Washington State University
MAJOR CURRICULAR CHANGE FORM - - COURSE
(Submit original signed form and ten copies to the Registrar's Office, zip 1035.)

Future Effective Date: 01/13/2014 (**effective date cannot be retroactive**)
☑ New course ☐ Temporary course ☐ Drop service course
☐ There is a course fee associated with this course (see instructions)

☐ Variable credit _____
☐ Repeat credit (cumulative maximum _____ hours)
☐ Increase credit (former credit _____)
☐ Lecture-lab ratio (former ratio _____)
☐ Number (former number _____)
☐ Prefix (former prefix _____)
☐ Crosslisting (between WSU departments) **(Must have both departmental signatures)**
☐ Cooperative listing (UI prefix and number _____)
taught by: WSU ☐ UI ☐ jointly taught ☐
☐ Conjoint listing (400/500)
☐ S, F grading
☐ Request to meet Writing in the Major [M] requirement **(Must have All-University Writing Committee Approval)**
☐ Request to meet GER in _____ **(Must have GenEd Committee Approval)** ☐ Fulfills GER lab (L) requirement
☐ Professional course **(Pharmacy & Vet Med only)** ☐ Graduate credit **(professional programs only)**
☐ Other (please list request) _____

Mech	516	MICRO/NANOSCALE THERMAL ENGINEERING
course prefix	course no.	title

3	3	0	0	Graduate standing
credit	lecture hrs per week	lab hrs per week	studio hrs per week	prerequisite

Description (**20 words or less**) This course introduces the fundamentals and applications of micro/nanoscale thermal science and engineering.

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Contact: Yoon Jo Kim Phone number: (360) 546-9184 Email: yoonjo.kim@wsu.edu
Campus Zip Code: 99686

- Please attach rationale for your request, a current and complete syllabus, and explain how this impacts other units in Pullman and other branches (if applicable).
- Secure all required signatures and provide 10 copies to the Registrar's Office.

10/15/12	10/12/12	
Chair/date	**Dean/date**	**General Education Com/date**
Chair (if crosslisted/interdisciplinary)*	**Dean (if crosslisted/interdisciplinary) ***	**Graduate Studies Com/date**
All-University Writing Com/date	**Academic Affairs Com/date**	**Senate/date**

***If the proposed change impacts or involves collaboration with other units, use the additional signature lines provided for each impacted unit and college.**

Micro/nanoscale thermal science and engineering have been considered as the key technologies to realize the highly efficient and novel energy conversion devices/systems for thermal management, renewable/sustainable energy utilization and waste-heat harvesting. In current MSME program at WSU Vancouver, two courses are dealing with the topics related to thermal energy systems: Mech 515 (Advanced Heat Transfer) and Mech 542 (Advanced Thermal Systems). Although the courses provide the necessary and indispensable theoretical backgrounds in thermodynamics and heat transfer to understand, analyze, and design thermal energy systems, the solutions of problems in micro/nano devices and systems require a solid understanding of energy transport mechanisms in small dimensions and/or short time scales where classical equilibrium and continuum approaches may break down. Moreover, there are a number of IT companies gathered in northwest area, so called "Silicon Forest", which continuously and increasingly demand and seek for the experts in Micro/nanoscale thermal science and engineering. Thus, the new graduate level course we propose, "Micro/Nanoscale Thermal Engineering" is expected to greatly strengthen the capability of MSME program students toward their future career.

The new course, Mech 516, primarily deals with micro/nanoscale heat transfer and thermophysics. In first two-third of the course, the fundamental micro/nanoscale heat transfer theories will be mainly covered, which include thermal conductivity, Boltzmann equation, phonon transport, conduction in thin films and semiconductor devices, single-phase forced convection in microchannel, boiling & two-phase microchannel heat transfer, and radiation interaction in microstructures and materials. Micro heat pipe, nanofluids, and thermoelectric modules along with the micro/nanoscale modeling/simulation methods, i.e., Molecular dynamics, will be intensively explored as practical applications readily available for renewable energy utilization and waste-heat harvesting. The students will complete an individual project over the last half of the course. They will choose research topics related to micro/nanoscale energy conversion devices/systems under my approval and will conduct researches on the topics. The evaluation of the project will be done by the final presentation (10-15 min) and the final report.

Micro/Nanoscale Thermal Engineering

Instructor: Yoon Jo Kim, Assistant Professor, ENCS
VECS 301Q
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360-546-9184

Lecture Hours: Mondays/Wednesdays from 12 p.m. – 1:15 p.m.
Location: VSCI 18
Office Hours: Mondays /Wednesdays from 2:00 p.m. – 3:00 p.m.
and by appointment

Text: Microscale and Nanoscale Heat Transfer: Fundamentals and Engineering Applications, 1st Edition, by C. B. Sobhan and G. P. Peterson (required)
Nano/Microscale Heat Transfer, 1st Edition, by Z. Zhang (recommended)
Heat and Fluid Flow in Microscale and Nanoscale Structures, 1st Edition, by M. Faghri and B. Sunden (recommended)

Prerequisites: Graduate standing

Course description: This course introduces the fundamentals and applications of micro/nanoscale thermal science and engineering. The primary topics throughout the course will be micro/nanoscale heat transfer and thermophysics in various emerging technologies including thermal management, renewable energy utilization, thermoelectric energy conversion, waste-heat harvesting, micro heat pipe and nanofluids.

Homework: Problem sets will be assigned over the course of the quarter, approximately one every two weeks. You are encouraged to work along with your colleagues, but each of you must provide your own individual solution set. Plagiarism will result in a zero for that set.

