Scoring Rubric for Program Outcome

1) An ability to identify, formulate, and solve engineering problems

Level 5 performance characterized by:

- Demonstrates creative synthesis of solution and creates new alternatives by combining knowledge and information
- Can relate theoretical concepts to practical problem solving
- Can predict and defend problem outcomes
- Uses appropriate resources to locate information needed to solve problems
- Takes new information and effectively integrates it with previous knowledge
- Demonstrates understanding of how various pieces of the problem relate to each other and the whole
- Formulates strategies for solving problems
- The answer is correct and properly labeled
- The solution is correct and checked in other ways when it can be; the interpretation is appropriate and makes sense

Level 3 performance characterized by:

- Demonstrates solution with integration of diverse concepts or derivation of useful relationships involving ideas covered in course concepts; however, no alternative solutions are generated
- Connects theoretical concepts to practical problem-solving when prompted
- Occasionally predicts and defends problem outcomes
- Uses limited resources to solve problems
- Must be assisted in integrating previous knowledge and new information
- Is missing some of the pieces of the whole problem
- Has some strategies for problem-solving, but does not apply them consistently
- The answer is nearly correct, but properly labeled (within reasonable and logical range of the correct answer—it's in the "ballpark")
- The solution is correct, but not checked in other ways

Level 1 performance characterized by:

- Demonstrates solutions implementing simple applications of one formula or equation with close analogies to class/lecture problems
- Does not see the connection between theory and practical problem solving
- Is unable to predict or defend problem outcomes
- Uses no resources to solve problems
- Has no concept of how previous knowledge and new information relate
- Does not realize when major components of the problem are missing
- Has no coherent strategies for problem solving
- The answer is incorrect and not checked for its reasonableness
- No attempt at checking the obviously incorrect solution—no commentary

Scoring Rubric for Program Outcome

1a) An ability to apply math & science in engineering

Level 5 performance characterized by:

- Combines mathematical &/or scientific principles to formulate models of chemical, physical and/or biological processes and systems relevant to chemical engineering
- Applies concepts of integral and differential calculus and/or linear algebra to solve chemical engineering problems
- Shows appropriate engineering interpretation of mathematical and scientific terms
- Translates academic theory into engineering applications and accepts limitations of mathematical models of physical reality
- Executes calculations correctly
  - By hand
  - Using mathematical software
- Correctly analyzes data sets using statistical concepts

Level 3 performance characterized by:

- Chooses a mathematical model or scientific principle that applies to an engineering problem, but has trouble in model development
- Shows nearly complete understanding of applications of calculus and/or linear algebra in problem-solving
- Most mathematical terms are interpreted correctly
- Some gaps in understanding the application of theory to the problem and expects theory to predict reality
- Minor errors in calculations
  - By hand
  - Applying math software
- Minor errors in statistical analysis of data

Level 1 performance characterized by:

- Does not understand the connection between mathematical models and chemical, physical, and/or biological processes and systems in chemical engineering
- Does not understand the application of calculus and linear algebra in solving chemical engineering problems
- Mathematical terms are interpreted incorrectly or not at all
- Does not appear to grasp the connection between theory and the problem
- Calculations not performed or performed incorrectly
  - By hand
  - Does not know how to use math software
- No application of statistics to analysis of data

Scoring Rubric for Program Outcome

1b) An ability to use the techniques, skills, and modern tools of engineering practice

Level 5 performance characterized by:

- Uses computer-based and other resources effectively in assignments/projects
- Seeks information on problems from multiple resources
- Is able to interpret and understand information from a variety of resources
- Maintains current, state-of-the-art abilities in PC use
- Is able to learn and implement process simulation software
- Understand the organization and use of the library

Level 3 performance characterized by:

- Uses computer-based and other resources occasionally in assignments/projects
- Looks only to class resources in solving problems and homework
- Requires assistance in interpretation of information from outside resources and/or only uses a small number of outside resources
- Can perform simple tasks requiring personal computer use
- Has difficulty implementing process simulation and other software
- Requires assistance in locating materials from the library

Level 1 performance characterized by:

- Does not use computer-based and other resources for assignments and projects
- Often does not even use the course textbook to help solve problems or homework (comes to office hours unprepared)
- Is not willing to use outside resources unless required
- Struggles with simple tasks in PC use and is unable to use current software packages
- Relies on others to perform tasks in which computer-based skills are required
- Does not use the library

Scoring Rubric for Program Outcome

2) An ability to design a system, component or process

Level 5 performance characterized by:

- Develops a design strategy, including a plan of attack, decomposition of work into subtasks, development of a timetable
- Suggests new approaches and improves on what has been done before
- Develops several potential solutions and finds optimum
- Understands how areas interrelate and demonstrates ability to integrate prior knowledge into a new problem
- Thinks holistically: sees the whole as well as the parts
- Uses computer tools and engineering resources effectively
- Supports design procedure with documentation and references
- Develops a solution that includes economic, safety, environmental and other realistic constraints
- Applies engineering and/or scientific principles correctly to design practical processes
- Recognizes practical significance of design outcome/answer (i.e. no outrageously sized reactors, 600 m towers, or pipes 1 mile in diameter!)

