

# Graduate Programs

Fred W. DePiero, Associate Dean  
Engineering Bldg. (13), Room 266  
805 756-2131

## Programs of Study/Specializations Available

Aerospace Engineering– MS (see page 170)

with Specializations in:

Research

Space Systems Engineering

Biomedical Engineering – MS, see page 175

Civil and Environmental Engineering – MS, see page 181

Computer Science – MS, see page 190

Electrical Engineering – MS, see page 194

Engineering – MS with Specializations in:

Biochemical Engineering

Bioengineering

Biomedical Engineering

Integrated Technology Management

Materials Engineering

Water Engineering

Fire Protection Engineering – MS

Industrial Engineering – MS, see page 199

Mechanical Engineering – MS, see page 205

## Blended BS+MS Programs

### Joint Programs:

Engineering Management Specialization,  
MBA/MS Engineering, see page 166

Transportation Planning Specialization,  
MCRP/MS Engineering, see page 166

## Graduate Certificate Programs

Fire Protection Engineering:

Fire Protection Engineering Applications

Fire Protection Engineering Science

## MS FIRE PROTECTION ENGINEERING

### General Characteristics

The profession of Fire Protection Engineering is directed toward the identification, analysis and mitigation of fire hazards and risks across a broad spectrum of applications, including buildings, consumer products, industrial processes, transportation vehicles, infrastructure facilities and the wildland-urban interface.

A pilot program, the Master of Science in Fire Protection Engineering prepares individuals to assess and reduce the potential for property and human loss from fire in these and other settings. Students learn to analyze how buildings are used, how fires start, how fires grow, and how fire and smoke affect people, buildings and property. Fire protection

engineers use the latest engineering and construction technologies to:

- Design systems that control fires, alert people to danger and provide means for escape;
- Evaluate buildings to identify fire risks of and the means to prevent or mitigate them;
- Conduct fire safety research on consumer products and construction materials; and
- Investigate fires to discover how fires start, how they spread, why protective measures fail, and how those measures could be designed more effectively.

To meet these program goals, the fire protection engineering curriculum requires that students successfully complete a total of 45 units including a fire protection engineering project as the culminating experience (FPE 596). The culminating experience will be innovative and require independent thinking. Typically, the students will perform a detailed fire and life safety evaluation of a selected building, the preparation of a comprehensive report documenting the results of this evaluation and the presentation of their analysis and findings in an oral defense to a review committee. Other innovative culminating experiences of similar scope and complexity may be submitted for approval.

### Program Goals

The Fire Protection Engineering program is designed to build on the skills, knowledge, and broad engineering principles students acquire in an undergraduate engineering program. The required and elective courses composing the Master of Science degree in Fire Protection Engineering address the specific body of knowledge required by the fire protection engineering profession. Students completing the program will possess the technical knowledge, skills and tools required to practice fire protection engineering in a variety of local, national and international settings. Upon completion of this program, students should possess the necessary knowledge and skills to pursue professional certification and licensure in the fire protection engineering discipline. Furthermore, the program addresses unique fire challenges faced by California and other western states, including wildland-urban interface fires and post-earthquake fires. Upon completing the requirements for a Master of Science degree in Fire Protection Engineering, students should be able to:

- a) Identify relevant fire safety codes, standards and regulations, comprehend the fire safety performance objectives and criteria associated with these documents, and apply these fire safety objectives and criteria to a broad range of applications.
- b) Analyze the flammability characteristics of different materials, interpret the results of standard and non-standard fire test methods and evaluate the fire hazards associated with different materials in a range of anticipated settings.

c) Analyze the dynamics of fires in and around buildings and other structures through the application of fundamental principles and the use of state-of-the-art computer-based fire simulation models.

d) Understand how people interact with fire conditions in buildings and calculate evacuation times through the application of fundamental principles of people movement and the use of state-of-the-art computer-based evacuation models.

e) Design fire detection and alarm systems, fire suppression systems, smoke management systems, egress systems and structural fire protection to achieve specified performance objectives.

f) Perform comprehensive fire and life safety evaluations of buildings and other structures through application of the knowledge, skills and tools acquired in this program and effectively communicate the results and findings of such evaluations.

