# An Introduction to Course-Embedded Assessment

Dr. Tim Koeltzow
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Psychology

## Why do Course-Embedded Assessment?

NCA Accreditation:

- **Provide list of department/unit's student learning outcomes for majors, minors and other constituencies.**
- **Assessment data to show how student achievement meets department/unit's desired learning outcomes.**

## Why do Course-Embedded Assessment?

NCA Summary Report (2010):

"The university is still finding its way with regard to assessment... Many units... have a solid history of assessment successes and see the assessment process as a rational approach to evaluation and accountability that will lead to continuous quality improvement. (T)he general education and graduate programs seem to be further behind in the overall process of assessment. Overall, there is inconsistency and lack of cohesion in institution-wide assessment."

"...useful assessment tools and processes for the assessment of graduate programs and the general education requirements need to be developed."

## Why do Course-Embedded Assessment?

From a General Education perspective:

- **Provides some assurances that the course is achieving the goals defined in the master syllabus (e.g., has the course drifted?).**
- **Provides some assurances that courses with multiple sections exhibit congruence.**
- **Provides information that can feed back to course design.**
- **Fuels valuable conversations and reflection.**

## How to do Course-Embedded Assessment

- Faculty must identify student learning objectives
- Goals should be succinct
- For multiple sections, there should be consensus on goals and measurements.

## Learning Outcomes: Science & Technology

Fundamental concepts in science (FS) focus on the comprehension of the fundamentals of science and the scientific method as disciplined modes of thought and procedure. They introduce essential scientific principles, concepts and terminology, develop an understanding of the scientific method, and generate critical and systematic thinking that students can transfer to a number of other intellectual pursuits. Science and society courses (TS) will develop an understanding of scientific and technological principles, applications and implications in modern society, while involving critical thinking and communication.

# Learning Outcomes: Science & Technology

**Outcomes include:**

- A. understand essential scientific principles sufficiently to formulate questions and hypotheses
- B. make scientific observations and organize, interpret and analyze the data to address the questions and test the hypotheses
- C. reach scientific conclusions concerning the questions and hypotheses
- D. communicate the results of the scientific process
- E. demonstrate comprehension of the fundamentals of science and the scientific method as disciplined modes of thought and procedure (FS)
- F. demonstrate understanding of how science and society affect each other (TS)
- G. demonstrate awareness and understanding of science that may be related to the contemporary world (TS)
- H. understand the impact of science on civilization (TS)

# PSY 201: Brain and Behavior

**Course description:** Students will be introduced to scientific concepts and terminology describing the cellular components of the nervous system, neurotransmitters, and gross anatomical structures of the brain. The course will incorporate recent experimental studies to introduce students to contemporary neuroscience research methods and to advance scientific literacy. Students will gain an understanding of the biological underpinnings of complex phenomena such as language, memory, hemispheric lateralization, psychological and neurological disorders, sensation and perception, motivation, and movement.

**Course objectives include:**

A. understand essential scientific principles sufficiently to formulate questions and hypotheses

- Understand the vocabulary and methods of neuroscientists. This means that students should be able to acquire a functional understanding of the basic mechanisms of neuronal communication, link brain structures to function and understand the relationship of the brain to complex behavioral processes.
- Students will access the primary neuroscientific literature and perform critical analyses that represent a comprehension of scientific methodology and process. Students will acquire skill in scientific observation, analysis and interpretation.
- Understand the broad impact of neuroscience on society.

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**Course objectives include:**

F. demonstrate understanding of how science and society affect each other (TS)

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# Curricular Elements

**Knowledge and Reasoning in the Natural Sciences (NS)**

Bradley graduates will develop scientific reasoning skills supported by an integrated knowledge of the natural sciences to interpret technical information with the sophistication necessary to be contributing members of a knowledge-based society. Curiosity about the natural world and recognition of the rapidly expanding body of scientific information are essential to success and fulfillment in contemporary society.

**Curricular Elements**

- NS1 Recognize science as an ongoing process, guided by ethical standards of practice, that generates and refines knowledge.
- NS2 Engage in multiple aspects of the scientific process.
- NS3 Apply scientific principles in their personal and professional lives as active members of their communities.

