AC 2012-4811: ELECTRONIC STUDENT HOMEWORK MANAGEMENT SYSTEMS FOR CONTINUOUS IMPROVEMENT AND PROGRAM ASSESSMENT

Prof. George E. Meyer, University of Nebraska, Lincoln

George Meyer, professor, has taught graduate and undergraduate classes for 34 years involving plant growth and environmental factors, modeling, and instrumentation and controls for both agricultural and biological systems engineering students. He has received national paper awards and recognition for his work in distance education and university teaching awards. His current research include greenhouse systems, measurement and modeling of crop water stress, fuzzy logic controls for irrigation, and plant species identification for spot spraying control and precision agriculture.

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Kim Cluff is a Ph.D. graduate student with the opportunity both to teach and co-advise students. He has been active in creating a high-tech learning environment and embrace new technology, such as using clickers, smart-boards, video animations, and tablet PC’s in the class room to make digital ink-notes and recordings. These tools help him to cycle through different models of instruction to appeal to different student learning styles. In his research, he is currently developing new disease monitoring techniques for patients that have suffered muscle damage from peripheral arterial disease. The new diagnosis and treatment monitoring measures include muscle damage classification by morph metric (shape analysis), biochemical, and Raman spectral analysis to provide objective criteria for diagnosis and treatment monitoring.

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Jeyamkondan Subbiah is an Associate Professor of food engineering at the University of Nebraska, Lincoln, with joint appointments in the Departments of Biological Systems Engineering and Food Science & Technology. His research focuses on spectral imaging for predicting food quality (beef tenderness) and early diagnosis of human diseases (peripheral arterial disease). He has active research in the area of food safety engineering through integration of heat transfer model and predictive microbial growth/death models for food safety risk assessment. Every fall, he teaches a large sophomore-level class on engineering properties of biological materials, which consists of both lectures and laboratory sessions with an enrollment of more than 70 students. Every spring, he teaches a junior-level course on principles of bioprocess engineering which has an enrollment of about 25 students.
Electronic Student Homework Management Systems for Continuous Improvement and Program Assessment

Abstract

Student enrollment for the Department of Biological Systems Engineering at the University of Nebraska-Lincoln has been increasing for the past twenty years. The Department has two Accreditation Board for Engineering and Technology (ABET) engineering programs; Agricultural Engineering (AGEN) and Biological Systems Engineering (BSEN). Freshman enrollments have been 80 plus students for the past three years. Required class enrollments have been recently steady at 40 to 60 students per class. Two core example courses: “Engineering Properties of Biological Materials” and “Instrumentation and Controls” have investigated the use of electronic teaching delivery and grading methods, electronic submission and grading of student homework, laboratory reports, and quizzes. The rationale was to become more efficient at grading consistency improving time management and reducing the amounts of hardcopy materials. Student submissions are graded electronically with touch screen technologies. Graded materials are recorded, archived to an ABET Continuous Improvement and Program Assessment (CIPA) database, and returned to the students electronically by an email system. Student evidence is important for timely updates to course and curriculum outcomes matrices, one of the assessment methods recently published in the department’s CIPA manual. Timely feedback to students on their course performance is very important. Areas addressed include the traditional engineering problem solving approach, along with computer solutions and laboratory reports. User friendly assessment, student work recovery, delivery, and electronic grading systems were evaluated for efficacy and performance. Advantages and disadvantages of these systems are discussed.

Keywords: Biological systems engineering, curriculum design, teaching and grading methods, electronic technology.

Introduction

The Agricultural Engineering (AGEN) program at the University of Nebraska-Lincoln (UNL) is one of the oldest in the country and has been offered since 1910. It was first accredited in 1936. The Biological Systems Engineering (BSEN) program has been offered since 1990 and was first accredited in 1992. Both programs were last successfully accredited in 2011. Distance education capabilities were added in 1990. A Continuous Improvement and Program Assessment (CIPA) manual was developed to provide a guide for the faculty in the assessment, evaluation, and continuous improvement process. Concurrent with development of the CIPA manual, the faculty reduced the number of data sources used for assessment to six in order to provide a more effective process for evaluating student attainment of outcomes and program educational objectives. The UNL CIPA database system is presented in another ASEE paper, at this conference.