Project: Students will complete an individual project as part of this course. Every student should choose his/her own term project topic related to micro/nanoscale heat transfer or energy conversion and will conduct the researches. The research activities will include, but not limited to, literature survey on recent advances and/or issues, numerical simulation and experimental work. The students will be required to submit a project report and make an oral presentation in the last week of the class.

Exams: There will be a midterm and a comprehensive final exam. Each will be open books and notes.

Grading:

Homework	20%
Project	25%
Midterm	20%
Final exam	35%

Website: Class updates and homework will be provided via the on-line Angel website (lms.wsu.edu).

Academic Integrity: Academic integrity is the cornerstone of the university and will be strongly enforced in this course. Any student caught cheating on any assignment will be strongly reprimanded for the course and will be referred to the Office of Student Conduct.

Disabilities: Accommodations may be available if you need them in order to fully participate in this class because of a disability. Accommodations may take some time to implement so it is critical that you contact Disability Services as soon as possible. All accommodations must be approved through Disability Services, located in the Student Resource Center on the Lower Level of Student Services Center (360) 546-9138.

Emergencies: WSU has made an emergency notification system available for faculty, students and staff. Detailed information is located at the following links:

- WSU Vancouver Campus Safety Plan:

  http://www.vancouver.wsu.edu/safety-plan

  - Comprehensive listing of university policies, procedures, statistics, and information relating to campus safety, emergency management, and the health and welfare of the campus community.

- WSU Vancouver Public Safety web site:

  http://www.vancouver.wsu.edu/police

- WSU Vancouver ALERTS web site:

  http://www.vancouver.wsu.edu/alerts/

  - Information about emergencies and other issues affecting WSU Vancouver.

- ZZUSIS portal:

  http://zzusis.wsu.edu

  - Register/update your emergency contact information for the Crisis Communication System (CCS). Enter your network ID and password and you will be taken to the zzusis portal page. Look for the Vancouver Emergency Info box on the left side of the page and click on "update your emergency contact information" where you can enter your cell, landline, and email contact information.

Course Outcomes:

Students will be able to:

1. Understand the basic concepts of micro/nanotechnology in thermal engineering.
2. Apply fundamentals of physics in micro/nanoscale to identify, formulate, and solve thermal engineering problems involving micro- and nanotechnology.
3. Design a micro/nano energy conversion system, component, or process to meet desired needs.
4. Evaluate the impact of contemporary issues related to micro/nano-technology.
5. Deliver well-organized, logical oral presentations.

Outcome Evaluation:

WSU Learning Outcome	*At the end of this course, students should be able to:*	*Course topics that address these learning outcomes*	*This outcome will be evaluated primarily by:*
SLO-1	• Understand the basic concepts of micro/nanotechnology in thermal engineering. • Apply fundamentals of physics in micro/nanoscale to identify, formulate, and solve thermal engineering problems involving micro- and nanotechnology.	Introduction (week 1); Conduction (weeks 2-4); Convection (weeks 5-9); Radiation (weeks 11-12)	Homework; Exams
SLO-2	• Design a micro/nano energy conversion system, component, or process to meet desired needs. • Evaluate the impact of contemporary issues related to micro/nano-technology.	Nanofluids (week 13-14); Thermoelectric module (week 15-16); Class project (weeks 9-16)	Homework; Exams; Project report
SLO-3	• Deliver well-organized, logical oral presentations.	Research project presentation (week 16)	Project presentation

Course Calendar

Week	Topics	Homework/Notes
1 (1/13)	Overview of microscale heat transfer (Ch1, Sobhan)	
2 (1/20)	Review of conduction heat transfer (Ch2.1, Sobhan); conduction at the microscale (Ch2.2-4, Sobhan);	
3 (1/27)	Thermal conductivity (Ch2.5, Sobhan); Boltzmann equation & phonon transport (Ch2.6, Sobhan)	HW1 due
4 (2/3)	Conduction in thin films (Ch2.7, Sobhan); conduction in semiconductor devices (Ch2.7, Sobhan)	
5 (2/10)	Review of convection heat transfer (class note); single phase forced convection in microchannels (Ch3.2, Sobhan)	HW2 due
6 (2/17)	Boiling & two-phase flow in microchannel (Ch3.2, Sobhan & class note)	
7 (2/24)	Recent advances in microscale convective heat transfer (Ch4.2, Sobhan)	HW3 due
8 (3/3)	Micro heat pipes (Ch4.3, Sobhan)	Project assigned
9 (3/10)	Computational analysis of microscale convective heat transfer (class note)	**Midterm Exam** in class; HW4 due
10 (3/17)	Spring break	
11 (3/24)	Review of radiative heat transfer (Ch5.1, Sobhan); radiation interaction with microstructures and materials (Ch5.4, Sobhan)	
12 (3/31)	Modeling of microscale radiation (Ch5.5, Sobhan)	HW5 due
13 (4/7)	Nanoscale thermal phenomena (Ch6.1, Sobhan); nanoparticles and nanofluids (Ch6.2, Sobhan)	
14 (4/14)	Molecular dynamics simulation for nanofluids (Ch6.4, Sobhan)	HW6 due
15 (4/21)	Thermoelectricity (Ch5.4, Zhang)	
16 (4/28)	Thermoelectric generation & refrigeration (Ch5.4, Zhang)	**Project** presentations; **Project** report due
17 (5/5)	Final exam (Comprehensive)	HW7 due