# Articulating Student Learning Outcomes

| Curricular Elements | How they are addressed | Assessment Plans |
|---|---|---|
| **NS1 Recognize science as an ongoing process, guided by ethical standards of practice, that generates and refines knowledge.** | Instruction emphasizes the historical bases of contemporary neuroscience, emphasizing the evolution of understanding from early work to current innovations. APA ethical guidelines are introduced and utilized to explore contemporary ethical concerns. Students will understand the roles of IRBs and IACUCs. | Assessment includes 4 exams that include multiple choice, short answer and short essay questions that can measure these objectives. In addition, periodic quizzes are administered to gauge student mastery of these concepts. |
| **NS2 Engage in multiple aspects of the scientific process.** | Course includes at least 2 laboratory simulations, at least one of which includes parameters (variables) that are defined by students. Students will also be asked to procure and summarize at least 2 peer-reviewed articles linked to course content. | Lab reports will require students to operationally define variables, hypotheses and to summarize results of experimental simulations. Summaries of peer-reviewed articles will require students to identify variables and hypotheses and to determine whether the data supports the hypotheses. |
| **NS3 Apply scientific principles in their personal and professional lives as active members of their communities.** | Neuroscience and Society guides students through opportunities to critique neuroscientific concepts as they are portrayed in media. | In class discussions of emerging neuroscience concepts will routinely orient students towards critical analyses of science in the media. Neuroscience and Society summaries will require students to seek the original scientific reports and critique the quality of media coverage. |

- **NS1 Recognize science as an ongoing process, guided by ethical standards of practice, that generates and refines knowledge**

Does student provide evidence of an understanding that neuroscience is an interdisciplinary endeavor?
Can student identify various techniques that advance knowledge of neuroscience?
Can student recognize key ethical considerations of neuroscience?

Neuropsychology as a sub-discipline is primarily focused on which one of the following types of research approaches?
a. The effects of brain damage in human patients*
b. Measuring bioelectrical activity in the body
c. The manipulation of neurochemistry through drug administration
d. Surgical and electrical manipulation of the brain directly

Which of the following methods is best for imaging white matter tracts made of axons that connect neuron cell bodies to neurons in other regions of the brain.
a. Magnetization Prepared Rapid Acquistion Gradient Echo (MP RAGE)
b. Diffusion Tensor Imaging (DTI)
c. Computed Tomography (CT)
d. Positron Emission Tomography (PET)

Scientific progress is most likely when different approaches are focused on a single problem, particularly when the strengths of one approach compensate for the weaknesses of the others. This is called
a. Converging operations
b. Comparative analysis
c. Critical thinking
d. Scientific inference

**Short Answer.** Converging operations are useful for neuroscientists in exploring the link between brain and behavior. Describe two ways in which different perspectives and methods promote a better understanding of neuroscience.

- **NS1 Assessment:**

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**NS2 Engage in multiple aspects of the scientific process.**

Can student distinguish between scientific theory and hypothesis?
Can student distinguish between dependent and independent variables?
Can student interpret data to reach a conclusion?

In a study entitled the effects of cocaine on locomotor activity, the dependent variable is:
a. The cocaine injection
b. The saline injection
c. The measurement of locomotor activity*
d. None of the above

Which of the following is not true in regards to theory?
a. Theory makes predictions that direct future research
b. Theory explains the data
c. Theory is linked to deductive reasoning
d. Theory is Truth*

**Essay Question (5pts)** Dr. Jones wants to understand the relationship between activity in $D_1$ receptors and sexual behavior. Briefly describe a study design he might use to explore this question. Your answer should include: 1) a directional hypothesis described at the operational level; 2) the specific neurobiological method to be used and its strengths or weaknesses; 3) An explicit description of the independent and dependent variable at the operational level; 4) The sample to be used for the study; and 5) At least one strength and one weakness of the approach you've chosen.

**Short Answer** Dr. Stark believes red robot suits are scarier than silver robot suits, but wants to test his belief. To test this he wants a neural measure of fear taken from a magnetic resonance imaging (MRI) scanner, because Dr. Stark never does anything simply or cheaply. He decides to alternately show each participant several photos of suits of different colors and look at each person's brain response to those pictures using functional MRI. He focuses on the amygdala because he read in a newspaper that the amygdala is the fear center of the brain. Briefly identify the hypothesis of this study, the conceptual definitions of each variable, the operational definitions of each variable, and which of the variables is independent and which is dependent.

