



California State University, Los Angeles



Department of

## **Mechanical Engineering**

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College of Engineering, Computer Science, and Technology

# **CSULA Mechanical Engineering Students An assessment of the EIT Examination Results 2001 - 2005**

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## **Background**

The Mechanical Engineering program provides instruction in the basic sciences and in engineering design and analysis. The undergraduate program has approximately 150 students and awards the Bachelor of Science in Mechanical Engineering to its graduates. The current assessment plan requires that the program be assessed every year to ensure that the student learning outcomes are being met. The assessment of the program and the student learning outcomes require both indirect assessments (surveys) and direct assessments (portfolio assessments, senior capstone project presentations and a licensure exam (the EIT). The purpose of this report is to present:

1. The purpose of using the EIT
2. How the EIT is implemented into the program
3. The results of past EIT exams
4. Assessment of these results
5. Program modifications based on these results

## **Student Learning Outcomes to be Assessed**

The student learning outcomes for the Mechanical Engineering program describe the characteristics of CSULA Mechanical Engineering graduates. The two outcomes to be examined using the EIT as an assessment tool are:

- an ability to apply knowledge of mathematics, science, and engineering. In particular, an ability to apply knowledge of:
  - chemistry and calculus-based physics.
  - advanced mathematics through multivariate calculus and differential equations.
  - statistics and linear algebra.
- an ability to identify, formulate, and solve engineering problems.

## **Description of the EIT Exam**

The Engineer-in-Training (EIT) exam is eight hours long and is administered by the state of California. In order to be eligible for the exam, one must have completed at least three years of study at an engineering program accredited by ABET. The exam covers most fundamental engineering, science, and mathematics topics. This certification is the first step required under State law towards becoming licensed as a professional engineer. A license in engineering is required for most consulting work and many government positions. After the exam is graded, all engineering Deans receive anonymous results that indicate the percentage of correct answers in each question area (e.g. material science).

## **Timetable for Implementation**

In order for the EIT to be an effective assessment tool, all of the students in the Mechanical Engineering program must attempt it. Programs that make the exam voluntary, will only encourage the top students to attempt the exam and will therefore obtain a positively skewed assessment result. Due to university policy, the department

can not make passing the EIT a graduation requirement. However, we have made attempting the exam a graduation requirement. We have learned from other universities that many students need an incentive to do well on the exam. Currently we reward students by reimbursing them for exam costs if they provide proof of passing.

Our senior design sequence of courses is three consecutive quarters long and is completed during students' final year. We believe that this is the best location in our curriculum to implement this assessment tool. Prior to 2005, we required students to apply for the exam as a prerequisite to completing the senior design sequence of courses. Unfortunately, the dates for application, testing, and release of the results do not align with our quarter system as can be seen in the Fig. 1 below:

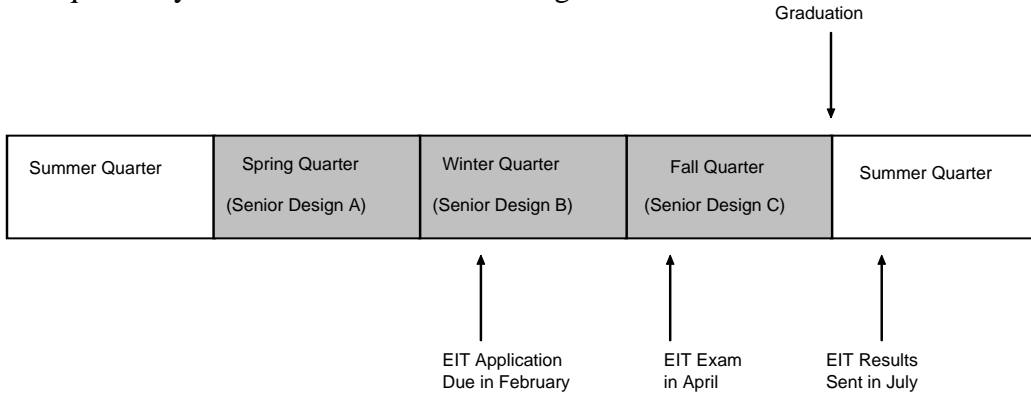


Fig. 1 Failed Implementation Schedule

Students would sit for the exam in April and the results would be delivered in July (after they had graduated). We learned in July that over half of the student who applied for the exam did not sit for it. Thus we were not obtaining an adequate number of results to perform reliable assessment. Since it was after the students graduated, we had no follow through and did not have a long enough data sample to implement the tool.

