

Spring 2018 Self Study

Certificate in Engineering Thermal Energy Systems

Date submitted: March 12, 2018

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1. Program Description and Context

Thermal energy systems either employ thermal energy directly or convert thermal energy to other energy forms. The objective of the Certificate in Engineering Thermal Energy Systems (CETES) is to provide engineering students with an organized set of courses that will improve their capability to analyze and design thermal energy systems. The award of the certificate with a diploma will be of value to students who are seeking employment in the energy field. This program is related to, but differs from the existing Certificate in Engineering for Energy Sustainability (CEES). The relationship between the two Certificates is described below, in "Relationship to Other Units."

Prerequisites for acceptance into the certificate program:

The Certificate is open to all undergraduate students who have been accepted into an engineering program, and while it is housed in Mechanical Engineering, it is expected that this program will be of interest to students in other engineering departments, such as Nuclear Engineering, and Chemical and Biological Engineering.

Courses required for the completion of this certificate program (minimum of 18 credits total)

The CETES program requires a total of 18 credits.

Required Courses : Nine (9) credits may be for courses related to thermal fluids that are required by the student's undergraduate program. For example, in ME a student might take:

ME 361 (Thermodynamics),
ME 363 (Fluid Mechanics), and
ME 364 (Heat Transfer)

which are required for graduation and count them towards the certificate.

Electives :

Additional credits must be selected from any of the following courses in order to reach the required 18 credits. Courses not on this list must be specifically approved by the personnel who oversee the certificate.

Mechanical Engineering

- [ME 461](#): Thermal Systems Modeling
- [ME 466](#): Air Pollution Effects, Measurement and Control
- [ME 469](#): Internal Combustion Engines
- [ME 520](#): Two Phase Flow and Heat Transfer
- [ME 561](#): Intermediate Thermodynamics
- [ME 563](#): Intermediate Fluid Dynamics
- [ME 564](#): Heat Transfer
- [ME 565](#): Power Plant Technology
- [ME 566](#): Cryogenics
- [ME 567](#): Solar Energy Technology
- [ME 569](#): Applied Combustion
- [ME 572](#): Intermediate Gas Dynamics
- [ME 573](#): Computational Fluid Dynamics

Chemical and Biological Engineering:

- [CBE 320](#): Introductory Transport Phenomena
- [CBE 430](#): Chemical Kinetics and Reactor Design
- [CBE 567](#): Solar Energy Technology

Civil and Environmental Engineering:

[CEE 423](#): Air Pollution Effects, Measurement and Control

Nuclear Engineering and Engineering Physics:

[NE \(NEEP\) 520](#): Two-Phase Flow and Heat Transfer

[NE \(NEEP\) 550](#): Advanced Nuclear Power Engineering

[NE \(NEEP\) 565](#): Power Plant Technology

[NE \(NEEP\) 566](#): Cryogenics

Mission

Most engineering students are required to take a number of technical elective courses. For example, Mechanical Engineering students are required to take 12 credits of technical elective courses. There is a great deal of freedom in the selection of the elective courses as almost any upper level course in engineering or physical sciences can be taken for technical elective credit. Currently, the Department provides little direction regarding which courses a student should take, other than the informal discussion students may have with their advisors. The unique aspect of the proposed certificate program is that it will provide an organized set of courses for students who are interested in energy systems to select from, while fulfilling their technical elective degree requirements. The award of the certificate with a diploma will be of value to students who are seeking employment in the energy field.

Student Learning Goals

These learning goals were outlined in broad terms in the original proposal for this certificate; they are slightly amended here and in the Self Study that is currently being drafted for this Certificate, due for review Spring 2018. (The amendments primarily shifted the language from objectives of the Certificate to learning outcomes the students will achieve, a matter of semantics only.)

Students who complete the Certificate in Engineering Thermal Energy Systems will . . .