**NS2 Engage in multiple aspects of the scientific process.**

Can student distinguish between scientific theory and hypothesis?
Can student distinguish between dependent and independent variables?

Can student interpret data to reach a conclusion?

- **Article Review Assignment 1**: Use Scopus to find Koeltzow et al., 1998 and download the article. Identify at least one idea from the Introduction that provides the reasoning for performing the experiments. Based on the first experiment (Fig. 1), state the hypothesis and provide the operational definition of at least one dependent variable and at least one independent variable. Did the data support the hypothesis? Based on the Discussion section, identify at least one limitation of the study.

**NS3 Apply scientific principles in their personal and professional lives as active members of their communities.**

Can student recognize source material from popular media news items about neuroscience?
Can student perform a critical analysis of media coverage?
Does student value neuroscience as important to their lieves?

Essay Question (3 pts) Describe the most important idea or concept you have learned in this class and describe why this is of value to you.

**Neuroscience and Society (N&S)**: Identify a neuroscience-related topic that appears in the popular media (newspapers, blogs, magazines, etc.). Identify the original source of the topic (peer-reviewed article). Your job is to provide a very brief summary of the research topic and a critique of the popular media coverage of the research. The following rubric may be useful: a) Why was this research of interest to the popular media (i.e., why is it perceived as important, controversial, newsworthy)? b) Was the media coverage of the research an accurate representation of the research (i.e., what are the limitations of the research and was this conveyed by the media?)? c) Do you detect bias by the news source (i.e., are the authors of the research neutral? Is the media source neutral, or is there an agenda in providing coverage of this topic?)? d) Is there additional information that you would like to have or that consumers of media should have, and what is it? e) What is the broad, long-term impact of this research on society?

# Summary of Process

Good News:

- Made Progress on operationalizing the curricular elements.
- Several key elements of course design and assessment are already in place

Challenges:

- Need to place greater emphasis on ethics instruction and assessment.
- Need to formalize an evaluation rubric.
- Need to define the extent to which performance is "good enough."

# Assessing Student Outcomes

David C. Zietlow
Professor
Mechanical Engineering

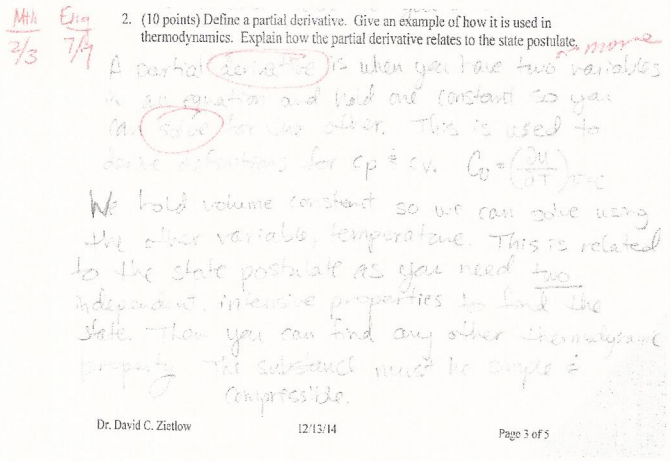
# Definitions

- Outcome-capability of a student at time of graduation
  - Eleven outcomes in engineering
  - Focus on one here
- Performance Indicator-a measurable skill
  - Each outcome has two or three performance indicators
  - Design exam questions to measure the skills

# Mapping

| Student Outcome | Performance Indicators |
|---|---|
| **A. An ability to apply knowledge of mathematics, science, and engineering** | A.1. Mathematics: use algebra, calculus and differential equations to solve a problem |
| | A.2. Science: use chemistry or physics, to solve a problem |
| | A.3. Engineering: use engineering fundamentals to solve a problem |

# Short Answer Example



2. (10 points) Define a partial derivative. Give an example of how it is used in thermodynamics. Explain how the partial derivative relates to the state postulate.

