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Contents

Contributions in: Thermodynamics, Mechanical Engineering, Aerospace Engineering, Civil Engineering, Structural Dynamics, Electrical Engineering, Education Research

- A. Ibrahim, J. Turner** 1–2 Editorial
- P. Junglas** 3–10 WATER95—A MATLAB[®] Implementation of the IAPWS-95 Standard for Use in Thermodynamics Lectures

WATER95 is an open source implementation of IAPWS95, the current standard formulation of the properties of water and steam for scientific use. It is written in MATLAB and is aimed primarily at educational use. Its value for teaching standard processes with water as a working medium is shown on the basis of worked exercises. They provide examples of isobaric and adiabatic processes and the calculation of the efficiency of the standard Clausius–Rankine cycle for steam turbines, and show how to extend the package for the computation of processes of constant enthalpy. Finally the advantages and drawbacks of using the package in a thermodynamics course are discussed.

Keywords: IAPWS95; water and steam properties; teaching thermodynamics

- G. L. Juste, J. L. Montanes and A. Velazquez** 11–16 Micro-Jet Test Facility for Aerospace Propulsion Engineering Education

This paper describes the methodology that has been developed and implemented at the School of Aeronautics (ETSIA) of the Universidad Politecnica de Madrid (UPM) to familiarize aerospace engineering students with the operation of real complex jet engine systems. This methodology has a two-pronged approach: students carry out preparatory work by using, first, a gas turbine performance prediction numerical code; then they validate their assumptions and results on an experimental test rig. When looking at the educational aspects, we have taken care that, apart from being sufficiently robust and flexible, the experimental set-up is similar to real jet engine rigs, so the students are not constrained to exploring a much too limited parametric space. Also, because a facility like this is usually subject to extensive and somewhat rugged use, we have focused on a low cost design.

Keywords: micro-jet engine test facility; aerospace propulsion

- P. Kar and J. W. Evans** 17–23 A MATLAB-Based Teaching Approach to Dilute and Concentrated Solution Theories of Electrochemical Cells

Students at high school as well as at early college level are sometimes confused, when studying electrochemical cells, over the mass transfer in the electrolyte and conduction within the cells, which results in the completion of the electrical circuit. Dilute and concentrated solution theories are two of the predominant concepts for understanding the mass transfer within the electrolyte. A MATLAB[®] based program has been developed to help in teaching and to aid the understanding of the dilute and concentrated solution theories of electrochemical systems. The MATLAB[®] based code that has been developed can be used to supplement a lecture on electrochemical cells as part of an electrochemistry course for early undergraduate students. The objective is to help in the understanding of the migration and diffusion of ions in electrochemical systems and how they affect the current, concentration distributions and potentials within a cell. The role of a ‘supporting electrolyte’ and its function, as seen in case studies for dilute solution electrolytes, is reported. In addition, basic chemistry and early engineering college students can be given assignments to manipulate a variety of parameters as part of a larger assignment and to observe the effects of these parameters on the working of a simple electrochemical system, draw inferences and modify or extend the software to a number of different cases.

Keywords: electrochemistry; electrolytic/galvanic cells; electrochemical potentials; transport phenomena; corrosion; energy storage, computer-based learning.

- D. Ramirez, S. Martinez, J. Rodriguez, C. Carrero and M. Blanco** 24–32 Educational Tool for the Implementation of Electric Drives Control System with Real Time Data Exchange

The practical implementation of a control system for an industrial electric drive involves a wide variety of well-integrated fields such as control electronics, power electronics and electric machines and drives. The learning tool presented here allows students to work with all these different fields. Furthermore, once the control system is running, this tool also provides the student with a fine-tuning system that aids understanding of the processes involved. The tuning is quite a complex task, since the whole system needs to be running in order to test the effects of successive adjustments. Traditional tuning is tedious because it is necessary to introduce the changes offline, execute the program, stop it and collect the information to be analyzed. Since the system is based on an industrial DSP, it allows an in-depth analysis of all the different phases needed to carry out the practical implementation of the drive control program on it. The low cost of this industrial DSP facilitates its use on several work benches for educational purposes. The learning system also implements a Real Time Data Exchange feature, which allows for real-time monitoring of the desired variables, such as currents, voltages and intermediate control variables.