The biomedical engineering area, including additional expertise and instructional resources were broadened in 2005. A new instrumentation teaching laboratory was completed in 2009. A new biomedical teaching laboratory was added in 2011 to provide cutting edge learning environments for students in the BSEN program. The newest lab included installation of two 84-inch diagonal NEC DVIT Smart boards (NEC Inc., Irving, TX). Two new courses, (Introduction to
Biomaterials and Tissue Engineering, have greatly expanded the elective biomedical engineering offerings in BSEN. A new course, Computational Tools and Modeling for Agricultural and Biological Systems Engineering, to be taught during the fourth semester has been developed to enhance students’ programming skills. The course also provides a bridge between the introductory courses in which students learn basic programming and upper division courses in which they need those skills.

The objective of this paper is to discuss the current utilization of electronic technologies for teaching and grading student materials for two courses, in lieu of recent increased enrollments in the program. Also, discussed are some of the issues of implementation and student feedback. The two required courses that were taught with electronic assisted teaching technologies are: “Engineering Properties of Biological Materials (sophomore level)”, and “Instrumentation and Controls (senior level)” (Meyer, et al, 2008). The ABET outlines for these courses are shown in Appendices A and B, respectively.

Classroom Design

All AGEN/BSEN engineering classes and laboratory sections are taught on the lower two levels of Chase Hall, East Campus of UNL. The main building with a total of 61,700 ft² was built in 1917. The building was completely renovated in 1981, and is now one of the better classroom-laboratory buildings on campus, with high outside demand for course instruction. Classes are held in various sized lecture halls with capacities of 16, 24, 40, 46, and 112 seats. These classrooms were constructed during the 1981 renovation, and have served the department with continued improvement made possible by financial support from the National Science Foundation and UNL. Plans have been developed and some funding identified to remodel the largest lecture hall to change its configuration, to improve the learning environment, and to upgrade the presentation technology. That construction is planned for the summer of 2012.

Each Chase classroom is equipped with white boards, a multimedia teaching station that includes a computer, digital projector, and an overhead visualizer or camera. The stations are connected to the internet. Two of the lecture halls also have distance education capability with a central control room, high resolution cameras, and microphones. Power is also available for student laptops at their desks in some of the halls. Wireless computer access (801.2n, (54 Mbit/s to 600 Mbit/s)) is available to students and staff on all levels of the building. However, a recent problem has been the saturation of bandwidth at certain times of the day due to the increasing popularity of wireless internet. The status of the technology in all classrooms is assessed annually, improved, and upgraded as needed. A special multimedia conference room was completed in 2009 and has been used occasionally for instructional purposes, including a Regional National Instruments LabVIEW Community Users Group, and to provide lectures from remote or visiting engineering companies and university faculty.

All classrooms in this department, as indicated, have relatively modern, built-in multimedia capabilities. Students have designated desktop computers in their own special lab (55 Windows 7 work stations). A new Canon Image Runner C7055 (Canon USA, Lake Success, NY) with network capabilities, was installed during the fall of 2011 and provides students black and white or color printing, electronic scanning, and designated emailing of scans to themselves or instructors. The main student computer lab is also equipped with a modern digital projector and
instructor station for teaching programming classes such as AUTOCAD and for lectures on special topics including both MATLAB and LABVIEW. Academic engineering and mathematical computer software/hardware are installed on each workstation. Students access these resources using an assigned username and password through the university network. Students are able to access their student accounts virtually anywhere on or off campus using their own purchased and registered notebook computers and wireless internet.

**Course Delivery Methods**

Traditional course delivery has been accomplished for many years using a combination of dry erase chalk and erasers, electronic video visualizers, computer electronic slides, and classroom demonstrations of engineering fundamentals. Methods are chosen according to each instructor’s preference. However, instructors in all AGEN/BSEN courses take advantage of a university courseware site license BLACKBOARD® (BLACKBOARD Inc., Washington, DC) for electronically delivering course materials, on-line assessments, recording of student grades, a discussion board, virtual chat capability, course statistics, and many other features. The system supports various file formats, as well as providing on-line multimedia and selected links to trusted internet sites, selected by the instructor. BLACKBOARD enables students to download audio-visual aids used by the instructor to their own computer at home, or onto laboratory computers, using the Internet. Faculty members in the department use the “Community” features of BLACKBOARD for rapid deployment of key advising deadlines, meeting announcements, etc. BLACKBOARD has provided outstanding interaction between instructor and students. Adobe Connect®, Skype, and Polycom video conferencing has been used on occasions for external visitation and instruction.