A partial derivative is when you have two variables in an equation and hold one constant so you can solve for the other. This is used to derive definitions for $c_p$ & $c_v$. $c_v = \left(\frac{\partial u}{\partial T}\right)_v$

We hold volume constant so we can solve using the other variable, temperature. This is related to the state postulate as you need two independent intensive properties to find the state. Then you can find any other thermodynamic property. The substance must be simple & compressible.

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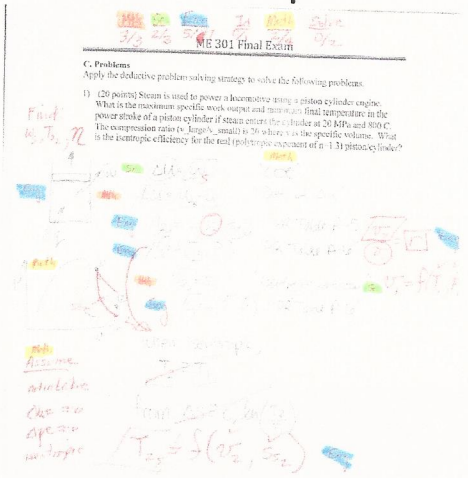
# Problem Example One

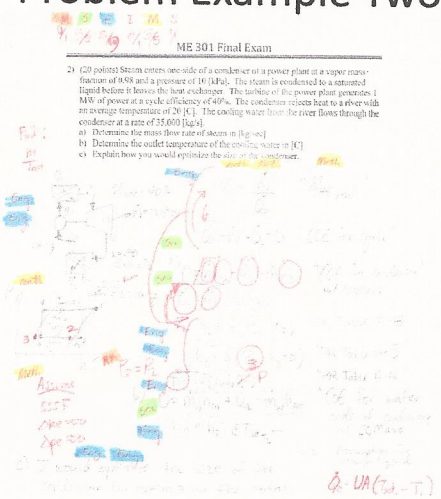


ME 301 Final Exam

C. Problems
Apply the deductive problem solving strategy to solve the following problems.

1) (20 points) Steam is used to power a locomotive using a piston cylinder engine. What is the maximum specific work output and minimum final temperature in the power stroke of a piston cylinder if steam enters the cylinder at 20 MPa and 800 C. The compression ratio (v_large/v_small) is 26 where v is the specific volume. What is the isentropic efficiency for the real (polytropic exponent of n=1.3) pistons/cylinder?

# Problem Example Two



ME 301 Final Exam

2) (20 points) Steam enters one side of a condenser of a power plant at a vapor mass fraction of 0.98 and a pressure of 10 [kPa]. The steam is condensed to a saturated liquid before it leaves the heat exchanger. The turbine of the power plant generates 1 MW of power at a cycle efficiency of 40%. The condenser rejects heat to a river with an average temperature of 20 [C]. The cooling water from the river flows through the condenser at a rate of 35,000 [kg/s].
a) Determine the mass flow rate of steam in [kg/sec]
b) Determine the outlet temperature of the cooling water in [C]
c) Explain how you would optimize the size of the condenser.