Fortunately, the exam is offered twice a year so starting in 2005, we had the students apply for the exam in August. Thus, the results are ready in January (See Fig. 2).

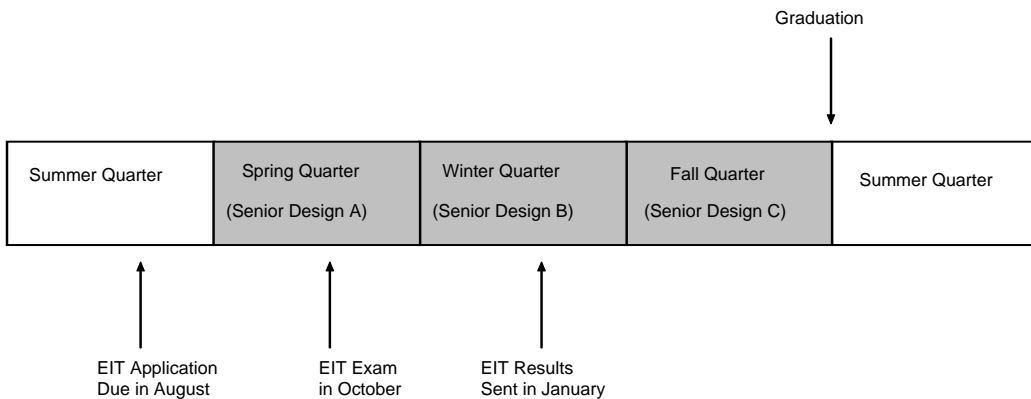


Fig. 2 2005 Implementation Schedule

# Data

## Previous FE Examination Results

The summary results presented here are based on data provided by the National Council of Examiners for Engineering & Surveying (NCEES) for the mechanical engineering students who appeared for the Fundamentals of Engineering Examinations (FE) during the period April 2001 to October 2005.

National Council of Examiners for Engineering and Surveying (NCEES)

Fundamentals of Engineering Examination

APRIL 2001 Administration

Board: CALIFORNIA  
Major: MECHANICAL

Name of Institution: California State U - LA  
PM Examination Selected: GENERAL

CSULA	National
Institution	

No. Examinees Taking	3	1991
No. Examinees Passing	1	1712
% Examinees Passing	33%	86%

<b>CSULA</b>	<b>National</b>
Average	Average
Percent	Percent
Correct	Correct

### AM Subjects

CHEMISTRY	61	64
COMPUTERS	48	81
DYNAMICS	52	67
ELECTRICAL CIRCUITS	56	69
ENGINEERING ECON	47	65
ETHICS	60	82
FLUID MECHANICS	58	71
MAT SCI/STR MATTER	46	70
MATHEMATICS	39	61
MECH OF MATERIALS	63	64
STATICS	39	51
THERMODYNAMICS	55	64

### PM Subjects

AUTOMATIC CONTROLS	33	49
COMPUTER	44	72
MECHANICAL DESIGN	44	43
DYNAMIC SYSTEMS	28	57
ENERGY CONSERVATION	44	44
FLUID MECHANICS	56	63
FANS/PUMPS & COMPR	44	60
HEAT TRANSFER	39	41
MEASUREMENT & INSTRU	33	67
MATL BEHAV & PROCESS	44	65

REFRIGERATION & HVAC	22	26
STRESS ANALYSIS	44	48
THERMODYNAMICS	44	62

➤ *Comments:*

Only 3 students took the exam, with only 1 passing the examination. Since this sample is so small, it is not possible to draw any reasonable conclusions.