One major problem facing instructors of any engineering undergraduate course is the need to provide students an updated, suitable, affordable, single volume textbook with adequate sample and assigned homework problems. Electronic delivery of textual material is now readily available as PDF or newer electronic book systems, such as Kindle (amazon.com) or Nook (Barnesandnoble.com) readers, as opposed to paper back and hard copy textbooks, so that is not a particular issue at this time. A suitable textbook is one that (a) accurately and richly presents the theory with text, equations, correct units, pictures, and graphics; (b) provides numerical sample problems that demonstrate the most salient principles; (c) provides a number of appropriate application problems to choose from for student homework and practice. In addition to the textbook, it is desirable to provide good supporting materials, problem solving steps (Cengel and Boles, 2002), and special lecture demonstrations of problem solving skills.

An important step is to provide an interactive student experience with a knowledgeable and experienced instructor. These are typically the lecture, laboratory, recitation, homework, and examination experiences. It is during these times, that a learning process occurs between the instructor and the student. With larger enrollments (50+ students per class), it has been imperative to investigate the use of technology to assist the management and grading of homework and examinations, while still assessing the ability of students to exhibit basic problem solving skills. The later must be continued in lieu of choosing alternative electronic multiple choice methods for last class sizes, where good guesses can replace actual knowledge of a solution method.
A review of the literature indicates there has been considerable activity at various universities toward adoption of certain electronic technologies for course delivery and student work assessment. Tingerthal (2011) suggested that when used properly, the tablet PC and video projector were superior to the traditional whiteboard in several ways. The instructor can face the classroom while teaching and then use electronic media seamlessly and interactively using handwritten notes and diagrams. Material that had been previously presented can be easily recalled to the screen. When set up with proper lighting and projector, the writing and graphics can be clearer and easier to read. Additional benefits include avoiding nuisances associated with dry-erase markers. Graphics and writing can be electronically captured. Frolik and Zurn (2004) developed base course notes using Microsoft Journal (which is included with Windows XP Tablet PC Edition). Walker, et al, (2008) conducted an initial study that evaluated students’ perception of how well the instructor can express ideas using a tablet PC. They found that students identified the intended benefits of the technology as well as several other unforeseen benefits to learning. The working hypothesis was that a tablet PC was well suited to engineering instruction that relies on problem-solving demonstrations. In some ways, a tablet behaved like a white board. On the other hand, a tablet also provided electronic media features. For example, graphs of scientific relationships that have complex annotations or animations of physical phenomena were used to illustrate points. Their survey results suggested that the students appreciated this combination of capabilities.

Walker, et al. (2008) also described downsides to using the tablet PC in the classroom. The most often encountered problems were usually technical in nature, such as the loss of a network, battery power or display connectivity, or PC hardware and software malfunctions. They emphasized that it was important to always have a backup plan (e.g. stashed dry erase markers) for such loss occurrences. Depending on the classroom size, traditional whiteboards should have sufficient real estate to allow for students to visually see more of the delivered material at a given time. If the classroom does not have a fixed projection system, then there was the added inconvenience of arranging, transporting and setting up projection equipment.

Tront (2007) found that electronic homework submission was typically difficult for engineering students since much of what was to be submitted consisted of not just text but mathematical script and sketches intermingled with text along with the occasional picture. He noted that several tablet-based tools available do offer students more flexibility in producing submissions. WORD, OneNote, PDF Annotator (GRAHL-software.com), and Adobe Acrobat all allow applying e-ink annotations to typed documents, which would make the process possibly easier for students to produce electronic homework submissions.