Keywords: electrical engineering education; electric machines; drive control

- A. Gelen and S. Ayasun** 33–41 Realization of Power Electronic Converter Based DC Motor Speed Control Methods Using MATLAB/Simulink

The MATLAB/Simulink realization of DC motor speed control methods is achieved here by controlling the voltage applied to the armature circuit using various controlled and uncontrolled power electronic converters. The power electronic converters used in simulation models include full-bridge diode rectifier, half controlled rectifier and pulse width modulated (PWM) chopper. These simulation models are developed as a part of a software laboratory to support and enhance undergraduate electric machinery courses at Nigde University, Turkey.

Keywords: DC motors, speed control; armature voltage control; education; MATLAB/Simulink

P. Sandborn, J. Myers, T. Barron and M. McCarthy 42–52 Using Teardown Analysis as a Vehicle to Teach Electronic Systems Manufacturing Cost Modelling

Product teardowns are used in an electronic systems cost modelling course at the University of Maryland. As part of a semester-long project, each student in the course chooses a product and determines its manufacturing cost using a combination of top-down cost analysis (to determine what the product must cost) and a detailed bottom-up model (that students calibrate using the top-down analysis). Products considered by students range from complex systems such as mobile phones to relatively simple systems such as memory sticks and McDonald's Happy Meal[®] toys. Using product teardowns and reverse engineering ideas has proved to be an effective vehicle for educating students on practical manufacturing cost modelling of systems and complements typical engineering economics analysis.

Keywords: Teardowns; reverse engineering; product dissection; cost modelling; top-down; bottom-up; electronics

B. Blototsky, E. Efrain and Y. Ribakov 53–64 Using a Small-scale Shake Table for Teaching Typical Problems of Structural Dynamics

A small-scale shake table is a very useful tool for studying structural models' dynamic behavior under real forces and for investigation of active and passive structural control systems' efficiency. Theoretical principles, forming a basis for numerical modeling of structural dynamic response, should be consistent with real behavior of structures. 'Hands-on' experiments demonstrate basic concepts in structural dynamics and provide undergraduate students with an opportunity to develop deep understanding of structural response to different dynamic loads. A shake table platform with programmable motion is used to create and apply real loads to structures. The load can be programmed as impulse or continuous, stochastic or prescribed in time and in magnitude. Changing the platform's position is used for creating dynamic loads acting in different directions, including a vertical one. The forces can be applied to an investigated structure by shake table acceleration and they can have a form proportional to the structural element's mass. Another possibility is to apply the loads directly to the structural elements.

Keywords: Structural dynamics; engineering education; shake table; laboratory tests

I. C. Jong 65–74 An Alternative Approach to Finding Beam Reactions and Deflections: Method of Model Formulas

This paper is intended to contribute an alternative approach—method of model formulas—to finding statically indeterminate reactions and deflections of elastic beams under loading. A set of four equations are first derived and then employed as model formulas. These formulas account for the flexural rigidity of the beam, concentrated loads, and linearly distributed loads. Thus, the proposed method of model formulas can effectively be applied to solve most beam problems involving reactions and deflections, encountered in the teaching of mechanics of materials and in engineering practice. A variety of examples are included in the paper.

Keywords: beam; reaction; slope; deflection; singularity function; model formulas

P. Colajanni, G. Falsone and A. Recupero 75–83 Simplified Formulation of Solution for Beams on Winkler Foundation allowing Discontinuities due to Loads and Constraints

The paper discusses material for a course in Structural Mechanics addressed to second-year Civil Engineering students. The response of beams on a Winkler foundation characterized by discontinuities in both the displacements (deflections and/or slopes) and forces (internal forces and/or loads) is studied. In particular, a simplified formulation for the solution of the discontinuous differential equation governing this problem is given. In some cases, the formulation is able to give the exact solution in a closed form. This is made possible through the use of the generalized functions, such as the well-known Unit Step Function and the Dirac delta function. The cases of discontinuities due to both loads and constraints are treated. The method of presentation of this material is by lecture. The time required to cover the arguments is 2 to 3 hours with 1 to 2 hours of revision. The lecture must be given after the classical beam theory has been covered. The new formulation presented in this paper will demonstrate that some particular aspects of mathematician analysis may be used to advantage to simplify an important problem in structural mechanics.

