

2006-910: TECHNICAL PROBLEM SOLVING WITH MATLAB FOR 21ST CENTURY ELECTRICAL AND COMPUTER ENGINEERING TECHNOLOGY PROGRAMS

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Technical Problem Solving with MATLAB for 21st Century Electrical and Computer Engineering Technology Programs

Abstract

In order for engineering technology students to cope and to thrive in the highly competitive 21st century global world – a world transformed by technology and human ingenuity, it is important for them to develop such essential skills as interpersonal and self-directional (emotional intelligence), creative thinking and problem solving, information processing, effective team communication and collaboration, and effective real-world computing skills. This paper explores the design, implementation, and assessment of a new course called Problem Solving with MATLAB which was designed to use the MATLAB and other computer information processing tools to develop students creative problem solving skills in a 21st century context with the use of relevant and real world examples and applications in the areas of mathematics, physics, environment, electrical, electronics, software, and more.

I. Introduction

Before we entered the 21st century, we witnessed many testimonies and reports calling for reform of our educational system to educate workforce with proper soft and creative technical skills needed to compete in the global economy. These include but not limited to “Testimony on Educating Our Force with Technology Skills Needed to Compete in the 21st Century,” presented on March 24, 1998, by John R. Reinert, past President of IEEE-USA, to United States House of Representatives¹, which stressed the critical importance of education, training and lifelong learning and called for the government to help developing the critical analytical, communications and problem solving skills that people need to succeed in a fast changing, technology driven workforce; 21st Century Learning Outcomes Project² which involving 16 community colleges and identify the following 8 competency areas: communication, computation, community, critical thinking and problem solving, information and management, interpersonal, personal, and technology skills; Microsoft’s Educating the 21st Century Citizen – White Paper³ urges the use of 21st century tools including computers, software, networking media tools and other technologies to develop learning skills (process-oriented and cognitive skills) including information/communication skills, thinking/problem solving skills, and interpersonal/self-direction skills; and in 1999, Technology Accreditation Commission/Accreditation Board of Engineering and Technology (TAC/ABET) approved its new accreditation criteria called TC2K⁴, in which the criterion 2 – program outcomes specify eleven attributes graduates of engineering technology programs are expected to have:

- a. an appropriate mastery of the knowledge, techniques, skills and modern tools of their disciplines,
- b. an ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering and technology,
- c. an ability to conduct, analyze and interpret experiments and apply experimental results to improve processes,

- d. an ability to apply creativity in the design of systems, components or processes appropriate to program objectives,
- e. an ability to function effectively on teams,
- f. an ability to identify, analyze and solve technical problems,
- g. an ability to communicate effectively,
- h. a recognition of the need for, and an ability to engage in lifelong learning,
- i. an ability to understand professional, ethical and social responsibilities,
- j. a respect for diversity and a knowledge of contemporary professional, societal and global issues, and
- k. a commitment to quality

As we entered the 21st century and experienced the challenges of more jobs were moved overseas. The cheap labor costs of Southeast Asia (India, Malaysia, and Pakistan) are kept calling more and more US employers who are seeking to lower support costs and improve profits. In 2003, Manufacturing & Technology News⁵ reported that an unprecedented high unemployment rate of 6.7 percent among electrical and electronics engineers and an even higher unemployment rate of 8 percent among engineering managers is creating a growing level of anxiety within the engineering community. Engineers fear that the situation will not improve in the near term given the loss of so many manufacturing plants and the growing trend to "offshore" engineering jobs. National Society of Professional Engineers (NSPE)⁶ and IEEE also raised the issues that U.S. firms have increasingly utilized offshore engineering workers from countries with lower overhead to provide drafting, design, and other services. For the America's technical workforce, that means the bar for entry-level positions is rising or the same positions are disappearing completely. What can we do to avoid losing out to offshore outsourcing?

As responsible engineering technology educators, we need to stay competitive and prepare students to cope and to thrive in the highly competitive 21st century global world – a world transformed by technology and human ingenuity. It is critically important for them to apply current basic skill sets, as well as develop such new essential skills as interpersonal and self-directional (emotional intelligence), creative thinking and problem solving, information processing, effective team communication and collaboration, and effective real-world computing skills. In addition, they need to understand the management, financial, business, environmental, economic and social constraints in which technical professionals and engineers operate.