## GRADUATE CERTIFICATE PROGRAMS

### Fire Protection Engineering Applications

#### General Characteristics

The courses offered in the Fire Protection Engineering Applications graduate certificate program will prepare students for a specialized career in fire protection engineering. Students completing the certificate program will be prepared for careers in:

- Consulting/Design Engineering Firms
- Fire Equipment and Systems Manufacturers
- Hospitals and Health Care Facilities
- Insurance Industry
- Research and Testing Laboratories
- Fire Departments
- Government

#### Program Goals

Upon completing the requirements for the graduate certificate, students should be able to:

- a) Identify relevant fire safety codes, standards and regulations, comprehend the fire safety performance objectives and criteria associated with these documents, and apply these fire safety objectives and criteria to a broad range of applications.
- b) Understand how people interact with fire conditions in buildings and calculate evacuation times through the application of fundamental principles of people movement and the use of state-of-the-art computer-based evacuation models.

- c) Design fire detection and alarm systems, fire suppression systems, structural fire protection systems, and egress systems to achieve specified performance objectives.

To meet these program goals, the fire protection engineering applications curriculum requires that students successfully complete a total of 16 units.

### Fire Protection Engineering Science

#### General Characteristics

The courses offered in the Fire Protection Engineering Science graduate certificate program will prepare students for a specialized career in fire protection engineering. Students completing the certificate program will be prepared for careers in:

- Forensic Investigations;
- Nuclear Fire Safety;
- Fire Science Research (R&D facility, Testing Lab, etc.)
- Government
- Fire Departments

#### Program Goals

Upon completing the requirements for the graduate certificate, students should be able to:

- a) Apply concepts associated with the thermal sciences, including thermodynamics, fluid mechanics, and heat transfer, to the analysis of fire protection engineering problems.
- b) Analyze the flammability characteristics of different materials, interpret the results of standard and non-standard fire test methods and evaluate the fire hazards associated with different materials in a range of anticipated settings.
- c) Analyze the dynamics of fires in and around buildings and other structures through the application of fundamental principles and the use of state-of-the-art computer-based fire simulation models.

To meet these program goals, the fire protection engineering science curriculum requires that students successfully complete a total of 16 units.

## MS FIRE PROTECTION ENGINEERING AND FIRE PROTECTION ENGINEERING SCIENCE CERTIFICATE PROGRAM

#### Prerequisites

For admission as a classified graduate student, an applicant should hold a bachelor's degree in engineering or a closely related field from a regionally accredited institution, college, or university. An undergraduate grade point average of 3.0 is required. On occasion, where other credentials are exceptionally strong, a GPA in the 2.5-3.0 range may be accepted.

**FIRE PROTECTION ENGINEERING APPLICATIONS CERTIFICATE PROGRAM**

**Prerequisites**

For admission as a classified graduate student, an applicant should hold a bachelor’s degree in engineering, fire science, fire protection and safety, or a closely related field from a regionally accredited institution, college, or university. An undergraduate grade point average of 3.0 is required. On occasion, where other credentials are exceptionally strong, a GPA in the 2.5-3.0 range may be accepted.

**MS FIRE PROTECTION ENGINEERING AND GRADUATE CERTIFICATE PROGRAMS**

**Tuition and Fees**

As special session programs through Continuing Education and University Outreach, the MS Fire Protection Engineering and Fire Protection Engineering graduate certificate programs are administratively and academically completely self-supporting. As such, the programs carry a separate tuition and fee schedule. Please refer to [www.fpe.calpoly.edu/cost.html](http://www.fpe.calpoly.edu/cost.html) for the current cost of the program.

**MS FIRE PROTECTION ENGINEERING**

*Units*

<b>Core Courses</b> .....	37
FPE 501 Fundamental Thermal Sciences (4)	
FPE 502 Fire Dynamics (4)	
FPE 503 Flammability Assessment Methods (4)	
FPE 504 Fire Modeling (4)	
FPE 521 Egress Analysis and Design (4)	
FPE 522 Fire Detection, Alarm and Communication Systems (4)	
FPE 523 Water-based Fire Suppression (4)	
FPE 524 Structural Fire Protection (4)	
FPE 596 Culminating Experience in Fire Protection Engineering (5)	
<b>Technical electives</b> .....	8
<i>Select 8 units from the following:</i>	
FPE 551 Fire Safety Regulation and Management (4)	
FPE 552 Smoke Management and Special Hazards (4)	
FPE 554 Forensic Fire Analysis (4) (12/26/12)	
FPE 555 Fire Protection Management in the Wildland-Urban Interface (WUI) (4) (11/1/12)	
ME 541 Advanced Thermodynamics (4)	
ME 554 Computational Heat Transfer (4)	
NR 455 Wildland-Urban Interface Fire Protection (3)	
	45