Keywords: Winkler foundation; generalized functions; discontinuous beam solution

R. Bhatt, C. P. Tang, L-F. Lee and V. Krovi 84–92 A Case for Scaffolded Virtual Prototyping Tutorial Case-Studies in Engineering Education

By permitting designers to realistically, accurately and quantitatively prototype and test multiple intermediate models within virtual environment, Virtual Prototyping (VP), also known as Simulation-Based Design (SBD), has rapidly gained popularity and become a crucial part of most engineering design processes. While there is a significant demand from industry for students trained in this methodology, currently there is not much room in engineering curricula to permit widespread adoption in the lecture-based classroom. It is possible to develop a rationale and its various stages for a series of web-based and self-paced scaffolded VP tutorial case-studies targeted at students on a course in machine and mechanism design. These undergraduate seniors are permitted to: (1) interactively explore the process of creating engineering analysis models in an integrated VP environment; (2) develop skills for interactive SBD of models; and (3) develop their engineering judgment by interactive exploration of a spectrum of examples. The outcome of a phased introduction of these exercises and our experience based on a number of successful courses offering are also discussed.

Keywords: Mechanisms and machines; engineering design; simulation-based-design refinement; web-based implementation; interactive exploration; self-paced scaffolded tutorials

D. Špelic, F. Novak and B. Žalik 93–101 Educational Support for Computational Geometry Course—The Delaunay Triangulation Tester

The paper presents a tool to verify the correctness of the generated 2D Delaunay triangulation that has been developed as an educational support for a computational geometry course. This tool allows students to discover possible flaws in implemented triangulations such as unused points, missing edges, non-Delaunay triangles and degenerated triangles. The associated benchmark data sets provide common checkpoints for the implemented solutions. The tool and the benchmark data set also assist teachers to evaluate students' work fairly.

Keywords: computational geometry course; Delaunay triangulation; benchmarks

J. M. Munoz-Guijosa, E. B. Paz, M. Fe Verdú-Riós, A. Díaz-Lantada, P. Lafont, J. Echávarri, J. L. Muñoz, H. Lorenzo and J. Muñoz 102–111 Application of Process Re-Engineering Methods to Enhance the Teaching–Learning Process in a Mechanical Engineering Department

This paper aims to demonstrate the feasibility of using systematic process re-engineering methods, which are in general use in the industrial and service sectors, in the university environment. By using these methods it is possible to make an in-depth analysis of the processes used, compare the results with those that are required for the organisation where the processes are run to achieve its goals and, depending on this comparison, set up a series of proposals for improvement, so that activities that do not lead to achieving the goals can be eliminated and thus make more effective those that do lead to success. In order to demonstrate the feasibility of this, a process to improve operations has been completed at the Mechanical Engineering Department at Madrid Technical University. The aim is to optimise performance regarding the achievement of the goals, which are to maximise the learning of its students, both with regard to learning and attitude—curiosity, entrepreneurship and a firmness of character oriented towards continuous improvement and individual responsibility. In particular, the methodologies of KJ, Ishikawa were used as well as those of Relevant Actions, and concepts

from the Toyota Production System. Improving the teaching-learning processes is extremely necessary today, taking into account the paradigm change involved due to the Bologna declaration and the European Higher Education Area. Given the reduced scale of the work, the results are very encouraging and show the potential for improvement that may be obtained on a large scale. Above all, this paper aims to provide a list of the causes of typical problems that arise in the university that will be of use to the reader and puts forward ideas for possible ways to improve the everyday running of the university.

Keywords: process re-engineering; KJ method; Toyota Production System; teaching; learning

H. Yavuz and S. Mistiköglü 112–121 Assessment of Transition from Mechanical Engineering to Mechatronics Engineering in Turkey

This paper gives an assessment of the transition from the mechanical engineering curriculum to the mechatronics engineering curriculum in Turkey. It looks at the requirements for the transition and analyses the approaches adopted by Turkish universities. To achieve this, the study provides a review of the mechanical engineering departments and the proportion of mechatronics courses taught within these departments. As presented in the paper, some universities prefer a separate department for mechatronics engineering; others introduce optional courses, while the rest replace some core modules with mechatronics engineering type courses. Therefore, this work classifies the universities into three groups. In addition to Turkish universities, some selected cases of universities from Asia, the USA, Canada, and Europe are also included as examples of each identified approach, thereby providing the necessary background for comparison. The comparative study reveals that there does not seem to be a definitive approach to updating a mechanical engineering curriculum or a mechatronics engineering curriculum with any clearly defined structure. Nevertheless, the proportions of mechatronics courses in mechanical engineering curricula in Turkish universities indicate that the required measures seem to have been taken in most of the cases. In this study an attempt was also made to identify the problems that Turkish universities are facing in mechanical engineering education and some suggestions were made to overcome these difficulties to improve the quality of such education in Turkey. The paper concludes with a general suggestion that consists of a set of solution models that may allow a smooth transition from a mechanical engineering to mechatronics engineering curriculum.