National Council of Examiners for Engineering and Surveying (NCEI)  
APRIL 2002 Administration

Board: CALIFORNIA	Name of Institution: California State U - LA
Board Code: 57	Institution Code: 06
Major: MECHANICAL	PM Examination Selected: GENERAL

	CSULA	State	National
No. Examinees Taking	12	235	2430
No. Examinees Passing	3	193	2150
% Examinees Passing	25%	82%	88%

	CSULA	National
	Average	Average
	Percent	Percent
	Correct	Correct

**AM Subjects**

CHEMISTRY	33	64
COMPUTERS	45	69
DYNAMICS	45	63
ELECTRICAL CIRCUITS	31	56
ENGINEERING ECON	48	66
ETHICS	52	64
FLUID MECHANICS	44	61
MAT SCI/STR MATTER	43	58
MATHEMATICS	52	67
MECH OF MATERIALS	39	58
STATICS	44	66
THERMODYNAMICS	48	61

**PM Subjects**

ELECTRICAL CIRCUITS	26	64
CHEMISTRY	30	42
COMPUTERS	44	62
DYNAMICS	40	46
ENGINEERING ECONOMICS	44	49
ETHICS	44	66
FLUID MECHANICS	52	56
MATHEMATICS	40	65
MAT SCI/STR MATTER	39	59
MECH OF MATERIALS	33	56
STATICS	50	68
THERMODYNAMICS	32	63

➤ *Comments:*

Only 12 students took the exam, with only 25% passing the examination. When compared to the national statistics, it is obvious that our students were not well prepared for the examination, and showed inadequate knowledge in the areas of Chemistry, Circuits, Computers, Mathematics, Materials, & Thermodynamics.

National Council of Examiners for Engineering and Surveying (NCEES)

APRIL 2003 Administration					
Board: CALIFORNIA		Name of Institution: California State U - LA			
Board Code: 57		Institution Code: 06			
Major: MECHANICAL		PM Examination Selected: GENERAL			
		<b>CSULA</b>	<b>State</b>	<b>National</b>	
No. Examinees Taking		10	266	2766	
No. Examinees Passing		5	220	2427	
% Examinees Passing		50%	83%	88%	
		CSULA	National		
		Average	Average		
		Percent	Percent		
		Correct	Correct		
<b>AM Subjects</b>					
CHEMISTRY		65	73		
COMPUTERS		47	61		
DYNAMICS		62	69		
ELECTRICAL CIRCUITS		35	54		
ENGINEERING ECON		46	58		
ETHICS		70	75		
FLUID MECHANICS		44	53		
MAT SCI/STR MATTER		51	59		
MATHEMATICS		53	67		
MECH OF MATERIALS		40	58		
STATICS		44	55		
THERMODYNAMICS		41	58		
<b>PM Subjects</b>					
ELECTRICAL CIRCUITS		33	45		
CHEMISTRY		54	51		
COMPUTERS		53	81		
DYNAMICS		28	41		
ENGINEERING ECONOMICS		40	51		
ETHICS		43	66		
FLUID MECHANICS		45	49		
MATHEMATICS		38	51		
MAT SCI/STR MATTER		57	68		
MECH OF MATERIALS		33	27		
STATICS		47	55		
THERMODYNAMICS		43	46		

➤ *Comments:*

Only 10 students took the exam, with 50% passing the examination. When compared to the national statistics, it is obvious that our students were not well prepared for the examination, and showed inadequate knowledge in the areas of Circuits, Computers, Mathematics, Fluids, & Thermodynamics



Board: CALIFORNIA	Name of Institution:
Board Code: 57	School Code: 5719
Major: MECHANICAL	PM Examination Selected: MECHANICAL

	CSULA	State
No. Examinees Taking	6	44
No. Examinees Passing	1	35
% Examinees Passing	17%	80%

**AM Subjects**

	CSULA Average Percent Correct	National Average Percent Correct
CHEMISTRY	38	58
COMPUTERS	33	75
DYNAMICS	48	57
ELECTRICAL CIRCUITS	24	57
ENGINEERING ECON	43	51
ETHICS	53	67
FLUID MECHANICS	75	73
MAT SCI/STR MATTER	23	57
MATHEMATICS	32	59
MECH OF MATERIALS	35	57
STATICS	33	55
THERMODYNAMICS	39	57