**FIRE PROTECTION ENGINEERING APPLICATIONS Graduate Certificate**

*Units*

<b>Core Courses</b> .....	16
FPE 521 Egress Analysis and Design (4)	
FPE 522 Fire Detection, Alarm and Communication Systems (4)	
FPE 523 Water-based Fire Suppression (4)	
FPE 524 Structural Fire Protection (4)	
	16

**FIRE PROTECTION ENGINEERING SCIENCE Graduate Certificate**

*Units*

<b>Core Courses</b> .....	16
FPE 501 Fundamental Thermal Sciences (4)	
FPE 502 Fire Dynamics (4)	
FPE 503 Flammability Assessment Methods (4)	
FPE 504 Fire Modeling (4)	
	16

# *Master of Science in Engineering*

## **MS Engineering General Characteristics**

The Master of Science degree program in Engineering has the following objectives:

- Provide an empowering terminal professional degree for students who intend to become practicing engineers, retaining the strong laboratory emphasis and industrial interaction found in the BS curriculum.
- Provide preparation for further study in engineering, leading to the Doctor of Engineering or Ph.D. degree.
- Provide job-entry education for the more complex and evolving interdisciplinary areas of engineering, such as research and development, innovative design, systems analysis and design, bio-engineering, biomedical engineering, manufacturing, mechatronics, and engineering management.
- Update and upgrade opportunities for practicing engineers.
- Allow graduates to maintain currency in their fields.

## **Prerequisites**

For admission as a classified graduate student, an applicant should hold a bachelor's degree in engineering or a closely related field with a minimum grade point average of 2.5 in the last 90 quarter units (60 semester units) attempted. Some programs impose higher GPA requirements.

Applicants for most graduate engineering programs are required to submit scores for the General Test of the Graduate Record Examination. An applicant who meets program standards but lacks prerequisite coursework may be admitted as a conditionally classified student and must make up any deficiencies before advancement to classified graduate standing. Contact the individual program graduate coordinator for details.

## **Program of Study**

Each graduate student must prepare a formal study plan with his or her advisor early in the program, usually before the 12th unit of approved courses is completed.

The formal program of study must include a minimum of 45 units (at least 23 of which must be at the 500 level) with a specialization in one of the following areas: Biochemical Engineering, Bioengineering, Biomedical Engineering, Integrated Technology Management, Materials Engineering, Water Engineering, or another individualized course of study.

## **Requirements**

The broad curriculum requirements for the Master of Science degree in Engineering are:

- a) a number of required units in the field of specialization, in many cases supplemented by analytical and technical breadth requirements;
- b) additional units taken as advisor-approved electives;

- c) at least 23 units of the 45 unit program at the 500 level;
- d) at least 32 units taken "in residence."

In some specializations, two culminating requirement options are available: a thesis/project option, which requires coursework and an up-to-9 unit thesis or project with oral defense; or a non-thesis/project option, which involves additional coursework and a comprehensive examination. The non-thesis option is normally allowed only for students who have completed a senior project or have had significant prior engineering project experience.

## **Blended BS + MS Engineering Program**

The blended program provides motivated students with an accelerated route to the MS Engineering, with simultaneous conferring of both bachelor's and master's degrees. Students in the blended program are provided with a seamless process whereby they can progress from undergraduate to graduate status.

### **Eligibility for Blended BS+MS Engineering**

Students majoring in BS General Engineering, BS Computer Engineering, BS Manufacturing Engineering, and BS Materials Engineering may be eligible to pursue the blended program toward the MS Engineering with a specialization in Biochemical Engineering, Bioengineering, Biomedical Engineering, Materials Engineering, or Integrated Technology Management. They may also be able to pursue blended programs incorporating other MS degrees or specializations in the College of Engineering.

In addition, students in departments with their own master's degrees may be able to pursue masters degrees in other areas, or the MS Engineering degree via the blended program, based on agreements between their bachelors granting program and their target masters program.

Participation in the program is based on prior academic performance and other measures of professional promise. Students are selected by a faculty committee, chosen on the basis of the student's area of interest. Please see page 60 for eligibility criteria.