Keywords: mechatronics education; mechanical engineering curriculum; mechatronics in Turkey

E. Ralph, K. Walker and R. Wimmer 122–130 Practicum-Education Experiences: Post-Interns' Views

The practicum component in undergraduate education across all professions (identified by various terms such as 'internship,' 'field education,' 'clinical experience' or 'co-op education') is typically rated by pre-baccalaureate students as the most important phase of their entire professional preparation. In this investigation, which formed one segment of a broader cross-Canada study, a group of post-practicum Engineering students from one Canadian university (who had just completed an internship with engineering firms) identified the most positive and the most negative aspects of that practicum experience. The authors compared these students' responses with those reported by post-practicum students from two other professions: Nursing and Teacher Education. Several positive aspects were identified by all three groups of students, such as: developing their professional competence and technical skills, increasing their personal self-confidence, and gaining real-world experience. Some of the negative aspects that all three cohorts mentioned were: receiving unsatisfactory internship placements, experiencing inadequate mentorship, and being assigned unproductive work tasks. The authors contend that practicum organizers across all professional fields should exchange with one another and examine such student data. The student voice provides a valuable dimension to the program-enhancement process, the ultimate goal of which, is to improve the 'experiential learning' phase of professional pre-training in all fields.

Keywords: practicum; internship; experiential learning; field education; co-operative education; cross-disciplinary collaboration; student voice

J. Uziak 131–137 Acceptance of Blackboard Technology by Mechanical Engineering Students at the University of Botswana

Technology-based teaching and learning is entering academic life at an amazing rate. It comes whether invited or not. Students and lecturers are confronted with new technologies. There are new teaching methods to accompany them, and new pressures to use them. E-learning is penetrating all areas of teaching and learning: academic institutions and corporate training alike. It has been generally accepted as a major and viable component of higher education. However, it is not clear how students accept the use of new technology. This paper deals with the question of acceptance by analysing the University of Botswana engineering students' reflection on Blackboard technology.

Keywords: e-learning; WebCT/Blackboard; acceptance; mechanical engineering students

A. Yadav and B. E. Barry 138–143 Using Case-based Instruction to Increase Ethical Understanding in Engineering: What Do We Know? What Do We Need?

Among various approaches, case-based instruction has been the most popular and widely employed method used in engineering ethics instruction. However, there is little empirical research on whether the use of cases is also the most effective teaching method in promoting ethical understanding for engineering students. This paper discusses the types of cases utilized and how they are implemented for educating undergraduate students in engineering disciplines. We then argue that empirical research is needed to examine the impact of case-based instruction on students' ethical understanding and that well-designed experiments can result in greater understanding of this approach and best practice for its use in ethics instruction.

Keywords: Ethics instruction, case-based instruction, case studies, research methodology

K. M. Y. Law, F. E. Sandnes, H-L. Jian and Y-P. Huang 144–151 A Comparative Study of Learning Motivation among Engineering Students in South East Asia and Beyond

This investigation covers learning motivation among engineering students and the relationships between learning approaches and those motivating factors. A questionnaire-based research framework that addresses these motivating factors and their linkages with team learning and action-learning approaches was employed. The findings from the study provide insights into the development of teaching inventories for engineering students. To enable students to learn effectively, a supportive setting with pulling forces should be provided (i.e. rewards, achievement, clear goals) and a cooperative group-based learning environment should exist (i.e. group pressure). Based on this study, suggestions are offered regarding what can be developed to promote students' motivation.