Level 3 performance characterized by:

- Uses a design strategy with guidance
- Can follow a previous example competently
- Can develop and compare multiple solutions to a problem, but does not usually arrive at the best result; conducts optimization but neglects one or two key aspects
- Can use prior knowledge to design individual pieces of equipment competently when guided to do so
- Does not think holistically: does not see the integration of the pieces clearly
- Minimal or incorrect use of computer tools and engineering resources
- Design is done, but procedures and equations are not documented or referenced
- Includes only minor or cursory consideration of economic, safety, and environmental constraints
- Applies engineering and/or scientific principles incompletely or incorrectly to design a practical processes
- Gives an answer, but does not check its practicality

Level 1 performance characterized by:

- No design strategy; haphazard approach
- Cannot design processes or individual pieces of equipment without significant amounts of help
- Only focuses on one solution to a problem; no optimization attempted
- Unable to relate prior knowledge to the design problem
- Has no concept of the process as a sum of its parts
- No use of computer tools and engineering resources
- Design is done incompletely without the proper equations and without references
- No consideration of economics, safety, and environment
- No application of engineering and/or scientific principles
- Design is incomplete, no answer is given

Scoring Rubric for Program Outcome:

3) An ability to design and conduct experiments, analyze and interpret data

Level 5 performance characterized by:

- Observes good laboratory safety procedures
- Formulates an experimental plan of data gathering to attain a stated objective (develop correlation, test a model, ascertain performance of equipment, etc.)
- Carefully documents data collected
- Develops and implements logical experimental procedures
- Can select appropriate equipment and instruments to perform the experiment
- Is able to operate instrumentation and process equipment
- Analyzes and interprets data carefully using appropriate theory; if required, translates theory into practice or applies to process model(s)
- Is aware of measurement error and is able to account for it statistically
- Seeks information for experiment(s) from multiple sources

Level 3 performance characterized by:

- Unsafe lab procedures observed infrequently
- Develops a simplistic experimental plan of data gathering, does not recognize entire scope of study (e.g. not all parameters affecting the results are investigated)
- Data collected are not all documented, units are missing, or some measurements are not recorded
- Experimental procedures most often followed, but occasional oversight leads to loss of experimental efficiency and/or loss of data
- Needs some guidance in selecting appropriate equipment and instrumentation
- Is tentative in operation of instruments and process equipment
- Applies appropriate theory to data when prompted to do so, but misinterprets physical significance of theory or variable involved; makes errors in unit conversions
- Is aware of measurement error but does not account for it statistically or does so at a minimal level
- Seeks information for experiment(s) from a few sources—mainly from the textbook or the instructor

Level 1 performance characterized by:

- Practices unsafe, risky behaviors in lab
- No systematic plan of data gathering; experimental data collection is disorganized, even random, and incomplete
- Data are poorly documented
- Does not follow experimental procedure
- Cannot select the appropriate equipment and instrumentation required to run the experiment(s)
- Does not operate instrumentation and process equipment, does so incorrectly or requires frequent supervision
- Makes no attempt to relate data to theory
- Is unaware of measurement error
- Seeks no extra information for experiments other than what is provided by instructor

Scoring Rubric for Program Outcome

4a) An ability to communicate effectively (oral)

Level 5 performance characterized by:

- Plans and delivers an oral presentation effectively; applies the principle of "(tell them)^3"—well organized
- Presentation has enough detail appropriate and technical content for the time constraint and the audience
- Presents well mechanically
  - Makes eye contact
  - Can be easily heard
  - Speaks comfortably with minimal prompts (notecards)
  - Does not block screen
  - No distracting nervous habits
- Uses proper American English
- Uses visual aides effectively
- Professional appearance
- Listens carefully and responds to questions appropriately; is able to explain and interpret results for various audiences and purposes

Level 3 performance characterized by:

- Presents key elements of an oral presentation adequately, but "tell them^3" not clearly applied
- Presentation contains excessive or insufficient detail for time allowed or level of audience
- Has some minor difficulties with the mechanical aspects of the presentation
  - Eye contact is sporadic
  - Occasionally difficult to hear or understand speaking
  - Overuses prompts or does not use prompts enough—occasionally stumbles or loses place; appears to have memorized presentation
  - Occasionally blocks screen
  - Some nervous habits (um, ah, clicking pointer, etc.)
- Occasionally uses an inappropriate style of English—too conversational
- Visual aides have minor errors or are not always clearly visible
- Appearance is too casual for the circumstances
- Sometimes misunderstands questions, does not respond appropriately to the audience, or as some trouble answering questions