Problem solving skill appears in many position papers and reports as an important skill needed by new workforce. To address this challenge, educators are revising curricula to include integrated learning environments which encourage learners to use higher order thinking skills, and in particular, problem solving skills⁷. The CPET 190 Problem Solving with MATLAB, a two credit hours course, was created in fall 2004 as a result of the continuing program improvement process⁸. It is intended to meet ABET Engineering Technology TC2K criterion 2f which requires that an engineering technology program must demonstrate that graduates have an ability to identify, analyze, and solve technical problems. Figure 1, a cause-effect diagram, shows that the AS Electrical Engineering Technology program outcomes 1 through 7 lead to the achievement of the AS EET program educational objective, where the CPET 190 Problem Solving with MATLAB and ECET 296 Electronics System Fabrication are the two courses

identified to fulfill AS EET Program Outcomes 5. All ECET students are required to take CPET 190, in the second semester, which exposes students to creative technical problem solving practice that will be part of their daily lives and future careers.

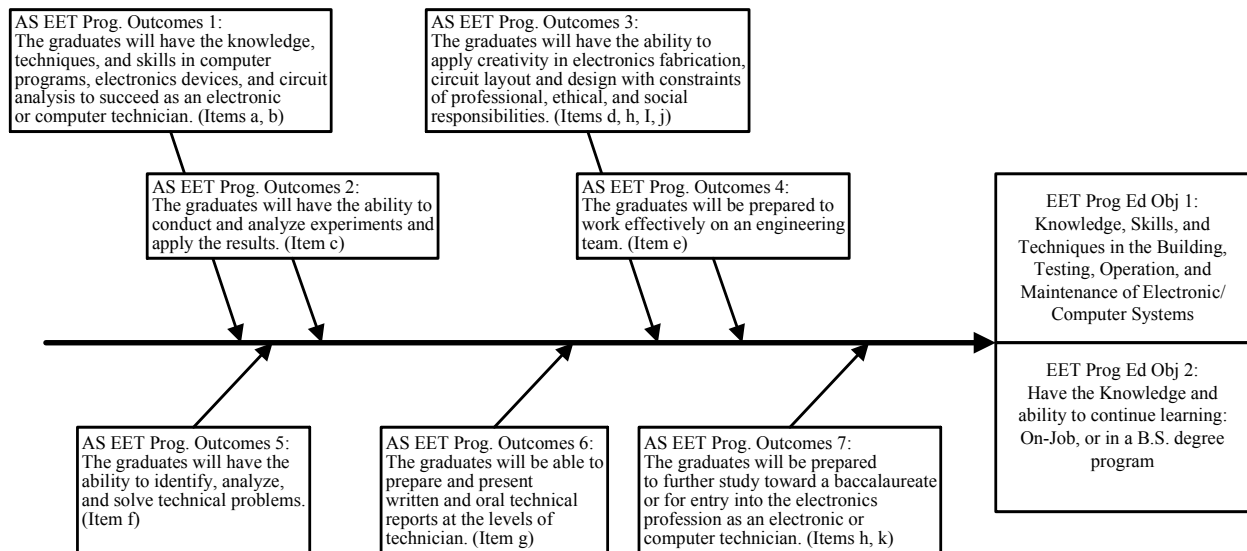


Figure 1. The Cause-Effect Diagram - AS Electrical Engineering Technology Program

This paper is organized as follows. Section II serves as an introduction to technical problem solving process. Section III discusses course design, computer tools, and delivery method. Section IV presents some technical problem solving examples used in the course. Section V assesses of the course outcomes. Section VI draws the conclusion.

II. Technical Problem Solving Process

It is observed that the problem solving models developed in the 1960s and 70s that are still used with many general problem solving courses found in academic are to teach math problem solving as a thinking skill, not integrated with the rest of the curriculum or work environment.

Through this course, students will learn about the computer-based problem solving on individual and team-based technical problems, by experiencing several independent and overlapping stages, including:

- 1) Problem statement
- 2) Analyze the problem statement and Plan inputs and outputs
- 3) Design solution or algorithm
- 4) Implement the solution (programming)
- 5) Verifying the solution
- 6) Document/report writing
- 7) Present the solution

The iterative technical problem-solving process as shown in Figure 2 is used in this course.

