

The International Journal of Engineering Education

Contents

- M. S. Wald** 617 Editorial
Engineering Education Policy and Research
- S. Ratnajeevan H. Hoole** 618–626 Viewpoint: Human Rights in the Engineering Curriculum
Besides discussing some human rights issues affecting all academics, this paper makes the general case why it is specially important to teach human rights to all engineering students. Examples from Sri Lanka, deeply rent by a civil war, are used to show that in divided societies where it is most needed to teach Human Rights, it is also the most difficult to teach it because of the sensitivity of the subject. The curriculum is described and the resources are shown to be widely and easily accessible. Experience in compulsorily teaching human rights to engineers for the first time is shared. As a secondary benefit, in stratified societies where students are reluctant to participate in class, a controversial subject like human rights that animates, proves useful in encouraging discussions and improving communications skills.
- J. D. G. Foster and J. Uziak** 627–632 Engineering Education in Botswana
The economy of Botswana has grown rapidly since it became independent in 1966, but the population is only 1.7 million. Engineering construction projects are of large scale. The University of Botswana offers engineering degrees in four disciplines, under programs that cover ten semesters. The particular challenges to engineering education in Botswana, as well as the structure of the present and future University of Botswana programs, are described in this paper. Emphasis is placed on a wide range of student individual investigation and design work, and the benefits of a particular project to the student and the program are stated in an illustration.
- James D. McCowan and Christopher K. Knapper** 633–637 An Integrated and Comprehensive Approach to Engineering Curricula, Part One: Objectives and General Approach
The need for increased professional skill development within engineering programs has been frequently discussed and is widely accepted. There is equal acceptance of the importance of increasing the social and environmental awareness of students of engineering. Efforts to increase these topics within engineering programs are often hampered by the fact that those programs are already heavy and demanding. Integrated Learning is an effort to utilise a broader range of learning techniques, including a conscious use of learning from one's environment, to address these issues in a comprehensive way within the constraints of a four-year program. This paper describes the educational objectives and the general approach. Subsequent papers will deal with issues of techniques, facilities and staffing.
- James D. McCowan** 638–643 An Integrated and Comprehensive Approach to Engineering Curricula, Part Two: Techniques
In Part I we described the educational objectives that have led to an approach to engineering education which we call Integrated Learning. In addition to improving professional skills and achieving more active learning, the objectives include an increased emphasis on design, an increased understanding of related disciplines, and an increased awareness of, and sensitivity to, societal and environmental factors. This paper deals with choosing learning techniques appropriate to the objectives. A subsequent paper will deal with issues of facilities and staffing.
- James D. McCowan** 644–651 An Integrated and Comprehensive Approach to Engineering Curricula, Part Three: Facilities and Staffing
There is widespread acceptance of the importance of including, within an engineering education, the development of professional skills, of social and environmental awareness, of lifelong learning skills and of a broad knowledge of other engineering disciplines. Integrated Learning is an effort to employ a broader range of learning techniques, including a conscious use of both structured and unstructured experiential learning, in order to address these issues in a comprehensive way without increasing the length of the program. The previous two papers discuss the objectives and techniques adopted in Integrated Learning. This paper addresses issues of facilities and staffing.
- Peng-Kiat Pek and Kim-Leng Poh** 652–666 Formulation of Tutoring Policy for Maximising Student Learning using a Decision-Theoretical Approach
This paper examines the nature of decision-theory approach and its application to education. In particular, a case study on selection of tutoring policy for maximising students' learning at Singapore Polytechnic is discussed. On the one hand, students' ability, availability of resources, and lecturers' preparation time are uncertainties. On the other hand, decision is influenced by individual preference for tutorial formats such as student-centred, chalk-and-talk, or computer-based tutoring. Moreover, the course of action is dependent on trade-off in values. Using decision analysis, uncertainties, preferences, alternatives and values are modelled and a defensible claim on maximising student learning can be made.
- Mechatronics*
- F. L. Tan, S. C. Fok and E. K. Ong** 667–673 A Pole Balancing Cart on an Unmodelled Terrain
A pole balancing cart comprises a wheeled or track-guided vehicle which can move under its own power in the fore-aft direction, and a pole pivoted at its lower end which can swing smoothly in the fore-aft plane like an inverted pendulum. The cart is able to balance the pole in a near upright position while it moves across an unmodelled terrain through sensing the inclination of the surfaces and noise compensation. The cart with an inverted pendulum is a classical example in the control of unstable systems. This paper describes the mechanical, electrical, and electronics design of such a pole balancing cart.

Chemical Engineering

**J. M. Lopes, F. Lemos, C. Pinheiro,
F. Ramôa Ribeiro, F. D. Magalhães,
A. Mendes and C. Costa**

674–681 Teaching Residence Time Distributions in the Laboratory

This article describes the approaches that have been used in the laboratory teaching of Residence Time Distribution (RTD) analysis for the study of chemical reactors, in the Chemical Engineering courses at Instituto Superior Técnico—Universidade Técnica de Lisboa (IST) and at Faculdade de Engenharia—Universidade do Porto (FEUP). An integrated set of experiments has been used to allow the students to test the fundamental knowledge and to analyze working reactors. This involves determining RTDs, both by impulse and step tracer injection techniques, and applying them to the modeling of the reactor flow and to the estimation of the behavior of a non-linear chemical transformation. Very simple forms of obtaining non-ideal reactor behavior are used, such as deficient agitation in continuous stirred tank reactors. Continuous tubular reactors were manufactured so as to present axially dispersed plug flow and laminar flow.