Level 1 performance characterized by:

- Talk is poorly organized, e.g. no clear introduction or summary of talk is presented
- Presentation is inappropriately short or excessively long; omits key results during presentation
- Major difficulties with the mechanical aspects of the presentation
  - No eye contact
  - Difficult to hear or understand speaking
  - Reads from prepared script
  - Blocks the screen
  - Distracting nervous habits (um, ah, clicking pointer, etc.)
- Uses poor English
- Multiple slides are unclear or incomprehensible
- Does not listen carefully to questions, does not provide an appropriate answer, or is unable to answer questions about presentation material

Scoring Rubric for Program Outcome

4b) An ability to communicate effectively (written)

Level 5 performance characterized by:

- Articulates ideas clearly and concisely
- Organizes written materials in a logical sequence to enhance the reader's comprehension (paragraphs, subheading, etc.)
- Uses graphs, tables, and diagrams to support points--to explain, interpret, and assess information
- Written work is presented neatly and professionally
- Grammar and spelling are correct
- Figures are all in proper format
- Uses good professional writing style
- Conforms to the prescribed format (if any)

Level 3 performance characterized by:

- Articulates ideas, but writing is somewhat disjointed, superfluous or difficult to follow
- Material are generally organized well, but paragraphs combine multiple thoughts or sections and sub-sections are not identified clearly
- Uses graphs, tables, and diagrams, but only in a few instances are they applied to support, explain or interpret information
- Work is not neatly presented throughout
- One or two spelling/grammar errors per page
- Figures are present but are flawed—axes mislabeled, no data points, etc
- Style is informal or inappropriate, jargon is used, improper voice, tense …
- The prescribed format is only followed in some portions of the paper

Level 1 performance characterized by:

- Text rambles, points made are only understood with repeated reading, and key points are not organized
- Little or no structure or organization; no subheadings or proper paragraph structure used
- Graphs, tables or diagrams are used, but no reference is made to them
- Work is not presented neatly
- Spelling/grammar errors present throughout more than 1/3 of the paper
- No figures or graphics are used at all
- The writing style is inappropriate for the audience and for the assignment
- The prescribed format is not followed

Scoring Rubric for Program Outcome

5) An understanding of professional and ethical responsibility

Level 5 performance characterized by:

- Student understands the Code of Professional Engineers and the MSU Students' Rights and Responsibilities Document
- Participates in class discussions and exercises on ethics and professionalism
- Demonstrates ethical behavior among peers and faculty
- Takes personal responsibility for his/her actions
- Is punctual, professional, and collegial; attends classes regularly
- Evaluates and judges a situation in practice or as a case study, using facts and a professional code of ethics
- Uses personal value system to support actions, but understands the role of professional ethical standards for corporate decisions

Level 3 performance characterized by:

- Student is aware of the existence of the Code of Professional Engineers and other bases for ethical behavior
- Does not take the discussion of ethics seriously but is willing to accept its existence
- Does not model ethical behavior among peers and faculty
- Doesn't recognize the need to take personal responsibility for his/her actions
- Sometimes exhibits unprofessional behavior; is sometimes absent from class without reason
- Evaluates and judges a situation in practice or as a case study using personal understanding of the situation, possibly applying a personal value system
- Uses personal value system to support actions, but confuses personal ethics with professional ethics

Level 1 performance characterized by:

- Student is not aware of any codes for ethical behavior
- Does not participate in or contribute to discussions of ethics; does not accept the need for professional ethics
- Student has been caught cheating or plagiarizing the work of others
- Blames others for own issues and problems
- Is frequently absent from class and is generally not collegial to fellow students, staff, and faculty
- Evaluates and judges a situation in practice or as a case study using a biased perspective without objectivity
- Uses personal value system to support actions to the exclusion of all other ethical standards

Scoring Rubric for Program Outcome

6) The ability to function on (multidisciplinary) teams and demonstration of team skills in general

Level 5 performance characterized by:

- Routinely present at team meetings or work sessions
- Contributes a fair share to the project workload
- Is prepared for the group meeting with clearly formulated ideas
- Cooperates with others (outside of the discipline)
- Shares credit for success with others and accountability for team results
- Shares information with others and provides assistance to others
- Demonstrates the ability to assume a designated role in the group
- Values alternative perspectives and encourages participation among all team members
- Remains non-judgmental when disagreeing with others/seeks conflict resolution; does not "point fingers" or blame others when things go wrong
- Is a courteous group member
- Has knowledge of technical skills, issues and approaches germane to disciplines outside of chemical engineering