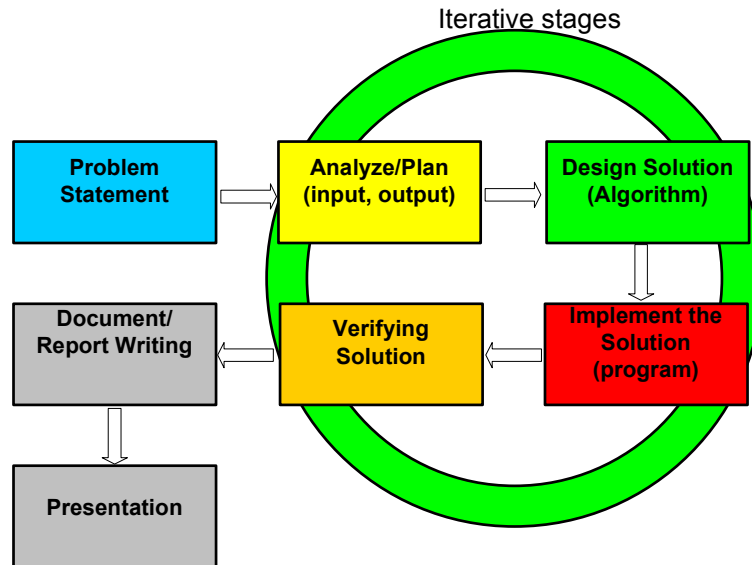


Figure 2. An Iterative Technical Problem-Solving Model

III. Course Design, Computer Tools, and Delivery Methods

This course is designed to provide a study of the principles and practice in problem solving using MATLAB. It emphasizes solving well-defined electrical, electronics, mathematical, and physics problems which often have known solutions, and are generally solved from the perspective of a particular domain using computation methods.

The course description states: “A study of the principles and practice of problem solving using MATLAB. Topics include MATLAB basics, functions and variables, file input and output, user-defined functions and program design, complex data manipulation, graphical user interface, and technical problem solving applications, etc. The students shall gain hands-on experience through several programming assignments, and practice strategies for collaborative problem solving such as creating specifications, brainstorming, sketching an idea, solution evaluation, and solution testing.”

MATLAB offers powerful numerical functionalities, extensive graphing capabilities. It also supports graphical user interfaces and structured programming paradigms. MATLAB was thus the software tool of choice for our technical problem solving course which required certain computation, graphical visualization, and programming.

The expected course outcomes state that students will gain:

1. Knowledge and skills of using MATLAB as a practical, technical problem solving tools (ABET TC2K Criterion 2, Item a)
2. An ability to apply problem solving skills in mathematics and engineering technology problems (ABET TC2K Criterion 2, Item b)
3. An ability to discuss ways and means of analyzing technical data (ABET TC2K Criterion 2, Item c)

4. An ability to practice technical problem solving process including problem formulation, understand the problem, problem analysis, collect data, model development, algorithm development, solution implementation, solution verification, and report/presentation (ABET TC2K Criterion 2, Items c, d, f, g)
5. An Understanding of professional and ethical responsibility (ABET TC2K Criterion 2, Item i, j)
6. An understanding the contemporary engineering technology application issues (ABET TC2K Criterion 2, Item k)

The course contents are organized and presented in the following order:

- Introduction to technical problem solving
- The MATLAB environment, desktop tools, constants, variables, operators and language syntax, useful commands and built-in functions, and M-file editor and debugger.
- Interactive calculations on electrical power, Ohm's laws and simple circuits, and math problem solving
- Using MATLAB arrays and array arithmetic, m-file scripts and functions
- Technical problem solving examples: Series circuit resistance, temperature conversion
- MATLAB Plotting: simple X-Y plots, multiple plots, log-scale plots, and plotting applications including math functions, trig-functions, electrical measurements – resistance and current, maximum power transfer
- Built-in functions for managing variables, workspaces, time and date, files, and operating systems
- Structured program design techniques, algorithms, flow control, conditional statements, switch construct
- Problem solving examples: full-wave bridge rectifier simulation, evaluating a function of two variables, calculating gain of Cardioid microphone, bit-wised digital circuit simulation, RC low-pass filter
- Introduction to basic statistics, statistical analysis (arithmetic mean, variance, standard deviation), and interpreting empirical linear equation
- Problem solving example – race car speed prediction
- Modular programming and writing user-defined M-file functions
- Problem solving examples – functions for computing parallel resistance, coordinate system conversion (polar – rectangular), sinewave generator
- Sorting algorithms
- File input and output
- Problem solving examples – creating, saving, and reading data files

This course was approved in April 2004 and offered the first time in fall 2004 as an online learning course. The recommended benchmarks for ensuring quality in Internet-based distance education are observed⁹. Starting spring 2005, the course is offered both online and as a traditional classroom-based course.

The textbook¹⁰ and instructor prepared Microsoft PowerPoint lecture notes are used as the basic course materials. Software tools including Microsoft Office, Visio, Project 2003, and MATLAB

6.5 with Simulink and some toolboxes are installed in all departmental labs and are available for students on the campus, however, distance online students were required to have a computer with Internet access, and a copy of MATLAB 6.5 Student Version with Simulink¹¹.