Ambikairajah, et al. (2005) described an electronic whiteboard-based Digital Signal Processing Teaching Laboratory and demonstrated that “SynchronEyes” software facilitated improved interaction between the lecturer and students via their monitors and the whiteboard. The SPTL laboratory was also employed for interactive tutorial sessions, where a key advantage of the system was that the interaction between students and lecturers catered for an increased understanding of the material taught, compared with traditional methods of teaching. Following interactive tutorial sessions, annotated discussions captured on the electronic whiteboard were
saved as PDF files and conveniently made available to all students for future reference. The capture of video files for handwriting and audio annotation of tutorial solutions were found to enhance self-paced student learning.

However, it has not been entirely clear that electronic pen writing is always the best approach to take. Pen writing does not improve one's cursive, unless special software is available. Bad handwriting with a standard ink pen or number-two pencil will not be improved by electronic pen writing. Also, current products such as the iPod, mini laptops, etc. feature very small displays. Screen resolution can be a problem, especially if classroom projectors cannot handle the resolution presented. Larger pen writing screens such as the 22-inch, Dell model ST2220T Pen and Touch software (Dell, Inc., Austin, TX) do provide a better writing surface. However, such screens need to be mounted or oriented into a comfortable position with minimal lighting glare. There is also the issue that typical writing is done in portrait as opposed to landscape positions. In general, such tablets need to be as light weight as possible with minimal glare screens. Some issues with internet-connectivity on digital projectors still exist, so these tablets or pen writers may have to be tethered or hardwired to an internet port.

**Electronic Graded Student Evidence**

The traditional method of problem solving using engineering paper still has great merit, where students engage in their own penmanship and provide homework and examination solutions in the form of an excepted problem solving format (Cengel and Boles, 2002). The choice as to whether a student writes to a hard copy such as engineering paper or to an electronic pen writer system is probably more of individual preference, comfort, and experience. A more significant problem really comes down to how a grader handles large numbers of either paper or paperless submissions. There is also the issue of how to return homework to students to conserve valuable class instruction time and maintain grade privacy. In this section, two recent approaches to electronically managing student work assessments are described. One system uses email attachments and an instructor-written LabVIEW implementation, while the other used new features found with BLACKBOARD 9.1 and an instructor-written MATLAB implementation.

During the period of 2009-2011, “Instrumentation and Controls” students were asked to submit all of their work electronically as email attachments. Specific rules were given for file types and file naming conventions. This senior course offering involved 42 to 46 students. Approximately 90 percent of the assignments would come through in a suitable WORD or Adobe Acrobat PDF format, even with detailed submission instructions. A small percentage came through as unreadable. File naming also became a problem, especially with regard to team submissions and the possibility of imbedding “illegal” Microsoft characters into file names. For large classes, it is hard to manually track who has submitted the homework. Electronic submission does provide a submission record. The “Instrumentation and Controls” graded assignments were available for the ABET 2011 evaluation.

A similar approach was conducted during fall 2011, for a required sophomore level course, “Engineering Properties of Biological Materials” with an enrollment of 70 students. Students were instructed to scan their homework assignments and lab reports, organize them into WORD or PDF documents, and submit them electronically into BLACKBOARD. In this case, the
instructor used the *Create Assessment* option in BLACKBOARD to allow students to upload their assignments, as opposed to emailing them to the grader. This method had a few improvements over emailing the assignment directly to the grader. For example, it did not matter what the students named the file because BLACKBOARD automatically added a prefix containing the exact assignment name and the student’s unique student ID. In addition, BLACKBOARD automatically appended a time stamp that can provide a record of when the homework was submitted. With either submission method, assignments were then downloaded to a grader’s computer for assessment. PDF grading could be done using either a tablet PC or touch screen monitor. The use of the BLACKBOARD system or MyRED records system also allowed a download of student names and corresponding email addresses (last name first) for individual courses.

The “Instrumentation and Controls” course has featured LabVIEW (National Instruments, Austin, TX) instruction for several years, and the instructor found interesting applications on the NI website to assist with the assessment process (Meyer, 2008). Two particular features of interest were the ability to concatenate and manipulate strings and the ability to use LabVIEW Invoke Nodes to access an SMTP email server. Most email systems including Lotus Notes® (IBM, Armonk, NY) and Microsoft Office 365® have this feature, that are often used with pop mail programs, such as Outlook (Microsoft, Seattle, WA) or Eudora (Qualcomm, San Diego, CA).