- 1. Follow a directed sequence of technical elective courses specializing in thermal energy systems**
- 2. Synthesize knowledge gained from a curriculum that focuses on applying fundamentals of engineering to the analysis of thermal energy systems.**
- 3. Be prepared for the job market with a solid background in the energy field.**

Relationship with other Units

This Certificate is designed to help students in several engineering disciplines choose courses that can prepare them for work in thermal energy systems; it is meant to complement degrees in such fields as Mechanical, Chemical, and Nuclear Engineering.

The Certificate in Engineering Thermal Energy is related to the Certificate in Engineering for Energy Sustainability (CEES), which also exists in the College of Engineering. The CEES aims to “offer undergraduate students a suite of courses addressing energy sustainability that span across the engineering curriculum, with firm roots in “real world” design and engineering practices.” That certificate focuses on providing students with an overview of the global energy and sustainability issues. In contrast, the Certificate in Thermal Energy Systems is very much focused on providing students with the engineering tools required to analyze and design specific thermal energy systems. These systems include energy conversion systems and their fuels, including electrical and mechanical power generation from fuel or thermal sources, refrigeration, combustion, solar energy, and fundamental courses that support these areas.

2. Demonstration of Need and Recruitment/Outreach

The Certificate in Thermal Energy Systems has been reasonably successful in recruiting students through advising sessions and information provided in existing required engineering courses. It has seen steady enrollment and presumably has been helpful in job searches. We do intend to add a question to the existing senior exit survey (EBI/Skyfactor Survey) to gather feedback on whether the Certificate has helped students land job offers.

3. Program Administration and Resources

The initial leader of the Certificate was Prof. Sanford Klein, who has since retired. Current leadership has been assumed by Prof. Greg Nellis. The student services Hub that administers this Certificate has seen turnover recently; Tyree Bolden, who had been in charge of processing Certificate applications, has changed jobs. In the process of completing this Self Study, we reached out to Catherine Turng, who is a new member of the academic services administrative Hub. She now processes applications for this Certificate. Because the CETES is a low-maintenance and zero cost certificate, it is expected that the enrollment and completion rate of the Certificate will hold steady. No additional resources are required.

4. Advising and Student Services

The student services office, in conjunction with the student’s advisor and the certificate director, assists the student in selecting appropriate courses that fulfill the certificate requirements. If a special student does not have a home department in the College of Engineering, the Department of Mechanical Engineering will advise and sponsor the student in this program. Advising is done primarily by the faculty in charge of teaching the main required courses, but students are also given materials and made aware of the Certificates available to them during annual advising days. It is required that all students enrolled

in the certificate meet with the director of the certificate. The DARS system has been coded to sort coursework and demonstrate where students have gaps in the CETES coursework; the DARS also provides them with a list of possible electives to take to complete the Certificate. There is no evidence that further monitoring is needed.

5. Faculty/Staff Participants

The following faculty currently serve as certificate advisors:

Greg Nellis (faculty), Mechanical Engineering

Thatcher Root (faculty), Chemical and Biological Engineering

Catherine Turng, Hub staff, Mechanical Engineering

All the required and elective courses are taught by faculty in multiple disciplines throughout the College of Engineering

6. Student Enrollment

Students must be admitted to an undergraduate engineering degree program to be admitted to the certificate program. There are no requirements on the undergraduate level for timing of student enrollment into the certificate program (it could be as early as sophomore and as late as senior). The certificate is awarded coincident with degree completion. The average time to degree for engineering students is between 4.0 and 4.5 years. Although a student may not be admitted to the certificate program until the junior or senior year, the certificate is awarded coincident with their BS degree, so the time to certificate is reported to be the same as the time to degree.

There are as of Spring 2018 currently nine students enrolled in the Certificate, though enrollment has been higher in past years.

Figure 1 shows the Certificate completion rate going back to 2012. It appears that interest in the Certificate grew steadily and then declined somewhat in the most recent year, something we will continue to monitor and address through more emphasis in advising.