Keywords: Learning motivation, influencing factors, team learning, action learning, engineering education

W. Hernandez, I. Argüelles, J. Blanco, G. Balabasquer, C. Ortíz and E. Gago 152–160 Educational Experience of Adaptation of the First-Year Course of the EUIT de Telecomunicacion to the European Higher Education Area

In this paper, the educational experiences of research in Engineering Education in the Escuela Universitaria de Ingeniería Técnica de Telecomunicacion at the Universidad Politécnica de Madrid are presented. The research attempted to go beyond the experiences in the framework of the European Higher Education Area during the academic years 2005–2007. This paper describes the experience within the first-year course in the Escuela Universitaria de Ingeniería Técnica de Telecomunicacion. Three years after the beginning of this research some feedback is given and some conclusions are drawn.

Keywords: educational experiences; engineering education; European Higher Education Area; collaborative work

W. Hernandez, J. Palmero, M. Labrador, A. Alvarez-Vellisco and J. Bonache 161–172 Analysis of Results of Application of a Student-Centered Learning System to Improve Performance of First-year Students

Analysis of the results of the application of a student-centered learning system (SCLS) aimed at achieving the objectives of the subject Analysis of Circuits I in the Escuela Universitaria de Ingeniería Técnica de Telecomunicación (EUITT) at the Universidad Politécnica de Madrid (UPM). The SCLS was based on the European Credit Transfer and Accumulation System and the educational experiment was carried out in the first semester of the academic year 2007–2008; a comparative analysis between the SCLS and the traditional teaching and learning system (TTLS) in the EUITT-UPM can be seen below. To conduct the statistical analysis of the data collected in the experiment and make the right decisions, both treatment and control groups were formed and several tests of the hypothesis were performed. The outcomes of the experiment were satisfactory and showed that the differences between the SCLS and the TTLS are not always significant.

Keywords: Student-centered learning system; first-year students; statistical analysis

R. P. Van Til, M. W. Tracey, S. Sengupta and G. Fliedner 173–180 Teaching Lean with an Interdisciplinary Problem-solving Learning Approach

Faculty from Oakland University's engineering, business and education schools working with Oakland University's Pawley Learning Institute, are teaching graduate students lean principles and applications in a unique venue. An interdisciplinary elective course entitled Lean Principles and Application educates students enrolled in engineering, business and human resource development degree programs about lean from different perspectives before they enter the workforce. By providing students with the knowledge and skills to implement lean principles to solve real world problems, these future employees are prepared to add immediate value to their companies. In order to achieve this goal, a problem-solving learning component is implemented involving a semester long project where student teams conduct a lean analysis of a real-world manufacturing system or service system.

Keywords: Lean manufacturing; industry partnership; interdisciplinary

J. L. Riskowski, C. D. Todd, B. Wee, M. Dark and J. Harbor 181–195 Exploring the Effectiveness of an Interdisciplinary Water Resources Engineering Module in an Eighth Grade Science Course

Engineering education has historically been given little attention in the USK-12 classrooms even though engineering incorporates scientific and mathematical concepts into meaningful, everyday applications. Including engineering and design projects in K-12 science and mathematics classes may improve student interest and comprehension, while also reaching a broader range of students than traditional lecture-based classes. For this study, the authors implemented an engineering design project focusing on water resources in 8th grade science classes. Students were exposed to either an engineering project (treatment) or a more traditional format (control) and their knowledge of water resource issues was evaluated using a pre-post assessment tool. Overall, students in the treatment classes showed statistically significant improvement in two areas—they displayed higher levels of thinking on open-ended questions and greater content knowledge. This research indicates the effectiveness of engineering in enhancing student learning and supports its inclusion in the middle school science curriculum.

Keywords: K-12 engineering education; project-based learning; middle school education; water resources

S. M. Lord 196–204 Integrating Effective 'Writing to Communicate' Experiences in Engineering Courses: Guidelines and Examples

Incorporating writing into the curriculum is a challenge for engineering faculty. Constructivist and knowledge transformation frameworks of how writing helps build knowledge suggest that successful writing experiences in engineering are 'writing to communicate'. Drawing from that literature, the author advocates five guidelines for integrating effective 'writing to communicate' experience into undergraduate engineering courses: authentic investigation, tying the writing to the technical content, an authentic well-defined audience, providing useful practice for an engineering career and not being overly burdensome to the engineering faculty instructor. Specific examples of activities based on these guidelines, from classroom, homework and laboratory activities in sophomore, junior and senior-level classes serve as suggestions for faculty seeking to creatively incorporate writing throughout the engineering curriculum.

Keywords: Effective communication; integrated writing assignments; technical communication; writing in engineering; writing to communicate