| | Summary of S2,P1 and P2 | | | | | | | Composite | | | % | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Math | Engineering | Science | ID | Math | Solve | Sum | Math (0.5*Mth+0.25*Eng+0.25*Sci) | ID | Solve | Math | Engineering | Science |
| Student | 7 | 23 | 6 | 2 | 9 | 3 | 50 | 10.75 | 5.5 | 6 | | | |
| 1 | 1 | 12 | 2 | 0 | 5 | 1 | | 4 | 2.5 | 3 | 50 | 70 | 44 |
| 2 | 4 | 15 | 4 | 1 | 0 | 2 | | 6.75 | 0.5 | 1 | 84 | 87 | 89 |
| 3 | 2 | 9 | 3 | 0 | 4 | 2 | | 4 | 2 | 3 | 50 | 52 | 67 |
| 4 | 4 | 20 | 4 | 2 | 7 | 0 | | 8 | 4.5 | 3.5 | 99 | 116 | 89 |
| 5 | 3 | 15 | 3 | 2 | 6 | 0 | | 6 | 4 | 3 | 74 | 87 | 67 |
| 6 | 4 | 16 | 6 | 2 | 7 | 0 | | 7.5 | 4.5 | 3.5 | 93 | 93 | 133 |
| 7 | 4 | 16 | 4 | 0 | 6 | 2 | | 7 | 3 | 4 | 87 | 93 | 89 |
| 8 | 2 | 12 | 4 | 1 | 3 | 1 | | 5 | 2 | 2 | 62 | 70 | 89 |
| 9 | 2 | 16 | 5 | 0 | 6 | 2 | | 6.25 | 3 | 4 | 77 | 93 | 111 |
| 10 | 4 | 16 | 5 | 1 | 5 | 2 | | 7.25 | 3 | 3.5 | 90 | 93 | 111 |
| 11 | 0 | 8 | 3 | 2 | 4 | 0 | | 2.75 | 3 | 2 | 34 | 46 | 67 |
| 12 | 5 | 13 | 6 | 2 | 4 | 2 | | 7.25 | 3 | 3 | 90 | 75 | 133 |
| 13 | 2 | 17 | 5 | 1 | 6 | 0 | | 6.5 | 3.5 | 3 | 81 | 98 | 111 |
| 14 | 1 | 12 | 3 | 1 | 3 | 1 | | 4.25 | 2 | 2 | 53 | 70 | 67 |
| 15 | 3 | 16 | 4 | 0 | 5 | 0 | | 6.5 | 2.5 | 2.5 | 81 | 93 | 89 |
| 16 | 3 | 16 | 5 | 0 | 4 | 2 | | 6.75 | 2 | 3 | 84 | 93 | 111 |
| 17 | 4 | 10 | 4 | 0 | 2 | 0 | | 5.5 | 1 | 1 | 68 | 58 | 89 |
| 18 | 1 | 9 | 4 | 2 | 6 | 2 | | 3.75 | 4 | 4 | 46 | 52 | 89 |
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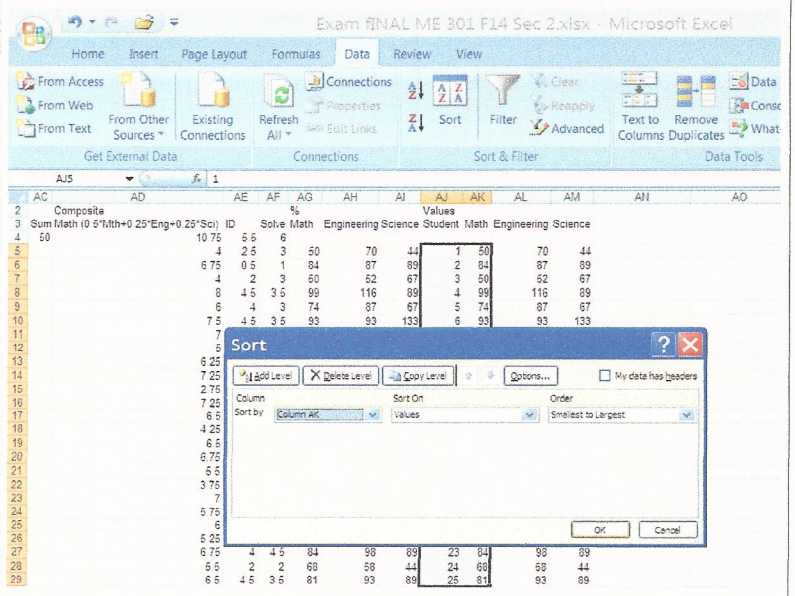
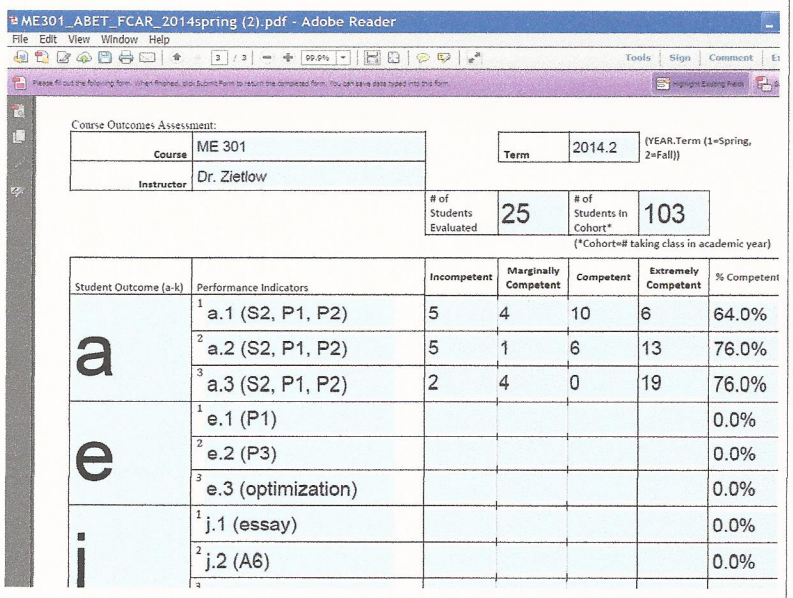
| 21 | 3 | 13 | 5 | 0 | 6 | 1 | | 6 | 3 | 3.5 | 74 | 75 | 111 |
| 22 | 2 | 12 | 5 | 1 | 3 | 2 | | 5.25 | 2 | 2.5 | 65 | 70 | 111 |
| 23 | 3 | 17 | 4 | 0 | 8 | 1 | | 6.75 | 4 | 4.5 | 84 | 98 | 89 |
| 24 | 5 | 10 | 2 | 0 | 4 | 0 | | 5.5 | 2 | 2 | 68 | 58 | 44 |
| 25 | 3 | 16 | 4 | 2 | 7 | 0 | | 6.5 | 4.5 | 3.5 | 81 | 93 | 89 |
| Average | 2.9 | 13.7 | 4.1 | 0.9 | 4.9 | 0.9 | | 5.91 | 2.88 | 2.90 | 73 | 79 | 92 |
| Adjusted | 3.9 | 18.2 | 5.5 | 1.2 | 6.5 | 1.2 | | 7.88 | 3.84 | 3.86 | | | |
| Percent | 55.6 | 79.3 | 91.5 | 58.6 | 72.3 | 40.9 | | 73.26 | 69.78 | 64.41 | | | |
| Standard Deviation | 1.3 | 3.1 | 1.1 | 0.9 | 1.8 | 0.9 | | | | | | | |
| Percent Deviation | 45.2 | 22.5 | 25.6 | 100.1 | 37.1 | 98.8 | | | | | | | |