Asynchronous online Internet-based teaching/learning process was facilitated mainly by Purdue University's WebCT Vista system, and a backup Web server supported by the School of Engineering, Technology, and Computer Science. The WebcT online course server system provided students access to course syllabi, lectures using Microsoft PowerPoint slides with recorded audio, lecture notes, course reference materials and links, homework and project assignments, quizzes, threaded discussions, group activities, email, and chat rooms. Students were given 14 lectures, 3 take-home open-book examinations, 7 individual homework assignments, and 2 group collaborative project assignments.

IV. Technical Problem Solving Examples

Throughout the course, we adopted the top-down problem solving technique which involves the process that divides a large and complex task into many smaller ones. These steps are

- Clearly state the problem
- Plan the program - define the inputs and outputs
- Design the algorithm and data structure
- Coding - translate the algorithm into MATLAB statements
- Test the program and verify the result
- Document the program, process, and the result

It is quite likely that every step that we mentioned here required some refinements to meet the needs. We use the following definitions for algorithms and pseudo code. Algorithm is a procedure for solving a problem in terms of the actions to be executed, and the order in which these actions are to be executed. Pseudo code can be defined as an artificial and informal language that helps programmers develop algorithm, or an intermediate step that helps a programmer to translate the English-language description of problem in to a computer program. Most students have difficulty in translating the problem statement into a specific program for implementation. Therefore the problem solving tools such as algorithm and pseudo code can be used to turn concepts into MATLAB program or other implementations.

Many technical example problems used in the class had been designed and solved using MATLAB. Here are some examples.

Example 1. A practical full-wave rectifier circuit as shown in Figure 3 includes the following components:

- A transformer for converting the input voltage level to appropriate an output level. In this case, we need 110V to 10 V step down transformer.
- A bridge rectifier with appropriate voltage and current rating for converting an AC input to a DC output
- Filter circuit (not given here)

- The output voltage appears at the load resistor R_L is called V_L .

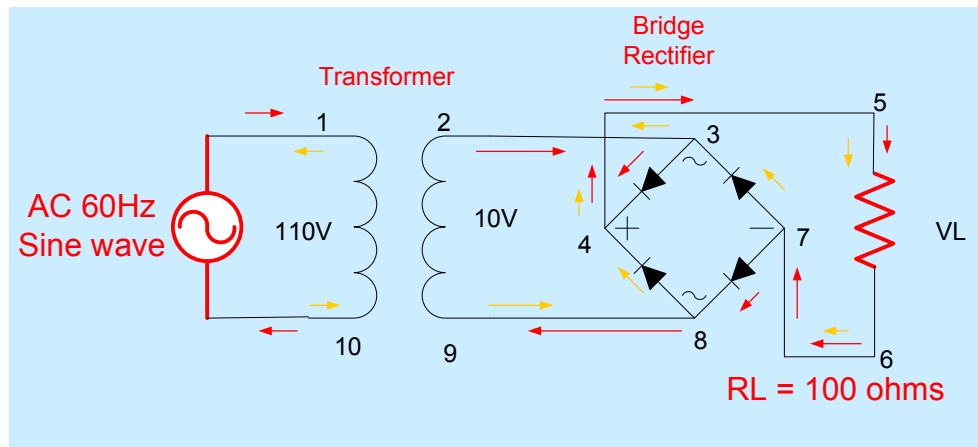


Figure 3. A Full-Wave Bridge Rectifier Circuit

Students were asked to design MATLAB programs using IF-END and FOR loop to simulate this full-wave rectifier circuit. The pseudo code includes the following major steps:

Step 1: Define a time vector for simulation (at least one complete sinewave cycle)

Step 2: Set up equations for primary and secondary voltages:

```
f = 60;
e1 = 10*sin(2*pi*f*t);
e2 = e1/10;
```

Step 3: Rectify input signal e_1 , using IF-END or FOR loop

Step 4: Plot AC input and rectified output voltages

We then translate the pseudo code into the MATLAB program as shown below, and the running result as shown in Figure 4 is also verified.

```
%full_rec.m
Vp = 110; % Primary side voltage
Vs = 10; % secondary side voltage
f = 60; % Frequency is 60 Hz
T = 1/f; % Period is 16.67 ms
dt = 10E-3*T;
t = 0:dt:T;% For showing 2 cycles
e1 = Vs*sin(2*pi*f*t);
len = length(e1);
% Rectifier operation
for n = 1: len,
    if e1(n) >= 0
        e2(n) = e1(n);
    else
        e2(n) = -e1(n);
    end
end
figure(1), plot(t, e2, 'r', t, e1,'b--'), grid on
```



```

title('Full Wave Rectifier');
xlabel('Time in sec');
ylabel('Volts');
figure(2), subplot(2,1,1), plot(t, e1), grid on
title('Input signal');
xlabel('Time in sec');
ylabel('Volts');
figure(2), subplot(2,1,2), plot(t, e2), grid on
title('Full Wave Rectified Signal')
xlabel('Time in sec');
ylabel('Volts');