Figure 1 shows the implementation of the system that was used for both classes. The first step at the beginning of the semester was to obtain the class names list and their associated email addresses. These were stored in a Microsoft Excel spreadsheet. LabVIEW has special functions to invoke nodes to access the individual cells of a spreadsheet. Using the last names column, one then could create a folder with individual student subfolders for each assignment. Standard Email or BLACKBOARD provided a record of who submitted the assignment and at what time it was submitted, relative to a given deadline. One could automate the assignment of an attached emailed homework to the homework folder using scripting; however, this was a good time to check for file integrity and to manually load a homework folder. Earlier versions of BLACKBOARD had a drop box system, but often times, student fail to identify their submission properly. The email approach always provided backup student identification. With BLACKBOARD an assessment was created with an assignment file with a deadline. When students click the assessment, BLACKBOARD allowed them to upload the file with answers for an assignment. BLACKBOARD recorded what time the students submitted the file. Those files were downloaded and graded traditionally or with electronic technology (pen writing, etc.).

For the “Instrumentation and Controls” course, a master list was used to create a default grade rubric file with the students first and last name for a specific assignment of examination. The rubric had a specific student name and assignment identification created from the student list. The rubric file identification name was later used for automatically associating and attaching files to an email statement for each student. A LabVIEW program in the form of a State Machine was written for this purpose (Figure 2). A grade rubric is as simple as: “No Submission Found!” as to “A zero grade is posted”. A student who had submitted no work would receive this rubric. This also invited the possibility of an appeal. It had been found that the internet has on a very few occasions failed the student. The reliability of the internet may be still a problem.
Electronic student submissions would arrive to the instructor’s computer in different name formats, even after detailed instructions were originally given. When this happened, the simple solution was to manually copy each student email attachment to a pre-prepared, preferred named file (known as: Copy As). Thus, a little amount of student-instructor interaction is worthwhile. It was also easy to check with the mouse to determine whether a particular homework had been submitted based on file size. By mousing over a given student rubric file, the instructor or grader could determine from the popup of file properties whether the file had been replaced by an actual submission. Student assignments were categorized as a problem set, a computer program solution, a quiz or examination, or a laboratory or a design report. The later could be either individual or team reports. In either case, each student requires an individual graded score response. Each type of these works still requires some interactive action by a grader (assignment of grade points, comments, etc.). WORD report documents may be graded with Track Changes and Insert Comments or converted to PDF and written over electronically using PDF Annotator. Typical software problem solutions are easily submitted, e.g. MATLAB script (Mathworks, Natick, MA), LabVIEW and many kinds of programming or computer-aided design languages are available.

As an alternative to a LabVIEW program, a MATLAB script (Appendix C) and graphical user interface (GUI) program (Figure 3) was written and presented to manage the return of assignments via email to students. The MATLAB script generates a log file, records the return of the graded assignment, and saves a copy of the file in a folder for ABET record keeping. Similar to the LabVIEW approach, a class roster was first downloaded, as an EXCEL file, from BLACKBOARD containing student names and unique student IDs. Making use of the MATLAB string find function inside of a for loop, the file name was compared to the student ID. The program could therefore match the student ID to the file name. Once a match was found, the program emailed the file to the student using the sendmail and setpref functions which allows the support of SMTP authentication. The MATLAB GUI script was wrapped up as an executable file for ease of use on other machines.

Hand scripted student problem solutions have been traditionally performed on engineering paper. The addition of the network attached Canon Image Runner in the student laboratory has facilitated bulk scanning of hand-written student documents and automatic capability to adjust for the lightness and contrast of scripts. The student only needs to enter the name of a scanned file and the email address to which to attach his/her document. Scanned homework assignments were graded with pen-writing software such as PDF Annotator and the Dell ST2220T monitor and pen laptops. One of the advantages of using the pen-writing software is that annotations may be erased or easily revised, which is not possible on hardcopy items when using ink pens.

