WRIGHT STATE UNIVERSITY

Program Assessment Report (PAR)

Biomedical Engineering (BME) Baccalaureate Degree

REPORT PREPARED by: Ganapathy, Subhashini

ACADEMIC YEAR COVERED BY THIS REPORT: 2021-2022

I. PROGRAM LEARNING OUTCOMES

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics 2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors 3. an ability to communicate effectively with a range of audiences 4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts 5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives 6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions 7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

II. PROCEDURES USED FOR ASSESSMENT

A. Direct Assessment

Assessment Measure Direct Assessment Means of Measurement - Assessment of student artifacts Academic years in which this data is collected (at least once every five years) - Every two years. The below list includes the learning outcomes assessed in the reporting year 2021-2022. In the attached document we have included the analysis for all the learning outcomes assessed in alternating years. Learning Outcomes 1 of 7 Graduates will be able to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics Method of Assessment BME 3530 (spring '22) In the design a digital IIR low-pass Butterworth filter using the bilinear transformation method, the following temporary analog filter specs have been found: • FC = 266.0 Hz • filter order = 3 1) Write the normalized low-pass Butterworth transfer function H(s) and determine the resulting (temporary) analog filter transfer function H(p), assuming fs = 1 kHz. Don't determine H(z) yet. 2) Determine the transfer function H(z) of the digital filter. 3) Write a few lines of MATLAB code that will plot 300 points of the amplitude response of the filter in dB on a logarithmic frequency axis using the "second-order sections" algorithm. 4) Write the corresponding difference equation y(n). 5) Determine the first two terms of the impulse response of this filter. ISE 2211 (BME students, Spring) Use Analysis of Variance (ANOVA) to test the null hypothesis that the treatment means are equal at the $\alpha = 0.05$ level of significance. Fill in the ANOVA table. Use Fisher's Least Significant Difference to determine which, if any, pairs of treatments show significant difference at $\alpha = 0.05$. Learning Outcomes 2 of 7 Graduates will be able to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors Learning Outcomes 3 of 7 Graduates will be able to communicate effectively with a range of audiences Learning Outcomes 4 of 7 Graduates will be able to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts BME 4703 (fall '21) An optical phantom is prepared by adding ink into milk to prepare well defined optical absorption coefficient (mua, μa) and scattering coefficient (musp, $\mu s'$). To characterize this phantom, a time-resolved measurement is performed using a picosecond laser pulse, which illuminated the sample at t=0 second and a fast-response detector collected the photons traveled through the tissue (source-detector separation is 25 mm). We can see that at 1 ns most of the photons traveled within 10 mm depth. If the source-detector separation is fixed at 25mm, what can be done to see deeper than 10 mm depth with the time domain measurements if you are not allowed to increase laser power to prevent tissue damage? If you did not have the time-resolved technique but instead continuous wave (CW) technique, how would you change the source-detector configuration to see deeper tissue? BME 4920 (Spring 22) Assignment: Your task is to assess the potential impact of your senior design project solution under each of the following contexts: global, economic, environmental, and societal. Assume that your prototype will transition to a marketplace product and that your team is the "company" who will market and support that product. Describe how each of these influences has affected or may affect your engineering design and product life cycle. In add cases, "company" refers to your client, and the "product" may be a physical product, or a system or process. Begin your paper with a concise yet thorough project description (~400 words). Then address each of the four contexts in a separate, focused subsection of your paper (~1000 words each). A set of questions related to each context is provided below to jumpstart your thinking. For full credit, you are encouraged to think beyond these sample questions rather than just answering what is listed. Format: Use 1" margins, 10-12 pt. font, and 1.5 line spacing. A title page is not required. Include a header (project name, team number, course, team member names) on the first page. Clearly label your subsections. Required Subsections1: 1. Project Description 2. Global Factors are influences that result from cultural and geographic features specific to a region or originating from the interaction of two or more culturally/geographically distinct regions.