```

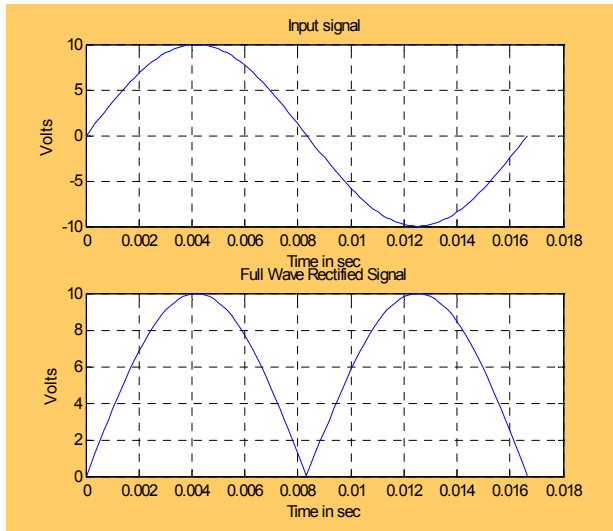


Figure 4. AC Input and Rectified Output DC Pulsating Waveforms

Example 2: A Low-Pass Filter.

Problem statement: Find the frequency response of the low-pass filter as shown in Figure 5. A low-pass filter is normally used to remove high-frequency noise and passing the desired signals in certain lower-frequency range. Components needed in the circuit include a signal source V_i , a resistor R and a capacitor C in series:

- The value of R is $16\text{ k}\Omega$, and C is $1\text{ }\mu\text{F}$
- Knowledge of using complex number for calculating on Amplitude and Phase angle, and the Gain = V_o/V_i will be needed
- Steady state AC circuit equations are also needed

Analysis: we need to figure out what is the appropriate frequency range response range for this circuit. We will take a guess using the RC product, which is also called the circuit time constant: $R \cdot C = 16\text{ k} \cdot 1\text{ }\mu\text{F} = 16\text{ milli-seconds}$. The reciprocal of RC is the 3-dB frequency which is about 60 Hz, so we will setup the sweep frequency ranges from 1 Hertz to 1000 Hertz for calculation. Circuit equations for this circuit are listed below:

- $X_c = -j*1/(2*\pi*f*C)$; X_c will be decreased when f is increased
- Output voltage $V_o = V_c = I*X_c = V_i/(R -jX_c) * (-jX_c)$
- Gain or response = $V_o/V_i = (-jX_c)/(R-jX_c) = 1/(1 + j2\pi fRC)$

From the above equations, the response is a complex number in rectangle form. We need to convert it to a polar form which consists of a amplitude and a phase component. We may want to have the subplot for amplitude-over-frequency in the LOG-LOG plot that uses Log scale for both Frequency and for Amplitude. The second subplot for phase-over-frequency is a semilogx plot, which means that only X-axis is in Log scale, the y-axis for Phase angle is a linear plot. How do we know when to chose Log? It is easy to see from this example that when there are a lot of data points to use, we will choose Log-scale for plotting.

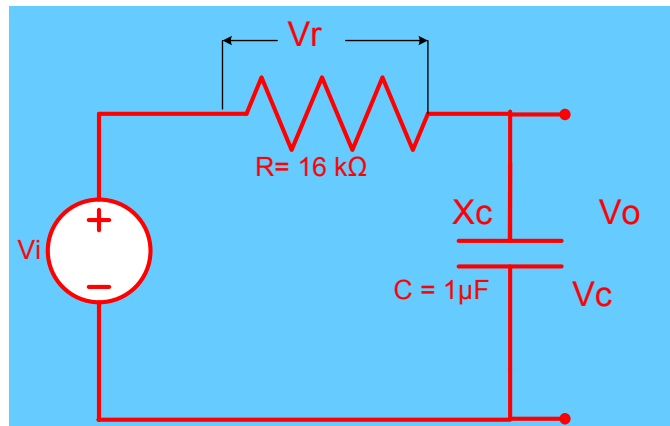


Figure 5. A Low-Pass Filter Circuit

The MATLAB Program listed below was tested, and the correct plots as shown in Figure 6 are also verified.

```
%rc_lpf.m
%
R = 1600; % 1600 ohms
C = 1E-6; % 1 uF
f = 1: 2: 1000;
% Frequency varies from 1 to 1000 Hz
% Response
Av = 1 ./ (1 + j*2*pi*f*R*C);
% amplitude
Av_amp = abs(Av);
% Phase angle
phase = angle(Av);
% Plots
figure(1), subplot(2,1,1), loglog(f, Av_amp); title('Amplitude Response - Gain'); xlabel('Frequency - Hz'); ylabel('Av = Vo/Vi'), grid on
figure(1), subplot(2,1,2), semilogx(f, phase); title('Phase Response'); xlabel('Frequency - Hz'); ylabel('Angle of Av = Vo/Vi in Radians'), grid on
```