## Results of sorting

| Student | Math | a.1 | Student | Engineering a.2 | Student | Science a.3 |
|---|---|---|---|---|---|---|
| 11 | 34 | Incompetent | 11 | 46 | 1 | 44 |
| 18 | 46 | <60 | 3 | 52 | 24 | 44 |
| 1 | 50 | | 18 | 52 | 3 | 67 |
| 3 | 50 | | 17 | 58 | 5 | 67 |
| 14 | 53 | 5 | 24 | 58 | 11 | 67 |
| 8 | 62 | Marginal | 20 | 64 | 14 | 67 |
| 22 | 65 | 60 to 70 | 1 | 70 | 2 | 89 |
| 17 | 68 | | 8 | 70 | 4 | 89 |
| 24 | 68 | 4 | 14 | 70 | 7 | 89 |
| 20 | 71 | Competent | 22 | 70 | 8 | 89 |
| 5 | 74 | 70 to 85 | 12 | 75 | 15 | 89 |
| 21 | 74 | | 21 | 75 | 17 | 89 |
| 9 | 77 | | 2 | 87 | 18 | 89 |
| 13 | 81 | | 5 | 87 | 20 | 89 |
| 15 | 81 | | 19 | 87 | 23 | 89 |
| 25 | 81 | | 6 | 93 | 25 | 89 |
| 2 | 84 | | 7 | 93 | 9 | 111 |
| 16 | 84 | | 9 | 93 | 10 | 111 |
| 23 | 84 | 10 | 10 | 93 | 13 | 111 |
| 7 | 87 | Extremely | 15 | 93 | 16 | 111 |
| 19 | 87 | Competent | 16 | 93 | 19 | 111 |
| 10 | 90 | >85 | 25 | 93 | 21 | 111 |
| 12 | 90 | | 13 | 98 | 22 | 111 |
| 6 | 93 | | 23 | 98 | 6 | 133 |
| 4 | 99 | 6 | 4 | 116 | 12 | 133 |




