductors, and insulators
5. Electron scattering and transport

4. Photon-Solid Interactions (2 wks)

1. Classical theories of EM waves in solids
2. Quantum theory of photon-solid interaction
3. Electron-hole recombination

5. Statistical Transport Theories (3 wks)

1. Time and length scales
2. Boltzmann transport equation
3. Carrier scattering
4. Moments of the BTE

6. Modern Applications (3.5 wks)

1. Monte Carlo simulation
2. Sub-continuum heat conduction
3. Electro-thermal modeling of semiconductor devices
4. Thermionics and thermoelectrics

Sample Projects

1. Thermal Effects on Operation and Reliability in Power Vertical DMOSFETs
2. Thermal Characterization of Field Emission from Diamond Thin Films
3. Microscale Engine Development: The Effect of Large Surface Area to Volume Ratio on Chemical Kinetics

COURSE NUMBER: ME 503

COURSE TITLE: Micro- and Nano-Scale Energy Transfer Processes

REQUIRED COURSE OR ELECTIVE COURSE: Elective

TERMS OFFERED: Spring

TEXTBOOK/REQUIRED MATERIAL: N/A

PRE-REQUISITES: Masters Standing

COORDINATING FACULTY: Timothy Fisher

COURSE DESCRIPTION: Transport of energy in natural and fabricated micro- and nano-scale structures. Physical transport of energy transport by three carriers – electrons, phonons, and photons. Bulk physical properties (e.g., thermal/electrical properties) are derived from statistical particle transport theories. Effects of spatial confinement on bulk properties are quantified. Contemporary interdisciplinary applications.

COURSE OUTCOMES:

Students in this course will:

1. Gain an understanding of the fundamental elements of *solid-state physics*.
2. Develop skills to derive *continuum physical properties* from sub-continuum principles.
3. Apply statistical and physical principles to describe *energy transport in modern small-scale materials* and *devices*.

ASSESSMENTS TOOLS: A midterm exam, regular homework assignments, a final project, and a comprehensive final exam.

PROFESSIONAL COMPONENT:

1. Engineering Topics: Engineering Science – 3 credits (100 %)
   Engineering Design -- 0 credits (0%)

RELATED ME PROGRAM OUTCOMES: N/A

NATURE OF DESIGN CONTENT: N/A

COMPUTER USAGE: Scientific cyberinfrastructure sites nanoHUB and thermalHUB are used for supplements and computational learning tools.

COURSE STRUCTURE/SCHEDULE:
Lecture – 3 days per week at 50 minutes.

PREPARED BY: Timothy Fisher

REVISION 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:	Timothy Fisher	Reviewer: Click here to enter text.
	Department:	Mechanical Engineering	
	Campus:	West Lafayette	Comments: Click here to enter text.
Date:	3/15/2010		
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 50300
Course Title:	Micro-and-Nano-Scale Energy Transfer Processes

A. Justification for the Course:

- This course has been taught two times on an experimental basis with the following enrollments: spring 2003 – 23 students, spring 2005 – 17 students, and spring 2007 – 12 students. This course provides students with the basic theory of solid-state physics, continuum physical properties, and energy transport in modern small-scale materials and devices.
- The propsed ME 50300 course focuses on energy transport in micro-and-nano-scale structures. Because of the advanced nature of this topic, the course is targeted to entry-level graduate students, although some undergraduates may take the course. The course will be offered in alternate years with an anticipated enrollment of 15-20 students, mostly entry-level graduate students.

B. Learning Outcomes and Methods of Evaluation or Assessment:

- Students in this course will: 1) Gain an understanding of the fundamental elements of solid-state physics, 2) Develop skills to derive continuum physical properties from sub-continuum principles, and 3) Apply statistical and physical principles to describe energy transport in modern small-scale materials and devices.
- A midterm exam, regular homework assignments, a final project and a comprehensive final exam.

- 1. Engineering Topics: Engineering Science – 3 credits (100%) & Engineering Design – 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		

C. Prerequisite(s):

- Masters standing
- Scientific cyberinfrastructure sites nanoHUB and thermalHUB are used for supplements and computational learning tools.

D. Course Instructor(s):

- Timothy S. Fisher, 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:

- 1. Microstructure of Solids (1 week), 2. Vibrations in Solids (3 weeks), 3. Electrons in Solids (2.5 weeks), 4. Photon-Solid Interactions (2 weeks), 5. Statistical Transport Theories (3 weeks), and 6. Modern Applications (3.5 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:

Week 1: Microstructure of solids

Weeks 2-5: Vibrations in solids

Weeks 5-9: Electrons in solids

Weeks 10-11: Statistical transport theories

Weeks 12-14: Applications to modern micro- and nano-devices

Week 15: Final project presentations