What is the purpose of the product, how does it work, what are the intended global market segments, and how are cultural needs addressed with the product? How do people with different cultures and demographics use the product and what are the functions that the product fulfills? How does the company address global market needs in the design of their current line of products? How can the company address these issues better in their future global product lines? 3. Economic Factors are influences that result from the economic conditions at the time of a product's development and its past, present, and projected sales and support life cycle. What were the economic conditions at the time this product was designed and manufactured and how are economic issues reflected in the product's design? To dissect the product, what tools are required, how many steps are needed, and how easy is it to do this? What are the competing products, and how are these economic issues reflected in the design of the product? Given current and projected economic conditions, what can engineers at the company do to enhance the economic impact of the product on the company? 4. Environmental Factors are influences that result from the product's environmental impact during development, manufacturing, sales, operation and disposal. What are the planned environmental impacts of this product and what are the environmental factors engineers had to consider in the design of the product? What material type and manufacturing process was used for each major component or group of components? What are the actual environmental impacts of this product and what are the environmental factors engineers have to consider in the design of the product? How can the company reduce the cradle to grave environmental impact in future products and product lines? 5. Societal Factors are influences that result from considering impacts, such as safety, ergonomics and lifestyle, on the people and society within which a product is being used. What is the planned impact of the product on the culture and lifestyles of the customer base? What is the primary function of each major component or group of components? Note how its structural form helps fulfill its function. What is the actual impact of the product on the culture and lifestyles of the customer base? How can the company address social use issues such as safety, ergonomics, product use experiences, and lifestyle impact better in future products? Grading: The Writing Assignment 3 grade breakdown is Project Description: 20% Each Factor Subsection: 20% Each subsection will be evaluated based on: Content – 40% Ideas, originality of thought, demonstrated understanding of the impact of engineering solutions and the associated factors that influence engineering design Assignment Completeness and Organization – 30% Logical, well-organized, and easy-to-follow presentation of ideas, supporting information shared/ cited, adherence to specified formatting and general expectations for required word count (no penalty for exceeding suggested word count) Fluency and Professionalism – 30% Professional writing style, appropriate use of English language (correct grammar), no typos or spelling errors 1. Definitions and sample questions from Devendorf E, Cormier P, Moore-Russo D and Lewis K (2011). Using Product Archaeology to Integrate Global, Economic, Environmental, and Societal Factors in Introductory Design Education, Proceedings of the ASME 2011 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference (IDETC/CIE), Washington DC, USA. Learning Outcomes 5 of 7 Graduates will be able to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives Learning Outcomes 6 of 7 Graduates will be able to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions BME 3512 (Spring '22) BME-ISE 3512L · BIOELECTRONICS II LAB Lab 7: Full-Wave Precision Rectifier Purpose The purpose of this lab is to build and test an op-amp-based precision rectifier and compare its performance to a simple bridge rectifier when used for small signals. Recall that a regular bridge rectifier was built in Bioelectronics I; we'll build a similar one first and test its performance using 1N4148 small-signal diodes rather than 1N4001 power supply rectifier diodes. Full-wave precision rectifiers are often useful when we need to take the absolute value of a time-varying signal; for example, when calculating its RMS value or driving a transducer that only responds to positive signals. The shortcomings of a regular full-wave bridge rectifier quickly become apparent when dealing with small-amplitude signals; particularly the two diode-voltage drops. Procedure 1) Set the function generator to produce a 10-VP-P, 1-kHz sinusoid. Connect it to a full-wave bridge rectifier circuit using 1N4148 diodes as shown below; pay very close attention to the polarities of the diodes. Like we did in the Bioelectronics I power supply lab, we need to use both channels of the oscilloscope in differential mode to achieve a true floating voltage measurement. Connect both common (black) leads of the oscilloscope inputs to the same common ground as the function generator; then connect Channel 1 (red) to VOUT + and Channel 2 (red) to VOUT −, as indicated on the bridge rectifier schematic above. Finally, put the oscilloscope channels in differential mode and view the waveform. [On the Agilent 54622A digital storage oscilloscope, simply press the "Math" button located between the two channel buttons, and select "1−2." You will want to turn off the individual channel signals.] Sketch the observed waveform. Does it resemble a full-wave-rectified sine wave? Measure the peak amplitude; is it close to the theoretical value for a silicon bridge rectifier of VPEAK – 2VD? 2) Increase the frequency of the function generator until the peak amplitude of the rectified waveform has decreased by 3 dB. Record the frequency. 3) Return the frequency to 1 kHz. Decrease the amplitude of the input waveform until the output is no longer visible. Record the peak-to-peak input voltage at drop-out. 4) Now build the precision rectifier circuit below using two 741-type op-amps and VCC = ±15 V. Set the amplitude of VSOURCE to 2 VP-P using your function generator. Connect Channel 1 of the oscilloscope in parallel with VSOURCE, and Channel 2 to VOUT. Sketch the observed output waveform. Does it resemble a full-wave-rectified sine wave? Measure the peak amplitude; is it close to the theoretical value for a precision rectifier of VPEAK? Switch to triangle and square waves and sketch the rectified signals. 5) Switch back to sine and increase the frequency of the function generator until the peak amplitude of the rectified waveform has decreased by 3 dB, OR the waveform no longer appears full-wave rectified. Record the frequency. 6) Return the frequency to 1 kHz. Decrease the amplitude of the input waveform until the output is no longer visible. Record the peak-to-peak input voltage at drop-out. Postlab Include all sketches and comments in your lab report. Discuss how the precision rectifier overcomes several shortcomings of a simple diode bridge Learning Outcomes 7 of 7 Graduates will be able to acquire and apply new knowledge as needed, using appropriate learning strategies

B. Scoring of Student Work

Scoring of assessment items was done using an answer key for marker questions on tests and using a rubric for more subjective assessment items. Scoring was done by the course instructor or by a student grader supervised by the course instructor. The students' level of performance was scored based on the following criteria, (based on a bell curve assessment for ABET) - We want at least 80% of the students to score 60% or better - We want at least 15% of students to score 85% or better

C. Indirect Assessment

Course evaluations and exit interviews are used as indirect assessment measures for the BSBE program. Details of assessment of the BSBE program can be found in the ABET self study.

III. ASSESSMENT RESULTS/INFORMATION:

Details of assessment and findings can be found in Criterion 4 of the ABET self-study.

Details of assessment and findings can be found in the attached spreadsheet.

Details of assessment and findings can be found in Criterion 4 of the ABET self-study.

IV. ACTIONS TO IMPROVE STUDENT LEARNING

Assessment data are shared in program committee meetings, and faculty then discuss what, if any, actions to take to improve results. Student outcomes are assessed on an alternating two year schedule. About half of the outcomes are assessed in one year and the other half in the following year. Analysis and change implementation happens in the opposite year.

V. SUPPORTING DOCUMENTS

Additional documentation, when provided, is stored in the internal Academic Program Assessment of Student Learning SharePoint site.