Once an assignment has been graded and of course the document name has been identified to the student owner, the next step is to relate the new document back to the corresponding email address. Both MATLAB and LabVIEW have fundamental string parsing and comparison routines. The last name token of the graded instrument can be easily compared and matched to last names in the Excel email address file. All of the attachments are collected in a single folder. The instructor’s email also contains summary information relative to the homework or examination. An important feature of the system is the arming and disarming of the email
delivery. The final checks are: that the correct attachments are ready, that the SMTP mail server is available, and that the email is ready to be sent. A single control then dispenses all email at once, and a copy is placed in the instructors email inbox. Arming the software is important to prevent scamming the students. The particular assignment is also archived for ABET assessment purposes.

**Student Response**

Student evaluation is still underway. However, students have been generally very complimentary on the electronic grading, distributing student homework or examination evidence, and ABET archiving system. What the students did not know was the savings in time for the instructor. Table 1 relates some initial comments from student reviews. Since we are in the initial stages, different rating systems are still under investigation. However, the three years of accumulated “Instrumentation and Controls” student evidence in electronic form was presented during the 2011 ABET accreditation visit. Similarly, in the “Engineering Properties of Biological Materials” course the electronic management of receiving, grading, and returning homework assignments in electronic form appears to be well received by the students. In addition, students are likely to benefits from having electronic copies of their course homework in the future, given that electronic items can be stored and searched for much easier than paper hard copies of homework.

**Table 1. Initial Comments (Instrumentation and Controls)**

<table>
<thead>
<tr>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>The homework’s were valuable.</td>
</tr>
<tr>
<td>Course material can be used for further research and studies.</td>
</tr>
<tr>
<td>Documents were well explained with all of the necessary material included.</td>
</tr>
<tr>
<td>Examinations were fair.</td>
</tr>
<tr>
<td>I feel I have a better understanding of LabVIEW than when I started.</td>
</tr>
<tr>
<td>I enjoyed the class and the labs are very valuable.</td>
</tr>
<tr>
<td>Good method of quizzes and homework.</td>
</tr>
</tbody>
</table>

**Summary and Conclusions**

Electronic technologies have and are currently assisting several core courses on this engineering program. If a particular technology works well with students, it will be transparent to the overall education process. Students may not comment on its use, unless it was distractive to their learning process. Technologies should be investigated or designed to improve time management, collect essential teaching data, and insure timely interaction and delivery of educational materials to the student.
Other forms of machine grading using multiple choice instruments have been often used for large classes, but are limited for lack of feedback. BLACKBOARD has a survey or examination system which may be incorporated with various kinds of questions such as true or false, multiple choice, and essay style questions. The system does wait for essay questions to be manually graded before reporting scores to students.

References


Mention of specific trade names is for reference only and not to imply exclusion of others that may be suitable.
Figure 1. An overall approach to submission, grading, storage of ABET evidence, and return of student homework or examination materials.
Figure 2. LabVIEW State Machine, Front Panel™ for implementing an electronic grading, distributing student homework or examination and archiving evidence for ABET (Available on Request).
Appendix A

Course: Engineering Properties of Biological Materials
Credits: 3 credit hours; two 1-hour lectures and one 2-hour lab per week
Textbook: None
Description: Introduce various engineering properties related to biological materials. Before introducing each category of engineering properties, the background and related fundamental laws are explained. Problems are solved to understand the role of properties in engineering design. Properties are then measured in the lab. Towards the end of the course, the students perform a design project that involves identifying an engineering problem and measuring relevant properties for engineering design. The students submit oral and written reports.

Course Goals:
Upon completion of the course, a student should:
1. Understand the importance of units and dimensions,
2. Understand and apply the uniqueness of biological materials,
3. Comprehend the general categories, definitions, and measurement methods of engineering properties, and
4. Apply the knowledge of engineering properties to the design and analysis of engineering processes.

Topics:
Units & Dimensions
Physical Properties
Water Properties
Rheological Properties:
   Solids – elasticity
   Liquids – viscosity
Biological materials – viscoelastic properties
Particle (aerodynamic) Properties
Thermal Properties
Optical Properties
Electrical Properties
Design Projects

Appendix B

Course: Instrumentation and Controls
Credits: 3; two hours lecture, two hours lab (senior level)
Textbook: *Instrumentation and Controls for Agricultural and Biological Engineering Applications using LabVIEW® as a Software Support System*. This is an electronic textbook; the text is supplemented by National Instruments educational materials, sample virtual instruments, and other commercial instrumentation handouts.