### **Program of Study**

Some programs allow students to complete a capstone experience that integrates the senior project with the graduate thesis. This arrangement also increases the possibilities for industrial interaction in students' professional programs.

The blended program may allow students to earn graduate credit for several senior electives, effectively decreasing the summed unit requirements for both degrees. Requirements concerning shared units vary by degree program. Contact the program graduate coordinator for details.

### **Other Blended Programs**

Blended BS+MS programs are also available in Aerospace Engineering, Biomedical Engineering, Civil and Environmental Engineering, Computer Science, Electrical Engineering, Industrial Engineering, and Mechanical Engineering. Additional information about these programs may be obtained from the individual departments.

**MS Engineering, Specialization in  
BIOCHEMICAL ENGINEERING**

<b>Required Courses</b> .....	37	<i>Units</i>
Analytical methods for engineering (6)		
Advanced mathematics (3)		
ENGR 599 Design Project (Thesis) (2) (2) (5) <i>or</i> 9 units of approved technical electives <i>and</i> written comprehensive examination		
<i>Select 19 units from the following:</i>		
ME 541 Advanced Thermodynamics (4)		
ME 552 Advanced Heat Transfer I (4)		
ME 553 Advanced Heat Transfer II (4)		
ENVE 421 Mass Transfer Operations (4)		
ENGR 581, 582, 583 Biochemical Engr (4,4,4)		
<b>Approved Electives</b> .....	8	
	<u>45</u>	

**MS Engineering, Specialization in  
BIOENGINEERING**

<b>Required Courses</b> .....	33	<i>Units</i>
ENGR 551 Advanced Topics in Bioengineering (4)		
MATE 530 Biomaterials (4)		
ENGR 581 Biochemical Engineering I (4)		
ENGR 599 Design Project (Thesis) (9)		
<i>Select 12 units from the following:</i>		
BIO 432		
CSC 471, 473, 474, 541		
ENGR 451, 582		
ENVE 443, 536		
IME 507		
MATE 425, 501		
ME 401, 504, 551, 552, 553, 554		
STAT 419, 512, 542		
<b>Approved Engineering Electives</b> .....	12	
	<u>45</u>	

**MS Engineering, Specialization in  
BIOMEDICAL ENGINEERING**

<b>Required Courses</b> .....	27	<i>Units</i>
BMED 450 Special Topics in Bioengineering (4)		
BMED 460 Engineering Physiology (4)		
BMED 530 Biomaterials (4)		
BMED 550 Advanced Topics in Bioengineering (4)		
BMED 563 Biomedical Engineering Graduate Seminar (2)		
BMED 599 Design Project (Thesis) (9) (BMED 591/592 substitute for 2 or 4 units of BMED 599)		
<b>Approved Engineering, Science and Mathematics Electives</b> .....	18	
	<u>45</u>	

**MS Engineering, Specialization in  
INTEGRATED TECHNOLOGY MANAGEMENT**

The program goal is to develop "industry ready" graduates who will be integrators of engineering disciplines, industry concerns, and technology management. Many of the program courses involve actual integrated problems or opportunities from industrial organizations in a collaborative learning environment.

<b>Required Courses</b> .....	29/30	<i>Units</i>
IME 417 Supply Chain/Logistics Management (4) <i>or</i> IME 430 Quality Engineering (4)		
IME 503 Applied Stat. Analysis for Engineers (4)		
IME 507 Graduate Seminar (2)(2)		
IME 556 Technological Project Management (4)		
IME 580 Manufacturing Systems (4)		
IME 596 Team Project/Internship (10) <i>or</i> IME 599 Design Project/Thesis (9)		
<b>Approved Electives</b> .....	16/15	
	<u>45</u>	

**MS Engineering, Specialization in  
MATERIALS ENGINEERING**

<b>Required Courses</b> .....	24	<i>Units</i>
MATE 599 Design Project (Thesis) (2) (2) (5)		
<i>Select 15 units from the following:</i>		
MATE 425, 430, 440, 481, 501, 504, 510, 522, 540, 550, 555, 570, 571, 580, 590;		
MATE/BMED 530;		
MATE/CHEM 446;		
MATE/IME 458		
<b>Approved Electives</b> .....	21	
	<u>45</u>	

