EDUCATION AND TRAINING IN ENGINEERING SOFTWARE AND APPLICATIONS

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Abstract ¾ *This paper describes structures, contents, evaluation methodology and statistics of a course on Engineering Software Packages and applications. This course is of practical nature and students have to choose projects from their own areas of interest and implement them using a variety of software packages. The softwares used are MATLAB, SIMULINK, Maple V, MATHCAD, Mathematica, Electronics Workbench, PSpice and LabView. This paper summarizes the experiences gained from such an innovative teaching effort. It has also helped the students to understand the other subject materials and, also, of much assistance in selection, and completion of final year projects.*

Index Terms ¾ Engineering software, Engineering education, Simulation, Software application.

INTRODUCTION

In most institutions of higher education, students use different software packages in a number of courses [1-10]. Symbolic computation packages including Maple V, Mathematica, and MathCAD are being used for analysis and design [1,8]. The use of MATLAB and its companion toolboxes, in teaching graduate and undergraduate control courses, are well documented [3,11,12]. SIMULINK with underlying MATLAB coding is an ideal package to simulate highly complex linear, non-linear and discrete systems [4]. The use of circuit simulators such as Electronics Workbench, PSpice and LabView has also increased in the analysis and design verification of electronic circuits [5,7,10]. With the availability of all the packages in computer laboratories, it is a useful experience for students to decide which software package is suitable for a particular problem to be solved. The whole scenario becomes more interesting if students have to choose the projects of their choice. This type of coaching and training could help them in using the right resources for solving particular tasks in their engineering careers. The software packages are also being updated with new versions. A new and unique subject is being offered to assist the students to experience the use and applications of such software packages. This course is offered to electrical, computer and mechatronic engineering students, but the students select problems according to their interests and subject materials covered in various courses. In the following sections, the author presents the rationale of the course, brief introduction about each software package, evaluation criteria on the software packages chosen by the students. It, also, assists the students to work at their pace, even at home or from home.

With developments in computer hardware and software, most engineers are hardly expected to write computer programs in low level or high level computer languages e.g. Assembler, C, C++, FORTRAN, BASIC etc. The new engineering graduates are expected to be familiar in the application of technical software e.g. MATLAB, SIMULINK, MATHEMATICA, MAPLE, MATHCAD, various finite element packages, (ANSOFT, COSMOS, EMAS), various circuit analysis packages (PSPICE, Electronics workbench) and others such as Labview etc. The importance and significance of these new developments in software are well recognized for engineering students. The students were expected to undertake one subject dealing with such software and their applications. Depending on their degree programs and disciplines, the students are encouraged to develop initiatives in the selection of software and problems from various sub-disciplines e.g. design, analysis, synthesis and simulation of various engineering systems. The students are encouraged to utilise the latest versions of software through School's own dedicated network and virtual computer laboratory. As most of students have access to personal computers at home, the students are also, encouraged to use dial-in facilities to access such software. The students are encouraged to select wide range of software and problems. The students are, also, expected to write formal reports and present their findings in the presence of their peers. This program has been running over last ten years, though the types; complexity and capabilities of software have increased many folds over the years.

SELECTION OF SOFTWARE PACKAGES

The spectrum of the software packages being used in the course is wide enough to classify them in three different categories as follows

- NUMERICAL ANALYSIS
  1- MATLAB 2- SIMULINK
- SYMBOLIC COMPUTATION

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1- Maple V 2- MathCAD 3- Mathemetica

- CIRCUIT ANALYSIS
  1- Electronics Workbench 2- Pspice 3- LabView

The students have to select one software package from each of three categories while B. Tech students are required to choose two packages from any two of three categories. In first three lecture hours the lecturer highlights the features of all these packages. Students are provided technical handouts, schedule of synopsis submission, project presentation and report submission. Once students get this information, they start attending three hours lab sessions per week supervised by the tutor and the lecturer. Students are encouraged to discuss their problems in choosing the project and deciding about the suitability of the package for the selected project.

The selected software packages cover wide areas of simulation analysis and design in engineering and technology. The salient features of these software packages are briefly outlined.

MATLAB: MATLAB has become a standard in software tools for solving scientific and technical calculation. This is powerful and versatile simulation software, extensively used in industry and academia. MATLAB consists of many pre-built functions and toolboxes that serve specific scientific problems such as control, image processing, signal processing, neural networks, optimization etc. It can be run on many systems ranging from PC, Mac, Sun, and VAX etc.