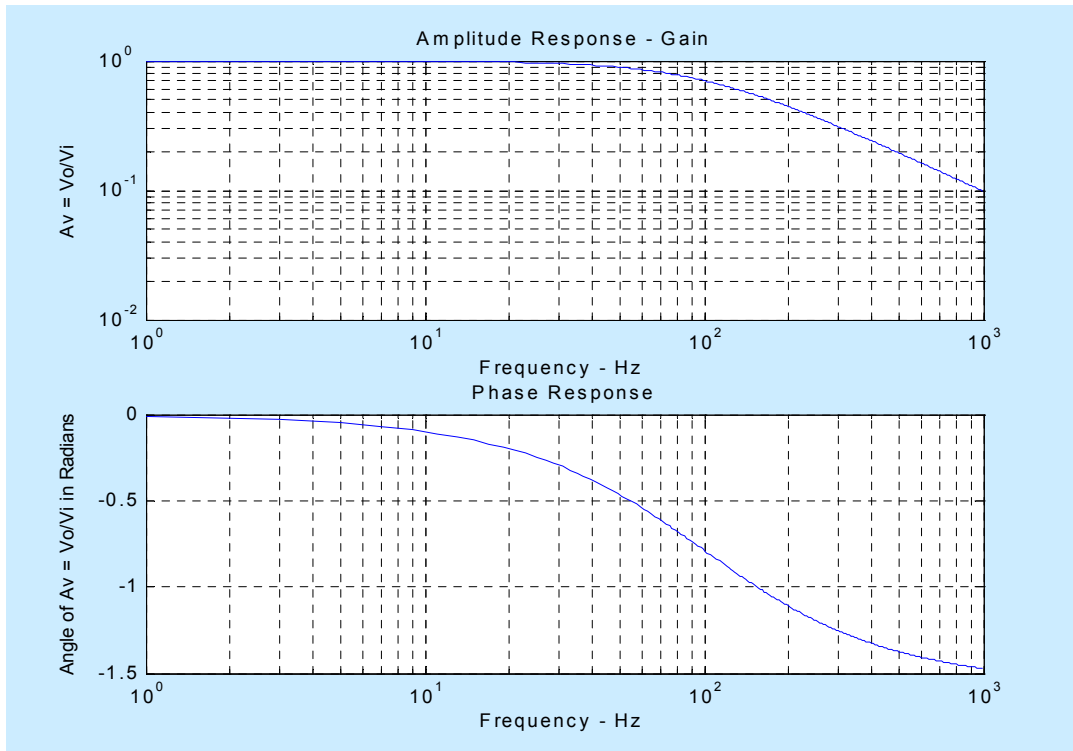


Figure 6. Amplitude and Phase Responses of a Low-Pass Filter

Example 3. A function for calculating total resistance of n-resistor in parallel.

Problem Statement: You are asked to develop a MATLAB function for calculating parallel resistance as shown in Figure 7.

Analysis: To solve this problem, the domain knowledge of electrical circuit is needed. We learned that the equation for two resistors R1 and R2 in parallel is

- $R_{eq} = (R1 + R2) / (R1 * R2)$, or Product-Over-Sum.

The function will be named as p_rs which includes two input arguments r1 and r2 for holding two resistance values, and the return value is Req. To create a robust function, we should check all other possible errors including

- If r1 or r2 is less than 0, we set Req = -1 to indicate this is an error. Remember that in real-world, all resistance are positive.
- If r1 or r2 is equals to zero, the total resistance Req is zero, no computation is needed.
- Finally, if the two normal values of resistance are provided we compute Product-Over-Sum, return the value.