# Summary

- Defined outcomes and performance indicators
- Developed problems to measure performance indicators
- Mapped components of the problem to performance indicators
- Recorded and analyzed data

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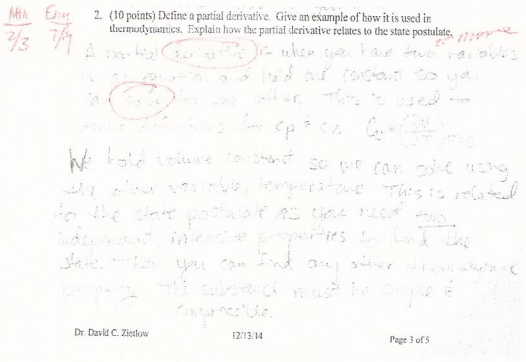
## Short Answer Example



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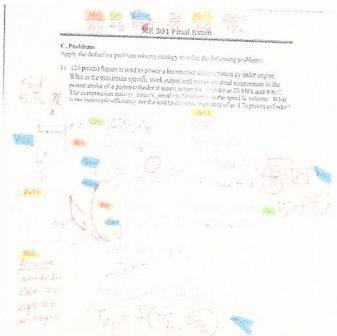
## Problem Example One



ME 301 Final Exam

C. Problems

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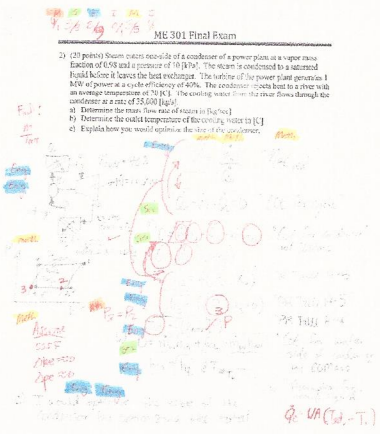
## Problem Example Two



ME 301 Final Exam

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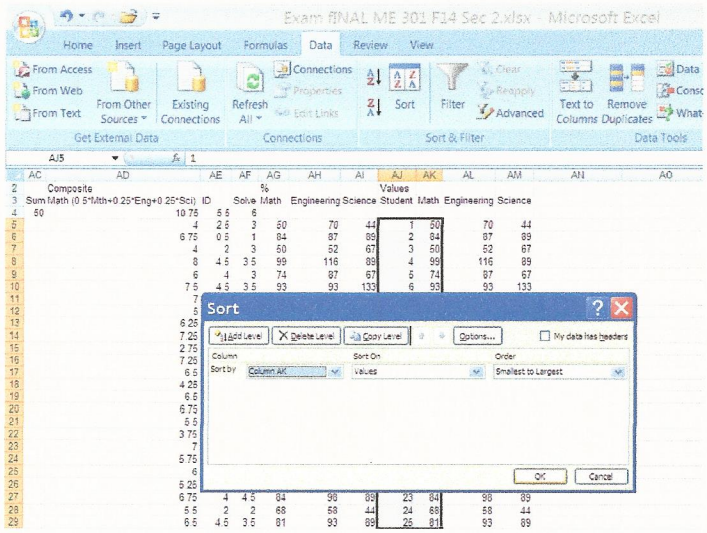
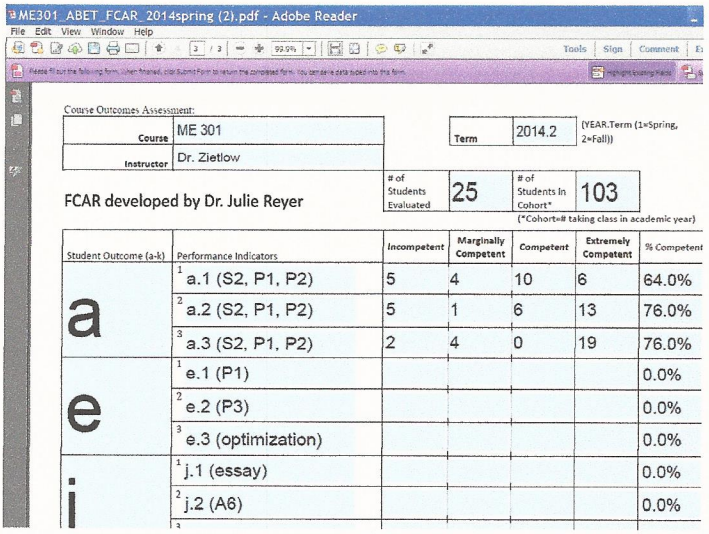
| 21 | 3 | 13 | 5 | 0 | 6 | 1 | | 6 | 3 | 3.5 | 74 | 75 | 111 |
| 22 | 2 | 12 | 5 | 1 | 3 | 2 | | 5.25 | 2 | 2.5 | 65 | 70 | 111 |
| 23 | 3 | 17 | 4 | 0 | 8 | 1 | | 6.75 | 4 | 4.5 | 84 | 98 | 89 |
| 24 | 5 | 10 | 2 | 0 | 4 | 0 | | 5.5 | 2 | 2 | 68 | 58 | 44 |
| 25 | 3 | 16 | 4 | 2 | 7 | 0 | | 6.5 | 4.5 | 3.5 | 81 | 93 | 89 |
| Average | 2.9 | 13.7 | 4.1 | 0.9 | 4.9 | 0.9 | | 5.91 | 2.88 | 2.90 | 73 | 79 | 92 |
| Adjusted | 3.9 | 18.2 | 5.5 | 1.2 | 6.5 | 1.2 | | 7.88 | 3.84 | 3.86 | | | |
| Percent | 55.6 | 79.3 | 91.5 | 58.6 | 72.3 | 40.9 | | 73.26 | 69.78 | 64.41 | | | |
| Standard Deviation | 1.3 | 3.1 | 1.1 | 0.9 | 1.8 | 0.9 | | | | | | | |
| Percent Deviation | 45.2 | 22.5 | 25.6 | 100.1 | 37.1 | 98.8 | | | | | | | |