Description: Analysis and design of instrumentation and controls for agricultural and biological production, management, and processing. Theory of basic sensors and transducers, analog and digital electrical control circuits, and the interfacing of computers with instruments and controls. Emphasis on signal analysis and interpretation for improving system performance.

Course Goals:
The objectives are to: (a) learn the technical language and aspects of electronic sensors and instrumentation through team interaction (knowledge); (b) develop an understanding how sensors interact with the “measurand” in biological, biomedical, and agricultural applications (comprehension); (c) develop an ability to select electronic components, design, assemble, and operate measurement systems for specific applications (application); (d) learn basic research skills when applying instrumentation to a specific application (analysis); (e) provide the student the opportunity to design, develop and present a specific measurement and/or control system of his/her area of technical interest (synthesis), and (f) provide the opportunity to utilize oral and written communication skills to describe their electronic instrumentation and control team project. Reinforce the basis for the need for life-long learning when encountering new measurement and control system opportunities. (evaluation).

Topics:
Measurement and control fundamentals
Flow measurement
PID and fuzzy logic control principles
Analog and digital signal interpretation and electronics

Appendix C: MATLAB Script for automating the return of electronically graded assignments via email.

```matlab
function varargout = email_routine(varargin)
% EMAIL_ROUTINE MATLAB code for email_routine.fig
% Last Modified by GUIDE v2.5 03-Sep-2011 23:33:28
% Begin initialization code - DO NOT EDIT
gui_Singleton = 1;
gui_State = struct('gui_Name', mfilename, ...
    'gui_Singleton', gui_Singleton, ...
    'gui_OpeningFcn', @email_routine_OpeningFcn, ...
    'gui_OutputFcn', @email_routine_OutputFcn, ...
    'gui_LayoutFcn', [] , ...
    'gui_Callback', []);
if nargin && ischar(varargin{1})
    gui_State.gui_Callback = str2func(varargin{1});
end
if nargout
```