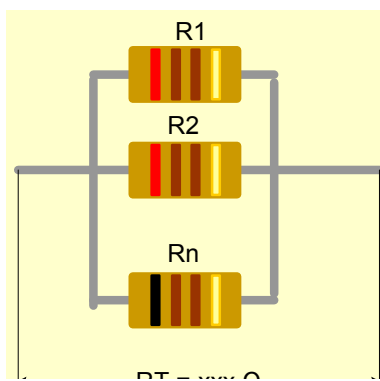


Figure 7. N-Parallel Connected Resistors

The function was coded using MATLAB editor, and was saved as p_rs.m.

```
function Req = p_rs(r1, r2)
% Comments
%
if r1 < 0
    Req = -1;
else if r2 < 0
    Req = -1;
elseif (r1 == 0) || (r2 == 0)
    Req = 0;
else
    Req = (r1 * r2)/(r1 + r2)
end
```

We also need to add documentation to the p_rs.m as soon as we can, which should include

- Purposes
- Calling sequence
- Defining Variables
- Record of revisions

We then test the function with various data for example, we tried 10 ohms and 10 ohms in parallel, p_rs(10,10) the answer is 5, and the unit is ohms. We tested it again with function within a function such as: p_rs(10, p_rs(20,20)). The MATLAB first calculates p_rs(20,20) and returns 10; it then computes p_rs(10,10) again, and returns 5 to the screen. We tried to assign variables ra = 100 and rb = 0, and p_rs(ra, rb) computes total resistance as 0 ohms.

Example 4. An example of open-ended team-based problem solving.

O'Hare Annual Noise Level Reports are available on following website link:

http://www.ohare.com/cnrc/ohare/o_noise_annual_noiselevel.shtm, with the following information: "The data presented summarizes the Day Night Average Noise Levels (DNL). DNL is a 24-hour time-averaged sound exposure level with a 10 db nighttime (10PM to 7AM) weighting. The data displays the measured aircraft DNL for each month, each quarter, and the year-to-date measurement. Aircraft noise is the noise associated with known aircraft operations at O'Hare. The quarterly noise levels for each site are displayed on the Aircraft DNL Chart. The daily aircraft DNL noise level varies from day to day. This is primarily because different

runways are used under different wind conditions that affect where the aircraft fly. The Aircraft DNL Chart plots the monthly aircraft DNL measured at each site.”

Inside this page, an Airport Noise Report Summary (Aircraft DNL) of December 2004 is available through the following link: <http://www.ohare.com/cnrc/ohare/noiseleveldec1.shtm>, and DNL chart can be found at <http://www.ohare.com/cnrc/ohare/noiseleveldec2.shtm>.

- Your team is first asked to gain domain knowledge about noise and airport noise, through the studying of the O’Hare noise level report and solving the following two problems, using MATLAB. These two problems can be found in on pages 163-164, Ch 4.3 of the MA 153/154 Text book, Functions Modeling Change – A Preparation for Calculus, by Connally, Hughes-Hallett, Gleason, et al., John Wiley & Sons:
 - Example 4, page 163 states: The sound intensity of refrigerator motor is 10^{-11} watts/cm². A typical school cafeteria has sound intensity of 10^{-8} watts/cm². How many orders of magnitude more intense is the sound of the cafeteria.”
 - Example 5, page 164 states: (a) If a sound double in intensity, by how many units does its decibel rating increase? (b) Loud music can measure 110 dB where normal conversation measure 50 dB. How many times more intense is loud music than normal conversation?

After acquire some domain knowledge of the noise, your team is then expected to study the O’Hare Airport Noise Report Summary of Dec. 2004, and FAA Airport Noise Standard (search it through Web), prepare a MATLAB program to plot the O’Hare Noise Report Summary of Dec. 2004, analyze the reported data, and make a report to conclude if the airport meet the FAA noise standard.

Procedure

1. Form a new team of up to 3-student maximum, select a team leader, identify individual responsibilities, estimate time needed for the project, and setup meeting times. (See WebCT Chat room & Whiteboard for team info. (10 points – an email memo from the team leader on the progress and what are accomplished)
2. Practice the Chat room & Whiteboard available on the WebCT, and prepare a one page report on how to use this team-work learning support system. (20 points - prepare a 2 page report on this problem solving environment)
3. Solve Example 4 and Example 5 using MATLAB and the problem solving approach as highlighted in the textbook: State the Problem, Defines the Inputs and Outputs, Design the Algorithm, Code MATLAB program, Test the Program. (40 points total, 20 points per question; use MATLAB for programming, MS word and equations editor for documentation)
4. Collect and log the following info: on team meeting, team collaboration, email, chat room & whiteboard, and other problem solving activities on a MS Word document. (50 points)
5. Search Web site for FAA airport noise report standard on noise level (30 points – a short report document the findings).
6. Study O’Hare Airport Noise Report Summary of Dec. 2004; write MATLAB programs (may be one is sufficient) to plot 10-row’s data (row 1 to 10), analyze noise data (in terms of average of a year, comparing to the noise standards, comparing with different communities, etc), and prepare a study summary and recommendation (in