**PM Subjects**

	CSULA Average Percent Correct	National Average Percent Correct
AUTOMATIC CONTROLS	33	34
COMPUTER	17	32
MECHANICAL DESIGN	39	56
DYNAMIC SYSTEMS	36	55
ENERGY CONVERSION	22	45
FLUID MECHANICS	36	59
FANS/PUMPS & COMPR	28	42
HEAT TRANSFER	39	60
MEASUREMENT & INSTRU	31	47
MATL BEHAV & PROCESS	17	41

REFRIGERATION & HVAC	22	33
STRESS ANALYSIS	33	48
THERMODYNAMICS	31	48

➤ *Comments:*

Only 6 students took the exam, with only 1 student passing the examination. When compared to the national statistics, it is obvious that our students were poorly prepared for the examination, and showed inadequate knowledge in the areas of Circuits, Computers, Materials, Measurements, and, & Thermodynamics.

### **October 2005 FE Examination Results**

Based on the mechanical engineering faculty initiatives and insistence, 28 (the largest group of our students to date) took the fall 2005 examination. 11 students (39%) passed the examination. However their passing scores were not available for our analysis. On the other hand, the scores for the 17 failing students were available to study their shortcomings.

#### ***Analysis of FE October 2005 Results***

<b>Percent(%)</b>		
<b>100</b>	<b># Who took the FE Examination</b>	<b>28</b>
<b>39%</b>	<b># Who Passed</b>	<b>11</b>
<b>61%</b>	<b># Who Failed</b>	<b>17</b>

#### **Analysis of Failed Student Scores**

##### ***AM Knowledge Areas***

	<b>Average</b>
Mathematics	<b>55</b>
Probability & Statistics	<b>43</b>
Chemistry	<b>49</b>
Computers	<b>40</b>
Ethics	<b>62</b>
Engineering Economics	<b>51</b>
Statics & Dynamics	<b>45</b>
Strength of Materials	<b>46</b>
Material Properties	<b>39</b>
Fluid Mechanics	<b>40</b>
Electricity & Magnetism	<b>30</b>
Thermodynamics	<b>37</b>

##### ***PM Knowledge Areas***

Adv. Engr. Mathematics	<b>42</b>
Engineering Probability & Statistics	<b>36</b>
Biology	<b>38</b>

Engineering Economics	46
Engineering Mechanics	36
Engineering Materials	36
Fluids	27
Electricity & Magnetism	29
Thermodynamics & Heat Transfer	33

## Assessment of Results

The FE examination results to date show that our students are not well prepared to pass the FE examination. Their performance in the AM areas seems to be better than the PM subject areas. While this assessment tool is still in its early stages of integration into our overall assessment process, we make the following observations:

1. In the past (April 2001 to April 2004) only a small number of students appeared for the examinations. As such, it is not possible to comment on their overall passing percentages. Only the fall 2005 examination has a large sample with clear trends in our students' strengths and weaknesses. This shows that our new implementation schedule works well.
2. We appear to provide inadequate practice preparations in our curriculum on typical problems that appear in the afternoon examination areas. Most students fail in Mathematics, Electrical Circuits, Materials, and Thermodynamics.

## Program Modifications

As mentioned before, most of our students fail in Mathematics, Electrical Circuits, Materials, and Thermodynamics. The majority of our students transfer into our program from community colleges with most of these courses already completed at entrance. Thus, this may be attributable to unsatisfactory transfer courses taken at community colleges. We need to assess the rigor of transfer courses in terms of background, texts used, and depth of subject matter covered. The faculty are also proposing placement exams in these subjects. Failure to pass these exams will require the students to repeat these course at CSULA.

Since the 2005 results were the first to provide us with a useful sample size, we are still learning how to assess the data. Starting this year, the department will survey both the passing and failing students to get a better handle of the disconnects between our courses and the FE exam emphases. We are considering

1. Providing practice examinations and
2. Providing tutorial help for our students
3. Requiring faculty to include as least one EIT type of problem on all tests in fundamental courses