Page 25.511.14
[varargout{1:nargout}] = gui_mainfcn(gui_State, varargin{:});
else
  gui_mainfcn(gui_State, varargin{:});
end
% End initialization code - DO NOT EDIT
% --- Executes just before email_routine is made visible.
function email_routine_OpeningFcn(hObject, eventdata, handles, varargin)
% Choose default command line output for email_routine
handles.output = hObject;
% Update handles structure
guidata(hObject, handles);
% UIWAIT makes email_routine wait for user response (see UIRESUME)
% uiwait(handles.figure1);
% --- Outputs from this function are returned to the command line.
function varargout = email_routine_OutputFcn(hObject, eventdata, handles)
% varargout  cell array for returning output args (see VARARGOUT);
% hObject    handle to figure
% Get default command line output from handles structure
varargout{1} = handles.output;
% --- Executes on button press in browse.
function browse_Callback(hObject, eventdata, handles)
% hObject    handle to browse (see GCBO)
% handles    structure with handles and user data (see GUIDATA)
inputpath=uigetdir(cd,'Browse to the Folder containing Graded Files');
setappdata(handles.browse,'inputpath',inputpath)
% --- Executes on button press in begin.
function begin_Callback(hObject, eventdata, handles)
% hObject    handle to begin (see GCBO)
% handles    structure with handles and user data (see GUIDATA)
start0=tic;
%Get the Subjectline for email
assignmentName=get(handles.edit1,'String');
subject=['Returned Graded ' char(assignmentName)];
%Get inputpath of graded assignments from handles.browse and generate list of student names and IDS
inputpath=getappdata(handles.browse,'inputpath');
[na roster]=xlsread(fullfile(inputpath,'Class_Roster.xlsx'));
lastname=roster(2:end,3);
firstname=roster(2:end,2);
blackboardID=roster(2:end,1);
recipients=roster(2:end,4);
% Modify these two lines to reflect
% your account and password.
myaddress='Grader@gmail.com';
mypassword='password';
setpref('Internet','E_mail',myaddress);
setpref('Internet','SMTP_Server',smtp.gmail.com');
setpref('Internet','SMTP_Username',myaddress);
setpref('Internet','SMTP_Password',mypassword);
props = java.lang.System.getProperties;
props.setProperty('mail.smtp.auth','true');
props.setProperty('mail.smtp.socketFactory.class', ...'
javax.net.ssl.SSLSocketFactory');
props.setProperty('mail.smtp.socketFactory.port',465);
listing=dir(fullfile(inputpath));
%total number of files
fids=c(1,3:end); % Sample IDS
filesize=c(3,3:end);
mfz=max(cellfun(@max,filesize))/(10^6); % max of filesize
% If statement that checks for file size limit 17 MB
if mfz>17 % filesize greater than 17 will kill program
    set(handles.filename,'string','Error you are trying to email files larger than 17 MB'); drawnow;
    button = questdlg('Error You are trying to email files larger than 17 MB..Exiting Mail Program', ...
    'Exit Dialog','Yes','No','No');
    switch button
    case 'Yes',
        disp('Exiting MATLAB');
        quit
    case 'No',
        quit
    end
end
idx=[];
% Enter for loop to match file name with student Blackboard ID
for i=1:length(blackboardID)
    for j=1:length(fids)
        student0=strfind(fids(j),char(blackboardID(i)));
        idx0=isempty(student0{:});
        if idx0==0
            idx=[idx;i j]; % i is the blackboardID of recipient and j is the file
        end
    end
end
day=date;
log = fopen([day 'email log.txt','w']); % Open a text file for writing the results
for jj=1:size(idx,1)
    start=tic;
    file=[inputpath ' ' char(fids(idx(jj,2)))];
    set(handles.filename,'string', char(fids(idx(jj,2)))); drawnow;
    set(handles.email,'string', char(recipients(idx(jj,1)))); drawnow;
    studentname=[char(firstname(idx(jj,1))) ' ' char(lastname(idx(jj,1)))];
    set(handles.currentstudent,'string', char(studentname)); drawnow;
    set(handles.progress,'string', ['emailing ' num2str(jj) ' of ' num2str(tot_ids)]); drawnow;
    fs=filesize{idx(jj,2)}/(10^6); % filesize
    set(handles.filesize,'string', ['filesize ' num2str(fs) ' MB']); drawnow;
    % Email the file
    try
        sendmail(char(recipients(idx(jj,1))), char(subject), 'This is an automated message. Do not reply to this email', char(file));
    catch
        status = fclose('all');
        button = questdlg('Error You experienced an internet connection failure..View Log file..Exiting Email Program', ...
        'Exit Dialog','Yes','No','No');
        switch button
        case 'Yes',
            disp('Exiting MATLAB');
            quit
        case 'No',
            quit
        end
    end
end
filename0=char(fids(idx(jj,2))); 
day2=datestr(now); 
fprintf(log, '%s %s 
', filename0, day2); 
tElapsed=toc(start); 
ff=['Emailed ' char(lastname(idx(jj,1))) ' in ' num2str(tElapsed) ' seconds']; 
set(handles.timer,'string',char(ff)); drawnow; 
tElapsed0=toc(start0); 
set(handles.totaltime,'string', ['Total time elapsed ' num2str(tElapsed0/60) ' minutes']); drawnow; 
end 
set(handles.totaltime,'string', ['Total time elapsed ' num2str(tElapsed0/60) ' minutes']); drawnow; 
set(handles.progress,'string', 'Done'); drawnow; 
fclosestatus = fclose('all'); 
function edit1_Callback(hObject, eventdata, handles) 
% --- Executes during object creation, after setting all properties. 
function edit1_CreateFcn(hObject, eventdata, handles) 
% hObject    handle to edit1 (see GCBO) 
% eventdata  reserved - to be defined in a future version of MATLAB 
% handles    structure with handles and user data (see GUIDATA) 
if ispc && isequal(get(hObject,'BackgroundColor'), get(0,'defaultUicontrolBackgroundColor')) 
set(hObject,'BackgroundColor','white'); 
end