Level 3 performance characterized by:

- Absent occasionally, but does not inconvenience group
- Sometimes depends on others to complete the work; contributes less than fair share
- Prepares somewhat for group meetings, but ideas are not clearly formulated
- Occasionally works as a loner or interacts to a minor extent with extra-disciplinary team members
- Makes subtle references to other's poor performance or sometimes does not identify contributions of other team members
- Sometimes keeps information to himself/herself; not very willing to share
- Takes charge when not in the position to lead
- Persuades others to adopt only his/her ideas or grudgingly accepts the ideas of others
- Sometimes criticizes ideas of other team members or blames others for errors
- Is not always considerate or courteous towards team members
- Has some knowledge of other disciplines, but gets lost in discussions with extra-disciplinary team members

Level 1 performance characterized by:

- Is absent from team meetings or work sessions >50% of the time
- Does not contribute to group work at all or submits own work as the group's
- Routinely fails to prepare for meetings
- Does work on his/her own; does not value team work
- Claims work of group as own or frequently blames others
- Hides in the background; only participates if strongly encouraged
- Does not willingly assume team roles
- Does not consider the ideas of others
- Is openly critical of the performance of others
- Is discourteous to other group members
- Has no knowledge of disciplines outside of chemical engineering

Scoring Rubric for Program Outcome

7) Understanding of the impact of engineering in a global societal context

Level 5 performance characterized by:

- Is familiar with the current trends in the chemical engineering discipline
- Respects the historical aspects of engineering solutions and their impacts
- Reads and is familiar with the content of periodicals that are relevant to understanding the global and societal impact of engineering
- Has a personal perspective on the importance (or lack thereof) of engineering in today's world

Level 3 performance characterized by:

- Is aware of current events in society
- Is aware of historical aspects of engineering solutions, but is not influenced by them
- Is aware of the existence of technical periodicals—would know where to look to find them
- Is interested in engineering because of what the discipline offers him/her personally

Level 1 performance characterized by:

- Is unaware of current events
- Is unaware of historical effect of engineering solutions
- Is not familiar with any technical periodicals
- Isn't sure why he/she is studying engineering

Scoring Rubric for Program Outcome

8) An ability to engage in lifelong learning

Level 5 performance characterized by:

- Demonstrates ability to learn independently
- Goes beyond what is required in completing an assignment and brings information from outside sources into assignments
- Learns from mistakes and practices continuous improvement
- Demonstrates capability to think for one's self
- Demonstrates responsibility for creating one's own learning opportunities
- Is able to understand, interpret, and apply learned materials and concepts in a format different from that taught in class (e.g. different nomenclature, understand equation from different textbook)
- Participates and takes a leadership role in professional and technical societies available to the student body

Level 3 performance characterized by:

- Requires guidance as to expected outcome of task or project
- Completes only what is required
- Sometimes is able to avoid repeating the same mistakes
- Does not always take responsibility for own learning
- Seldom brings information from outside sources to assignments
- Has some trouble using materials and concepts that are in a different format from that taught in class
- Occasionally participates in the activities of local professional and technical societies

Level 1 performance characterized by:

- Requires detailed or step-by-step instructions to complete a task
- Has trouble completing even the minimum required tasks
- Unable to recognize own shortcomings or deficiencies
- Assumes that all learning takes place within the confines of the class
- Shows little or no interest in outside learning resources
- Cannot use materials outside of what is explained in class
- Does not show any interest in professional and/or technical societies

Scoring Rubric for Program Outcome

9) A knowledge of contemporary issues

Level 5 performance characterized by:

- Has knowledge of current events in the engineering discipline and in society
- Has a good perspective on the current job market
- Able to discuss in-depth major political issues at national, state and local levels
  - Can summarize essence of several issues; take and defend a position on them
  - Is able to evaluate political solutions, or scenarios using a series of different measures –e.g., economic, quality of life; number of individuals affected; political ramifications; etc.

Level 3 performance characterized by:

- Has some knowledge of current events
- Has a somewhat narrow perspective on the current job market
- Able to comment on major political issues, but is not familiar enough with them to defend a position on them
  - Can summarize the facts of the issues
  - Can only comment on possible alternative political solutions, or scenarios using a few different measures –e.g., economic, quality of life; number of individuals affected; political ramifications; etc.

Level 1 performance characterized by:

- Has no clue about issues and events in the world
- Hopes that a job will fall into his/her lap
- Unable to comment on political solutions or is unaware of world and local happenings