WPI Department of Mechanical Engineering—2003 Course Review

Zhikoun Hou and Brian Savilonis reviewed four core courses in June, 2003. This was a trial use of rubrics for outcomes assessment and serves as a needed addition to the review work done with MQPs.

For each course, a notebook was assembled by a course coordinator. This included course objectives, topics, links to Mechanical engineering program outcomes and objectives, syllabi, assignments and handouts, and sample work from A, B and C level students.

METRICS

For outcome a. an ability to apply knowledge of mathematics, science and engineering, three rubrics were used. They were used to evaluate:

i. demonstrates specific knowledge of subject areas
ii. demonstrates analysis and judgment
iii. demonstrates knowledge of mathematics

For outcome b. an ability to design and conduct experiments, as well as to interpret data, two rubrics were used to evaluate:

i. shows skill at developing goal and procedures
ii. demonstrates us of judgment to design (formulate) and present experimental results

For outcome e. an ability to identify, formulate and solve engineering problems, three rubrics were used to evaluate:

i. demonstrates specific engineering knowledge of subject areas
ii. demonstrates analysis and judgment
iii. demonstrates effective communication in identifying, formulating and solving problems

For outcome g. an ability to communicate effectively, three rubrics were used to evaluate:

i. effective use of written communication tools
ii. effective use of oral communication tool
iii. shows evidence of teamwork

Each rubric had a 0-3 scale where 3 is outstanding, 2 acceptable, 1 marginal, and 0 not present.

ES 2001 Introduction to Material Science
Sisson – Coordinator, Apelian – prepared notebook

Course Objectives:
Understand the fundamentals of interatomic bonding in ionic, covalent and metallic materials
Understand the fundamentals of crystal structure in metals and ceramics
Understand the structure of polymeric materials

Understand and be able to apply the fundamentals of mechanical behavior to metals, ceramics and polymers
Understand and be able to apply the fundamentals of phase diagrams to engineering materials

Coordinator indicated links to the following Program outcomes: understanding of fundamental principles of mechanics and materials science, ability to apply mathematics, science and engineering to mechanical systems, written communication, demonstrated knowledge of chemistry and physics, multivariate calculus.

FINDINGS: The reviewers agreed the course presented and assessed the course objectives at a solid level. A level of Chemistry is seen, although physics is limited. The amount of calculus is very limited; the course is not a reasonable vehicle to assess math skills. No substantial writing takes place in the course, so communication cannot be assessed. Overall the course is working with the appropriate objectives and the student work shows a 2-3 level for Program Outcome **a**.

ME 3901 Engineering Experimentation
Sullivan- Coordinator

Course Objectives:

Develop experimental skill sin modern engineering measurement methods
Develop proficiency in the area of electronic instrumentation and computer-based data acquisition systems
Enhance concise and effective report writing and data presentation.

Coordinator indicated links to the following Program outcomes: understanding of fundamental principles of conservation laws and constitutive relationships, ability to apply mathematics, science and engineering to thermofluid and mechanical systems, Design and conduct experiments, modern engineering tools, written communication, and multivariate calculus and differential equations.

FINDINGS: the reviewers agreed the course presented and assessed the course objectives at a solid level. The amount of calculus assessed does not allow those skills to be evaluated. Overall the course is working with the appropriate objectives. The student work shows a 2-3 level for Program Objectives **a, b, gi and giii, and k.**

Of significance, the course work does NOT demonstrate the ability to DESIGN experiments, so this needs to be assessed in another manner or the course needs to be altered.

ES 2503 Introduction to Dynamic Systems
Cobb- Coordinator

Course Objectives:

Demonstrate that they can derive and properly apply kinematic and kinetic equations for particles, rigid bodies, and connected rigid bodies

Demonstrate that they derive and properly apply force and moment equations for rigid bodies and for connected rigid bodies
Demonstrate that they can derive and apply the equations of work-energy for particles and rigid bodies in planar motion

Students demonstrate that they can derive and apply linear and angular impulse relations for particles and rigid bodies in planar motion.

Coordinator indicated links to the following Program outcomes: understanding of conservation laws, ability to apply math science and engineering to mechanical systems, communication in writing, teamwork, calculus based physics, and apply advanced mathematics through multivariate calculus and differential calculus.

FINDINGS: the reviewers agreed the course presented and assessed the course objectives at a solid level. The calculus assessed is at the level of a first course, the ODEs are very simplistic, but the use if vectors and algebra is very high. Overall the course is working with the appropriate objectives. Communication and teamwork can not be assessed from the student work. The student work shows a 2-3 level for Program Objectives **a and e**.

ES 3003 Heat Transfer
Hermanson- coordinator, Esmaeeli – prepared notebook

Course Objectives:
To expose students to the fundamental concepts of conduction, convection, and radiant heat transfer and phase changes

To develop competence in calculating the heat transfer and temperature distributions in common basics structural components

To develop skill in modeling thermal systems

Coordinator indicated links to the following Program Outcomes: understanding fundamental conservation laws and constitutive relationships, apply math, science and engineering to thermofluid systems, knowledge of physics, multivariate calculus and differential equations.

FINDINGS: the reviewers agreed the course presented and assessed the course objectives at a solid level. The calculus assessed is at a very high level and includes elementary differential equations. The course has chosen to focus heavily on mathematical modeling. However, this reduces the emphasis on identifying, formulating, and solving open-ended engineering problems. Overall the course is working with the

appropriate objectives. The student work shows a 2-3 level for Program Objective **a,** including mathematics and **ei**. Based on the limited amount of work seen, the reviewers questioned whether course completion was strongly linked to the course Objectives. The A students were outstanding in every aspect, but the B/C student differentiation appeared blurred and one seemed able to pass the course without adequately mastering all the objectives.

SUMMARY: All four courses had solid objectives which were directly linked to Program Outcomes. In general, they show our Program meets Outcomes **a, b, e, and k**. There are three issues that should be addressed by the Curriculum Committee.

1. ME 3901 did not demonstrate the ability to design an experiment. Rather it did an excellent job in conducting experiments in both mechanical and thermofluid systems and analyzing experimental data. It uses modern tools at a high level.

2. Of the 4 courses, only ES 3003 really allows the assessment of calculus and differential equations. The work indicates that the better students have a strong mastery of mathematics; weaker students appear to have a reasonable understanding of heat transfer concepts, but they have a very poor ability to deal with higher mathematics. This is the strongest contrast seen in the course material – the ability to apply mathematics.

3. ME 2503 has sufficient open-ended problems that student work can be used to assess Outcome **e**. By contrast, ES 3003,as taught, focuses on mathematical analysis versus open-ended problems and engineering judgment.

The Reviewers also recommend that more student material be presented in the future. It would be desirable to have it randomly selected in proportion to the number of students who receive a given grade. Work that is Unacceptable should also be present, so one can better determine the minimum level that is allowed.