SIMULINK: The SIMULINK software package is capable of simulating highly complex linear, non-linear and discrete systems. It is certainly a useful teaching aid and a valuable contribution to hands-on laboratory experience based on graphical drag-drop model, SIMULINK helps in enhancing students' understanding of the materials and reducing the amount of time spent in performing computational home work assignment.

MAPLE V: Maple V is a system of mathematical computation of both symbolic and numeric types. Its library contains functions for performing complicated tasks such as polynomials, integration, solving systems of equations, Laplace and Z transforms etc. Maple V runs on many types of computer systems and OS(s) including Mac, PC, Unix. It is programmable, very flexible but rather complex and takes longer to master it. It requires the user to be familiar with the subject under study.

MATHCAD: MathCAD is a powerful tool in the engineering field to analyze complex systems through the computation of the corresponding mathematical models. It performs operations defined by the equations. It also combines the document interface of a spreadsheet with interface of a word processor. MathCAD combines the mathematical, visualization and calibration power.

MATHEMATICA: Mathematica combines symbolic and numeric calculation, plots, graphics programming, list calculation and structured documentation into a unified interactive environment. It is, therefore, an ideal tool for engineers, scientists and applied mathematicians. Mathematica is available for most popular operating systems including SGI, Sun, NeXT, Mac, Dos and Windows.

ELECTRONICS WORKBENCH: Electronics Workbench is circuit simulation software useful for analysis and design verification of electronic circuits. It simulates a real laboratory environment with meters, function generators, and oscilloscope and Bode plotter. Electronic Workbench features 14 analyses, more than 4000 device models and over 200 digital components and IC(s) to help students choose various devices.

PSPICE: Pspice is a CAD tool that begins with creation of a schematic using a computer, initialization of test parameters, and finish with the sophisticated analysis, which include data plots. File created with Pspice can be input in to printed circuit board design programs allowing complete design-to-implementation in minimum time

LABVIEW: LabView uses a virtual instrument front panel as its interface. User can wire together a set of icons on screen to make the panels functional. In the first version's diagram-based programming, this meant diagrams with a few simple functions, mostly "virtual components" for lab electronic components or complete virtual instruments including meters, amplifiers and oscilloscopes or even spectrum analyzers. Most users could put together a basic but useable instrumentation interface in a short period of time.

EVALUATION CRITERIA

The students have to present their results in a tutorial session in the presence of, tutors and their peers. They are allowed to use any presentation media including overheads, slide projectors, data display and PowerPoint to highlight their project's features. Attendance of all students in the class is compulsory. The attendance at all the presentations assists the students to know about other projects, methodologies and software packages. After the presentation, there is a general question answer session, which follows project demonstration, actually running on the system. A report on the project with a predefined format consisting of theoretical background of the project, software used, results, discussion and references have to be ready for submission and evaluation. Fifty percent of the total marks are allocated to

presentation and work done and the rest are awarded on report writing with emphasis on results and conclusions.

PROJECTS

The following is a sample list of selected projects, which has been done by the students enrolled in a particular semester, though the students change their projects in different semesters.

- Root Locus Design for Digital DC Motor Position Control
- Signal Coding and Decoding
- Voltage/Current Converters
- 12/16 Bit Digital-to-Analog Converters
- Stress Analysis of a Mechanical Structure
- Lead Compensation Design
- Liquid Level Control
- Active Filter Design
- Analysis of Comparators and Filters
- Design and Analysis of Amplifiers
- Design and Analysis of ALU Circuit
- Circuit Analysis using Maple
- Speech Analysis
- Computer Aided Topography
- Design and Analysis of a Battery Charger
- Digital/Analog Interfacing
- Simulation of Robot Arm Manipulators
- Pipeline Flow Analysis
- Temperature Control System
- Simulation of Timer Circuits
- Design and Analysis of Digital Clock
- Serial/Parallel Converter
- Study of Modulation and Demodulation
- Analysis of antenna patterns
- Dynamics and control of drive systems
- Traffic flow problem

CONCLUSIONS

In this paper, the author has presented the structure of an innovative course at UWS. The course lays emphasis on choosing a suitable software package to solve a particular engineering problem in a wide range of engineering areas. This course is different from other software programming courses where the students are taught various programming languages such as C++, JAVA, and Basic etc. The students were provided the opportunity to analyse, design and implement a number of projects from the areas ranging from PID control to Speech Analysis, Operational amplifier to Microprocessors and Filter Design to Pipeline Flow Analysis. The students have found it very useful experience in their employment.

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