Certificates and Doctoral Minors: Counts

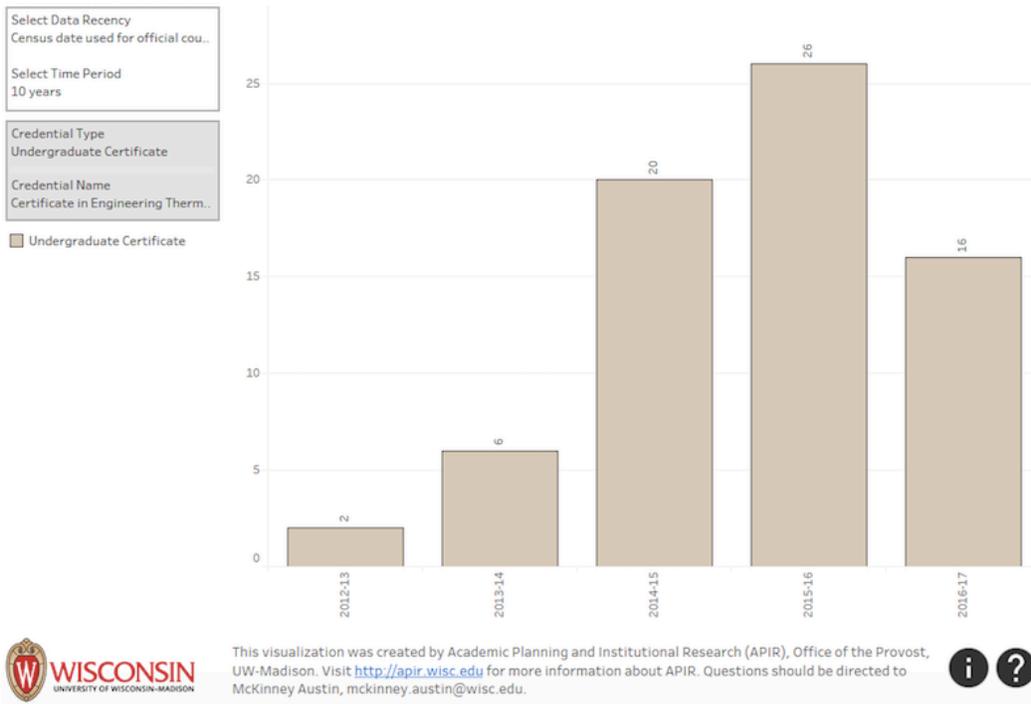


Figure 1. Chart showing CETES graduation trends since 2012.

7. Curricular Offerings and Enrollment Levels

There are no required courses required to complete the certificate. However, three courses (or nine credits total) can be obtained from classes that are required for graduation by the student's engineering degree. The remaining nine elective credits needed to complete the certificate span a multidisciplinary list of specialties offered throughout the College of Engineering: 1) mechanical engineering, 2) chemical and biological engineering, 3) civil and environmental engineering, and 3) nuclear engineering and engineering physics. The courses most often used to fulfill the three courses from the major are ME 361, ME 363, and ME 364; the enrollments in these courses for a few past years are detailed in Table 1.

Table 1 : Past enrollments of required courses needed to complete the program

		Lecture 1	Lecture 2	Lecture 3	Total Enrollment
Fall 2017	361	45	51	29	125
	363	53	56	44	153
	364	112			112
Spring 2017	361	52	59	56	167
	363	42	48	49	139
	364	138			138
Fall 2016	361	58	60	56	174
	363	51	67	29 and 38	185
	364	108			108
Spring 2016	361	46	61	59	166
	363	69	45		114
	364	142			142
Fall 2014	361	52	55	63	170
	363	73	73	35	181
	364	67	51		118
Spring 2014	361	56	54	63	173
	363	43	66	32	141
	364	65	51		116

A quick review of elective courses taught in ME that count toward this certificate reveals adequate enrollment for students interested in pursuing the Certificate; please see Table 2. Two courses, ME 520 and ME 566, appear not to have been taught since 2012, and ME 572 has not been taught since 2013, but the other courses are offered either in Fall or in Spring. The quick analysis of existing electives in ME indicates that the list of suggested courses for students pursuing this Certificate may need to be updated, particularly if some courses have been discontinued. It could be that other courses currently offered in the College may also be considered for inclusion in the electives lists, too. This process tends to occur naturally as students in the certificate identify courses that fit their interest and the intent of the certificate from across the college and petition the certificate director to add them.