- terms of if the O'Hare airport meet the FAA noise standard requirement, if not what remedy or correction is needed) (150 points)
7. Prepare a MS Word file, with the file name as cpet190_01_hw6_YourTeamName.doc that contains the following section
- (A) Cover Page
- Project Title: A Study of O'Hare Noise Summary Report
 - Project Team Member
 - Date
- (B) Background
- Rewrite the given problem statement here
- (C) Airport Noise
- Definition of Noise
 - Examples of Noise Calculation (item 3: Example 4 and Example 5 are place here)
 - FAA Airport Noise Standard (item 5)
- (D) O'Hare Airport Noise Study Report
- Data info (row, column, etc)
 - MATLAB Program(s) with data arrays, plot, average calculation, difference between each data rows, comparing to the standard noise level etc.
 - Summary and Recommendation
- (E) Appendix: Logs of Team-based Problem Solving Activities
- Project team formation (item 1)
 - Project Team Member responsibilities
 - Familiarization with the Problem Solving Tools (item 2: chatroom & whiteboard, email)
 - Logs of problem solving activities (item 4)

V. Assessment of Course Outcomes

The course entitled CPET 190 Problem Solving with MATLAB was designed in spring 2004, and officially approved for offering in fall 2004 by Purdue University. The instructor was selected to develop the course material during the summer. In the fall 2004, we had only 9 students enrolled in the course. The low enrollment was mainly due to insufficient time for proper advertisement through university master schedule. By the end of the semester, 6 students were successfully completed the course. For spring 2005, there are 16 students enrolled in the online section and 20 students enrolled in the traditional classroom class with Internet supplement. The enrollment for fall 2005 is similar to that of the spring 2005.

Institution Support - The instructional design support for faculty met the recommended quality benchmarks⁹. The redundancy of online delivery computer systems improved the reliability of the system and there is only a minor complain from students about the system. The WebCT Vista online course delivery system was well maintained and operational.

Course Development – ABET TC2K criterion 2 was used as a guideline for course development, design, and delivery. Our initial experience showed us that the instructor teaching the course

should be responsible for course development since he or she has a complete understanding of the course and how it functions. Instructional materials are reviewed periodically to ensure that students are engaged in problem solving activities.

Teaching/Learning – Authors agreed the teaching/learning methods noted in¹² which comments that the acquisition of knowledge and process skills (learning how to learn) is equally important. Process skills refer to the abilities to source, analyze, screen, prioritize, and apply a mass of information to solve the problem at hand. Throughout the course, students constantly interacted with faculty and other students through voice-mail and/or email, chat rooms, threaded discussions, and Macromedia Breeze real-time online teaching tools. To ensure continuing course improvement, students were constantly reminded to give feedbacks on lectures, assignments, and quizzes rather than just one time at the end of the semester. It is very important for faculty and students to agree upon expectations regarding times for questions/answering, and student assignment completion and faculty response. It was observed that students who possess self-motivation and commitment to learn at distance are the good candidate for taking online course. Therefore, we decided to offer another section in traditional classroom setting to serve another student population. Due to the workload concern, it is noted that an increase of credit hours from 2 to 3 was asked by students for the past two semesters.

Alternative Assessment Methods – To assess student's knowledge and process skills in problem solving, the assessment tools used in this course include individual homework assignment, team-based projects, and open-ended problems along with open-book examinations were used. The open-ended problems will supplement conventional methods for testing student's ability in analyzing and solving structured problems and help us assess the student's creative thinking abilities to solve non-structured and non-routine problems. Individual participation in class discussion and team activities were also graded to encourage the development of communication and teamworking skills.

Student Support – In addition to student teaching assistance available to help students with homework problems throughout the duration of the course, students also have access to technical assistance including detailed instructions regarding to electronic media use, practice sessions, and convenient access to technical support staff.

VI. Summary

This paper reported our initial experience of the design, implementation, and delivery of a new freshmen course entitled Problem Solving with MATLAB. Overall, using MATLAB as a tool for students to practice problem solving has been a very positive development since they can continue to use the same tool in many advanced courses including analog signal processing, digital signal processing, and senior design projects. Authors searched many ABET accredited Electrical Engineering Technology and Computer Engineering Technology programs and did not find any technical problem solving course of this kind yet. Considering the importance of problem solving skill and knowledge it is worthwhile to teach students well-structured problem solving methodology and process skills. In the long run, it will prepare students to adapt to changes, and with an ability to use various domain knowledge for modern applications integration in 21st century's global workplaces.

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