**MS Engineering, Specialization in  
WATER ENGINEERING**

<b>Required Courses</b> .....	35	<i>Units</i>
Analytical methods for engineering (6)		
ECON 410 Public Finance/Cost-Benefit Analysis (4)		
BRAE 414 Irrigation Engineering (4)		
BRAE 532 Water Wells and Pumps (4)		
BRAE 533 Irrigation Project Design (4)		
CE 533 Adv Water Resources Engineering (4)		
BRAE/CE 599 Design Project (Thesis) (2) (2) (5) <i>or</i> 9 units of approved technical electives <i>and</i> written comprehensive examination		
<b>Approved Elective Courses</b> .....	10	
<i>Select 10 units from the following:</i>		
BRAE 405, 435, 440;		
CE 434, 435, 440, 573;		
ENVE 438, 439, 535		

45

# Joint Graduate Programs

The College of Engineering offers two joint programs: in conjunction with the Orfalea College of Business, the MBA/MS Engineering, with a specialization in Engineering Management; and with the College of Architecture and Environmental Design (City and Regional Planning Department), the MCRP/MS Engineering, with a specialization in Transportation Planning.

## MBA/MS Engineering, Specialization in ENGINEERING MANAGEMENT

The dual-degree Engineering Management Program (EMP) is an interdisciplinary program linking the MBA and MS in Engineering degree programs. It is a cooperative effort between the Orfalea College of Business and the Cal Poly College of Engineering (Industrial and Manufacturing Engineering Department). Students are required to have a prerequisite degree in engineering, computer science, or equivalent technical degree to be admitted to both the College of Engineering and the Orfalea College of Business, and to be enrolled in both degree programs. Successful participants are awarded both MBA and MS in Engineering degrees, each with a specialization in Engineering Management.

The mission of the EMP is to develop high quality industry-ready graduates who will be facilitators of change and integrators of engineering, business, and people issues.

The three major objectives of this program are to:

- 1) integrate knowledge and skills from engineering and business disciplines for effective responses to rapidly changing technological and business environments;
- 2) prepare engineers for effective participation in the management of technology, management of technology-based organizations, and management of technological change; and
- 3) take advantage of the unique background of program participants and the unique strengths of Cal Poly.

### Prerequisites

Students are required to possess a bachelor's degree, from an accredited program in engineering, computer science, or equivalent technical degree.

### Admission/Acceptance Requirements

Admission to the EMP is based upon:

- successful completion of an accredited undergraduate program of study
- prior academic performance with particular emphasis placed on the last 90 quarter units (60 semester units)
- achievement on the Graduate Management Admission Test (GMAT)
- prior work experience (desirable).

## Culminating Experience

In order to satisfy the culminating experience requirement, students must satisfactorily complete a comprehensive examination at the end of GSB 562 or GSB 567 and satisfactorily complete a comprehensive project, IME 596 or design project/thesis, IME 599. Other courses and/or options may be available, but must be approved in advance by the Orfalea College of Business Associate Dean of Graduate Programs and by the College of Engineering, Engineering Management Program Coordinator.

	<i>Units</i>
<b>Required courses</b> .....	57-58
GSB 511 Accounting for Managers (4)	
GSB 513 Organization Behavior (4)	
GSB 523 Managerial Economics (4)	
GSB 524 Marketing Management (4)	
GSB 531 Managerial Finance (4)	
GSB 533 Aggregate Economic Analysis and Policy (4)	
GSB 562 Seminar in General Mgmt & Strategy (4) or GSB 567 Adv Sem International Business Mgmt (4) or other approved culminating experience	
IME 417 Supply Chain and Logistics Management (4) or IME 430 Quality Engineering (4)	
IME 503 Applied Statistical Methods in Engrg (4)	
IME 507 Graduate Seminar (4)	
IME 556 Technological Project Management (4)	
IME 580 Manufacturing Systems (4)	
IME 596 Internship/Team Project (10) or IME 599 Design Project (Thesis) (9)	
<b>College of Engineering approved electives</b> .....	16-17
<b>Other advisor approved electives</b> .....	16
	90

**Formal Study Plan.** The Formal Study Plan for this dual degree program must be approved by both the Orfalea College of Business – Associate Dean of Graduate Programs and by the College of Engineering – Engineering Management Program Coordinator.

