I. Assessment Outcomes from the Course Syllabus

☑️ (A) ABET Outcome: Ability to apply knowledge of mathematics, science and engineering. Application to EE 451:
    Understand baseband pulse transmission, including matched filtering and signal design for zero intersymbol interference and partial response channels. Understand digital modulation and demodulation, including analysis of their performance in noise. Understand basic concepts of source and channel coding. Ability to design and implement a computer program to simulate a digital communication system, and can conduct and analyze the results of Monte-Carlo simulations of a digital communication system.

☑️ (B) ABET Outcome: Ability to design and conduct experiments as well as analyze and interpret data. Application to EE 451:
    Ability to design and implement a computer program to simulate a digital communication system, and can conduct and analyze the results of Monte-Carlo simulations of the digital communication system.

☑️ (C) ABET Outcome: Ability to design a system, component, or process to meet desired needs: Application to EE 451:
    Ability to design a digital communication system at the conceptual level, implement a computer program to simulate a digital communication system, and conduct

☐ (G) ABET Outcome: Ability to communicate effectively in written and oral formats. Application to EE 451:
    Ability to communicate effectively via a written report.

☐ (H) ABET Outcome: A broad education necessary to understand the impact of engineering solutions in global, economic, and societal context.

☐ (I) ABET Outcome: Recognize the need for, and have the ability to engage in life long learning.
and analyze the results of Monte-Carlo simulations of a digital communication system.

☐ (D) ABET Outcome: Ability to function on multidisciplinary teams.

☒ (E) ABET Outcome: Ability to identify, formulate, and solve engineering problems. Application to EE 451: Ability to design at the conceptual level and implement a computer program to simulate a digital communication system, and analyze the results of Monte-Carlo simulations of the system.

☐ (F) ABET Outcome: An understanding of professional and ethical responsibility.

☐ (J) ABET Outcome: Have a broad education and knowledge of contemporary issues.

☒ (K) ABET Outcome: Ability to use techniques, skills and modern engineering tools necessary for engineering practices. Application to EE 451: Ability to design at the conceptual level and implement a computer program to simulate a digital communication system, and can analyze the simulation results.

II. List of Course Topics from the Course Syllabus

1. Entropy and Huffman codes. (3 hours)
2. Random variables, random processes, Monte Carlo simulation (6 hours)
3. Linear binary block codes. (8 hours)
4. Pulse amplitude modulation (PAM) and partial response signaling (PRS). (6 hours)
5. Equalization. (2 hours)
6. Quantization, PCM, DPCM. (2 hours)
7. Digital signaling (PSK, FSK, QAM) and hard decision decoding performance. (6 hours)
8. Trellis coded modulation, PRS, and the Viterbi Algorithm. (9 hours)
9. Selected topics (spread-spectrum communications) (3 hours)
### III. Course Assessment Summary Table: one row of the table should be devoted to each of the checked outcomes in part I.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Topics</th>
<th>Specific Measures (Samples should be available in the course materials file for inspection.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) ABET Outcome: Ability to apply knowledge of mathematics, science and engineering.</td>
<td>1-9</td>
<td>Homework exercises, e.g., Hmwk exercises 2.2, 2.3, 2.4; 4.1, 4.3; 7.1, computer exercises 1, 2; project report</td>
</tr>
<tr>
<td>(B) ABET Outcome: Ability to design and conduct experiments as well as analyze and interpret data.</td>
<td>2,3,4,7,8</td>
<td>Computer exercises 1-2; project report.</td>
</tr>
<tr>
<td>(C) ABET Outcome: Ability to design a system, component, or process to meet desired needs.</td>
<td>1,3,4,7,8</td>
<td>Computer exercises 1-2; project report; test 1 – design of Huffman code</td>
</tr>
<tr>
<td>(E) ABET Outcome: Ability to identify, formulate, and solve engineering problems.</td>
<td>1,2,3,4,5,7,8</td>
<td>Homework 6.2; project report</td>
</tr>
<tr>
<td>(G) ABET Outcome: Ability to communicate effectively in written and oral formats.</td>
<td>2,4,7,8</td>
<td>Project report</td>
</tr>
<tr>
<td>(H) ABET Outcome: A broad education necessary to understand the impact of engineering solutions in global, economic, and societal context.</td>
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<tr>
<td>(K) ABET Outcome: Ability to use techniques, skills and modern engineering tools necessary for engineering practices.</td>
<td>2,3,4,7,8</td>
<td>Homework 3.1 (use of Matlab), 6.1, 6.2, 7.3 (finite-state machine and trellis diagram); Computer exercises 1-2; project report</td>
</tr>
</tbody>
</table>
IV. Using the table as a guide, for each outcome summarize your evaluation of the students’ achievement of that outcome; cite student performance on the identified measures as evidence to support your conclusions.