Building and Construction Engineering

Nabil Kartam and Khaled Al-Reshaid

682–696 Design and Implementation of Web-based Multimedia Techniques for Construction Education

This paper describes the development of a novel tool for the enhancement of undergraduate technology-oriented education. This tool takes the form of an interactive, animated, multimedia web-based textbook, which provides the primary source of reference for an undergraduate senior-level construction course. The intent is to integrate emerging computer technologies such as CD-ROM-based knowledge management, computer visualization, web technology and computer simulation/gaming, to provide a rich learning environment. The multimedia web-based textbook facilitates self-study (for distance learning) at a location, time and pace suited to the user. The tools and utilities provided will, however, also be applicable to, and enhance learning in a traditional classroom environment.

Control Engineering

C. Mei

697–703 On Teaching the Simplification of Block Diagrams

Due to their simplicity and versatility, block diagrams are widely used by control engineers to model all types of dynamic systems. The complexity of a block diagram is in general caused by the existence of summing/pickoff points within a loop. A novel concept, the main branch stream concept and the corresponding shifting rule for the relocation of summing/pickoff points are introduced in this paper. It is found that the new concept and the corresponding shifting rule greatly help the simplification of block diagrams and make teaching the simplification of block diagrams much easier.

**Ali El-Hajj, Sami Karaki and
Karim Kabalan**

704–710 Graphical Simulation of an Analog Computer Using Spreadsheets

This paper presents a spreadsheet method for the graphical simulation of analog computers (AC) used in control systems. It is based on simulating basic AC blocks like adders, integrators, potentiometers, inverters, and nonlinear devices. To make the simulation simple and user friendly, the construction of an AC system is done graphically, whereby blocks are drawn at the simple clicks of buttons. Blocks can then be easily connected using a built-in graphical interface. The initialization and running of a given system is fully menu-driven and done using toolbars and buttons. The simulation of a system allows the calculation and plotting of its time response for any input signal. This toolbar-customized simulation is characterized by its low cost, flexibility, and simplicity. The procedure for building the graphical symbols and toolbars is briefly described, and illustrative examples are presented to show the capabilities of the developed simulation system.

Distance Controlled Laboratories

William J. Hutzel

711–716 A Remotely Accessed HVAC Laboratory for Distance Education

The widespread use of computer controls for optimizing the efficiency of mechanical and electrical systems in commercial buildings has created a unique opportunity for delivering lab-based distance education. Facility engineers routinely use building automation systems to access real-time performance data (e.g., chilled water pressure, temperature, and flow) over the Internet. This network capability has been applied in an educational setting to deliver laboratory experiments to large numbers of undergraduate students. Although educators need to be aware of the limitations of commercially available building automation systems, remotely accessed Heating, Ventilating, and Air Conditioning (HVAC) equipment is an excellent way to demonstrate real-world principles of thermodynamics, fluid mechanics, and controls.

Environmental Engineering

**Göran I. Broman, Sophie H. Byggeth and
Karl-Henrik Robért**

717–724 Integrating Environmental Aspects in Engineering Education

The key role of engineers for the transformation of society towards sustainability is a strong motivation for increasing the environmental knowledge within engineering education. Doing this by the concept of integration is presently considered more appropriate than to develop more new education programmes for environmental specialists. This paper describes the integration of environmental aspects into a mechanical engineering education programme. The Natural Step Framework has been used as a basis for this integration. It has been possible to include environmental knowledge without compromising the engineering quality of the programme.

**James N. Craddock and
Lizette R. Chevalier**

725–731 Development and Formative Assessment of Web-Based Multimedia Labware for an Environmental Engineering Laboratory

A web-based laboratory manual for an Environmental Engineering Laboratory is being developed. This paper presents an overview of the development and a summary of some formative assessment data collected during the initial phases of the project. The labware is intended to enhance student learning through the exposure to richer learning tools and advanced technologies by developing an interactive multimedia website for the laboratory, both before and after the actual experiment. For laboratories without the required equipment, the students can still investigate and link the theory, experimental methods, data collection, and analysis.

Manufacturing Engineering

Ismail Fidan and Ahmed Elsayy

732–735 The Development of a Knowledge-Based Engineering Tool for CNC Machining

Although there are many kinds of computer-aided manufacturing (CAM) packages available on the market, there is no educational system developed for the fundamental estimations of machining process parameters, such as cutting time, material removal rate (MRR), feed rate, and spindle speed. Having such a system is important for a number of reasons: cost estimation, life cycle analysis, machine programming, tool and workpiece selection, production rate, and number of machining steps, etc. In this paper a knowledge-based system (KBS) developed for the Computer Numerical Control (CNC) processes and its implementation in a junior level CNC class are presented.

This paper reports on a project, called S.m.i.L.E, which was launched by the Institute of Electronics, University of Federal Armed Forces, Hamburg, Germany. The intention of this project is to improve and supplement existing methods of teaching electrical engineering using a web-based and interactive course program. The paper describes the concept and contents of S.m.i.L.E and introduces its basic principles: simple usage, vivid and concise illustration and a high level of comprehensibility. The paper also presents the experiences made during the first two years of project lifetime. The technical realisation of S.m.i.L.E and future directions are presented as well.

A major objection to the idea of incorporating Monte Carlo methods along with other numerical methods such as finite difference and finite element into undergraduate classes such as heat transfer and electromagnetics is that they are only capable of calculating the potential at a single point at a time unlike other methods which provide simultaneously the solution at all the grid nodes. This paper shows how this major limitation is overcome using absorbing Markov chains to obtain the transition probability. Illustrative examples are provided to show that not only is this approach capable of providing the solution at all the grid nodes at once, the solution is more accurate than the fixed random walk and is not subject to randomness.