Table 2. Elective courses that count toward the CETES in Mechanical Engineering

Last semester taught	ME Elective Course	Enrollment
Sp 2017	ME 461	24
Sp 2017	ME 466	54
Fall 2017	ME 469	35
Fall 2016	ME 561	22
Spring 2017	ME 563	15
Fall 2017	ME 564	28
Fall 2017	ME 565	11
Fall 2017	ME 567	20
Fall 2016	ME 569	10
Fall 2017	ME 573	26

As one can see in Table 1 and Table 2, the number of students enrolled in the associated classes shows the potential to attract a satisfactory number of students into the Certificate program. These courses have enrollment capacity to allow progress and completion of the Certificate.

8. Assessment

There have been no assessments of this program done to date, but we did submit an Assessment Plan to the campus last fall. Figure 2 shows those detailed plans:

Assessment Planning (How)	For each learning outcome, indicate how you plan to assess whether or not students are meeting the expectation, as well as when each learning outcome will be assessed. Keep in mind that each academic degree program is expected to engage in at least one assessment activity per year and assessment activities, in total, must include one direct assessment method.		
Method for assessing learning (at least one direct method required)	GPA for courses that make up the Certificate must total > 3.0	Students will meet with a certificate advisor to review their course plan	Senior exit survey
Timetable for assessment activity	Ongoing: Student success in meeting the 3.0 GPA is automatically checked by DARS and reviewed prior to graduation by dept. student services personnel	Students meet first upon declaring their intent to pursue the Certificate	Administered December and May to graduating seniors

Figure 2. Assessment Plan submitted to Campus in Fall 2017.

Assessment Review and Reporting_ Certificate administrator Greg Nellis will be responsible for review and reporting, with collaboration from faculty committee members Thatcher Root, Dan Klingenberg, and Hub staff administrator Catherine Turng. The College of Engineering will ensure that a few questions regarding this Certificate are added to an existing exit survey for graduating seniors. Faculty will periodically review enrollment information, completion rates, and potential updates to the certificate implementation form and curriculum (adding or removing courses based on relevance to learning goals and availability).

The annual summary report will be a very short summary of key findings from the Exit Surveys for the previous academic year and a brief overview of student completion rates. Any significant changes are likely to be documented annually and reported in more detail when the Certificate goes through its regularly scheduled Self Study assessment for campus.

Any significant recommendations will be communicated to all designated faculty who advise students in the certificate program, with an opportunity for providing feedback. If the changes affect students currently in the program, those changes will also be communicated with students, and they will have several months to provide feedback. If the recommendations result in significant changes to the curriculum, the committee may determine a cutoff year to grandfather in existing students with the previous requirements and apply the changes to new students. The certificate website (<https://www.engr.wisc.edu/academics/undergraduate-academics/certificate-in-engineering-thermal-energy-systems/>) will maintain documentation of any changes to the curriculum or processes for students to complete the certificate.

9. Program Completion

As noted above in student enrollment, we have good evidence that students are enrolling in and completing the program at a satisfactory rate.

10. Overall Analysis of the Self Study and State of the Program: Recommendations

The graduation rates and enrollment levels indicate that the Certificate offers a valuable credential to engineering students interested in emphasizing thermal energy systems. Through our work on this Self Study, three recommendations have emerged:

1. The program could do more effective follow-up on the value of the Certificate to our students. All engineering students take a senior exit survey, administered through EBI/Skyfactor, so a question will be added to that survey to determine how well all Certificates in the College of Engineering are helping students land their first job. We may also consider adding a question about Certificates to the Alumni Survey, which is sent out periodically for ABET accreditation reasons.
2. We will continue to monitor the enrollment levels in the Certificate, as there appears to have been a slight decline in the most recent year, although the numbers of students enrolled show that the Certificate is still viable. To address this decline we should be sure new people in the program are aware of it and emphasize its value during advising days.
3. The electives listed for completion of this Certificate may need to be updated, as some electives seem to have been discontinued, and new courses may have emerged over the past six years that would warrant inclusion.