## Results of sorting

| Student | Math | a.1 | Student | Engineering a.2 | Student | Science a.3 |
|---|---|---|---|---|---|---|
| 11 | 34 | Incompetent | 11 | 46 | 1 | 44 |
| 18 | 46 | <60 | 3 | 52 | 24 | 44 |
| 1 | 50 | | 18 | 52 | 3 | 67 |
| 3 | 50 | | 17 | 58 | 5 | 67 |
| 14 | 53 | 5 | 24 | 58 | 11 | 67 |
| 8 | 62 | Marginal | 20 | 64 | 14 | 67 |
| 22 | 65 | 60 to 70 | 1 | 70 | 2 | 89 |
| 17 | 68 | | 8 | 70 | 4 | 89 |
| 24 | 68 | 4 | 14 | 70 | 7 | 89 |
| 20 | 71 | Competent | 22 | 70 | 8 | 89 |
| 5 | 74 | 70 to 85 | 12 | 75 | 15 | 89 |
| 21 | 74 | | 21 | 75 | 17 | 89 |
| 9 | 77 | | 2 | 87 | 18 | 89 |
| 13 | 81 | | 5 | 87 | 20 | 89 |
| 15 | 81 | | 19 | 87 | 23 | 89 |
| 25 | 81 | | 6 | 93 | 25 | 89 |
| 2 | 84 | | 7 | 93 | 9 | 111 |
| 16 | 84 | | 9 | 93 | 10 | 111 |
| 23 | 84 | 10 | 10 | 93 | 13 | 111 |
| 7 | 87 | Extremely | 15 | 93 | 16 | 111 |
| 19 | 87 | Competent | 16 | 93 | 19 | 111 |
| 10 | 90 | >85 | 25 | 93 | 21 | 111 |
| 12 | 90 | | 13 | 98 | 22 | 111 |
| 6 | 93 | | 23 | 98 | 6 | 133 |
| 4 | 99 | 6 | 4 | 116 | 12 | 133 |




# Summary

- Defined outcomes and performance indicators
- Developed problems to measure performance indicators
- Mapped components of the problem to performance indicators
- Recorded and analyzed data