## MCRP/MS Engineering, Specialization in TRANSPORTATION PLANNING

The Transportation Planning Specialization is a joint interdisciplinary program between the College of Engineering and the City and Regional Planning Department of the College of Architecture and Environmental Design. Participation in the program requires enrollment in both Colleges. Participants successfully completing the program are awarded both the MCRP and the MS in Engineering, each with a Specialization in Transportation Planning.

The major objectives of this joint program are to:

- (a) Provide an interdisciplinary graduate program which combines elements of transportation planning with city and regional planning to address a need for professionals who understand the technology of

transportation planning and the importance of transportation within the urban environment. The required master's project enables students to integrate their work through directed study applied to special areas of their choosing.

- (b) Provide planners with courses essential to understanding the technologies of transportation planning. Provide engineers with a broad background in urban studies and knowledge of contemporary environmental issues.
- (c) Take advantage of the backgrounds of program participants. The graduate students of both sponsoring departments include both mature professionals returning for advanced degrees and recent graduates with diversity of specializations.

**Prerequisites**

Applicants must have satisfactorily completed courses that cover the following or equivalent subject areas:

- CE 321 Fundamentals of Transportation Engineering *or* CRP 435 Transportation Theory
- COMS 101 Public Speaking
- ECON 201 Survey of Economics *or* ECON 222 Macroeconomics
- ENGL 148 Reasoning, Argumentation and Professional Writing *or* ENGL 149 Technical Writing for Engineers
- MATH 142 Calculus II
- PHYS 141 General Physics IA *or* PHYS 131 General Physics I
- STAT 321 Probability and Statistics for Engineers and Scientists *or* STAT 312 Statistical Methods for Engineers *or* STAT 221 Introduction to Probability and Statistics

Applicants for admission are expected to:

- \* Have earned a bachelor's degree from an accredited university or college,
- \* Have attained a grade point average of 3.0 in last 90 units of undergraduate work,
- \* Provide results of the Graduate Record Examination (GRE) Aptitude Test to the Admissions Committee (GRE requirement may be waived for Cal Poly bachelor of science graduates and applicants with superior academic records).
- \* Give indications of motivation, maturity, and high standards of academic involvement through work and references (three letters required) and submission of a project or paper demonstrating writing ability,
- \* Provide a statement (maximum of 500 words) addressing their understanding of and areas of interest in planning, career objectives, and educational objectives.

Applicants lacking prerequisites or other background requirements for classified standing may be admitted on a conditionally classified basis, depending on the results of an individual analysis of their applications.

	<i>Units</i>
<b>Core Courses</b> .....	64
CE 523 Transportation System Planning (4)	
CE 528 Transportation Analysis <i>or</i>	
CE 421 Traffic Engineering (4)	
CE 591 Graduate Seminar I (1)	
CE 599 Design Project (Thesis) (2,2,2) <i>or</i>	
CRP 599 Thesis (2)(2)(2) <i>or</i>	
CRP 596 Professional Project (2)(2)(2) <i>or</i>	
CRP 556 Community and Regional Planning Studio III (4)	
CRP 435 Transportation Theory (3)	
CRP 501 Foundations of Cities and Planning (4)	
CRP 509 Professional Development (1-3)	
CRP 510 Planning Theory (4)	
CRP 513 Planning Research Methods (4)	
CRP 516 Methods of Data Analysis (4)	
CRP 518 Policy Analysis for Planners (4)	
CRP 525 Plan Implementation (4)	
CRP 530 Planning Agency Management (3)	
CRP 535 Land Use Law (4)	
CRP 552 Community and Regional Planning Studio I (4)	
CRP 554 Community and Regional Planning Studio II (4)	
Advisor approved electives (4/8)	
<b>Emphasis Area (select one of the following)</b> .....	11
<i>Urban Development and Design Emphasis</i>	
CRP 520 Feasibility Studies in Planning (4)	
CRP 548 Principles of Urban Dev. and Design (4)	
Urban Development and Design elective (3)	
<i>Environmental Planning Emphasis</i>	
CRP 545 Principles of Environmental Planning (4)	
Environmental Planning electives (7)	
<b>Approved CE/ENVE electives:</b> .....	15
Select from: CE 421, 422, 423, 424, 500, 521, 522, 525, 526, 527, 528, 529, 573, ENVE 411 <i>or</i> other advisor approved CE/ENVE courses	