(A) Ability to apply knowledge of mathematics, science and engineering.

Outcome Achieved The students complete various homework exercises, two computer exercises, and a project that require application of knowledge of mathematics, science and engineering. Examples include: a) computing probability of symbol or bit error based on probabilistic models of channel noise (application of mathematics); b) analysis of decoding methods for codes based on finite state machines, such as using the Viterbi algorithm (application of mathematics and engineering) to perform maximum likelihood sequence estimation.

(B) Ability to design and conduct experiments as well as analyze and interpret data.

Outcome Achieved Each student completes two computer exercises and a design project requiring Monte Carlo simulation of system performance and analysis of the simulation results, including computing estimates of probability of decoding error. These exercises and project require each student to interpret and evaluate the simulation results and compare the simulation data to theoretical expressions for probability of error.

(C) Ability to design a system, component, or process to meet desired needs.

Outcome Achieved The students complete several homework design problems, such as design of Huffman codes (homework), design of a pre-coder for use in a partial response signaling system, and design of an optimum decoder for a linear binary block code. The students also complete a design project that requires design at the conceptual level and simulation as a computer program (typically using Matlab) of either a 2 bits/symbol partial response signaling system or a 4 bits/symbol trellis coded modulation signaling system.

(E) Ability to identify, formulate, and solve engineering problems.

Outcome Achieved The students completed a design project that emphasizes conceptual system design and implementation of a computer program to simulate system performance to solve a well-formulated design problem. The students complete a homework exercise (6.2) that requires analysis and design at the conceptual level of a coding system for a loosely formulated design problem.

(G) Ability to communicate effectively in written and oral formats.

Outcome Partially Achieved The students complete a design project and summarize the results in a written report. No oral presentations are required.

(K) Ability to use techniques, skills and modern engineering tools necessary for engineering practices.

Outcome Achieved The students complete homework, computer exercises, and a design project that require use of modern engineering tools (e.g., Matlab) for simulation of digital communication system performance, computation of probabilities of error, generation of pseudo-random noise samples, and presentation of results (e.g., effective plots of system performance).
V. Qualitative Assessment of Student Performance: using the arguments above and other data support the claim that students who completed this course with a grade of C or better have achieved each of the intended outcomes of this course.

All students completing the course with a grade of C or better satisfactorily completed a sufficient number of homework exercises, computer exercises, exams problems, or parts of the course project to satisfy the ABET Criterion 3 (A), (B), (C), (E), and (K), as described above. Specific examples include design of Huffman codes (in both homework and an exam), Monte Carlo simulation of digital communication system performance (in two computer exercises and the project), analysis of linear binary block codes (homework and exams), computation of bit and symbol error probabilities (homework, exams, computer exercises, and project), and system component design (such as design at the conceptual level of a partial response or trellis coded modulation signaling system).

VI. Concerns: state any concerns you may hold about this class – were the students adequately prepared coming into it? Are there topics or outcomes where (some) students were weak after completing the course? Other concerns? Were there any comments on students’ course evaluations that should be addressed in future instances of the course? This section is very important for improving our program: it provides critical input to the curriculum committee for identifying areas requiring attention.

Last year I had two main concerns regarding student performance in the course.
1. Background in probability and statistics: In 2006 the students’ background in probability and statistics appeared to be weak. In 2007 the students’ background in probability and statistics generally appeared to be stronger.
2. In 2006 the students’ programming skills needed improvement. This year the Matlab programming skills appeared to be much stronger. Only two or three of the students were unable to properly simulate the Viterbi algorithm decoding required in the project.

The course syllabus lists selected topics (spread-spectrum communications) as the final (optional) topic in the course. I was unable to find time during the lectures to include this topic. It is an advanced topic, and although important, perhaps should be removed from the syllabus and left to graduate courses.

I was generally very pleased with the performance of the EE 451 students this year, and believe it to be one of the strongest classes I have taught since joining the faculty at WSU eighteen years ago.

Signature __________________________________________ Date: _______________________

Please email a copy of the completed form to Patricia Arnold, patricia@eecs.wsu.edu and deliver a signed hardcopy to her mailbox.