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Internet aided courses in Mathematics for Engineers

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Abstract

Learning at JCT requires at the same time synchronous and asynchronous learning. For some introductory courses in Mathematics for Engineering students, we built websites according to a triple function model "homepage-tutorial-mailing list". We discuss here informally the structure of the websites and the contribution of this supplementary materials towards teaching efficiency and towards students' learning skills.

1 Introduction.

The Jerusalem College of Technology is an Engineering School with some special features. The most remarkable of these features is that students at JCT learn two parallel curricula: in the morning, they learn at what is called the Bet-Midrash, a typical Institute for Higher Talmudical Studies, and in the afternoon they learn Engineering courses. The stress induced by the lack of time available for learning/self-teaching is significant, so every method for facilitating the learning process is welcome.

As well, students can be called for army duty up to 4 or 5 weeks every year. When they return to their studies, they are faced with learning the material taught during their absence and, at the same time, trying to understand what is going on in current course-work (including active participation and submitting homework). They are are not obliged to hand in the missed assignments, but doing them is wise.

Providing effective means for both synchronous and asynchronous learning is very important for our students. One convenient method for addressing our

students' needs is the building of websites, where interactivity is an important feature.

In addition to the specific needs at our institution, there are also general reasons for the use of educational technology, as described in [3].

2 The website structure.

For each course, we built a website along the same guidelines:

1. A HOMEPAGE containing the following items:

   (i) the name of the lecturer and teaching assistants, together with their electronic addresses (e-mail) and office hours;

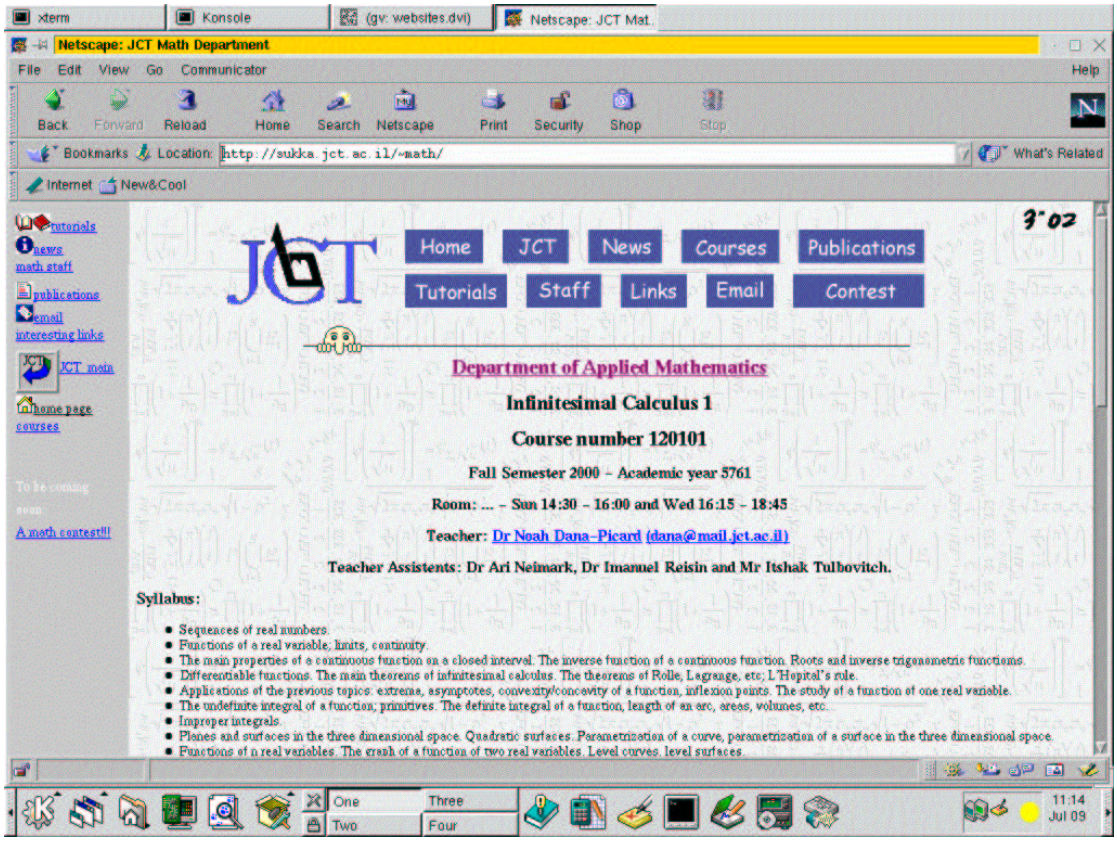


Figure 1: The homepage head.

   (ii) a general description of the course, together with a detailed syllabus;

   (iii) the course pace, meeting places, etc.;

(iv) the course's pre-requisites and the homework requirements;

(v) how the student will be assessed in the course;

(vi) the course's textbook and a bibliography of recommended books, available at our library;

(vii) links to solved exercises, according to homework assignments;

(viii) links to related useful websites;

(ix) links to previous exams, with solutions, as far as possible (see [6]).

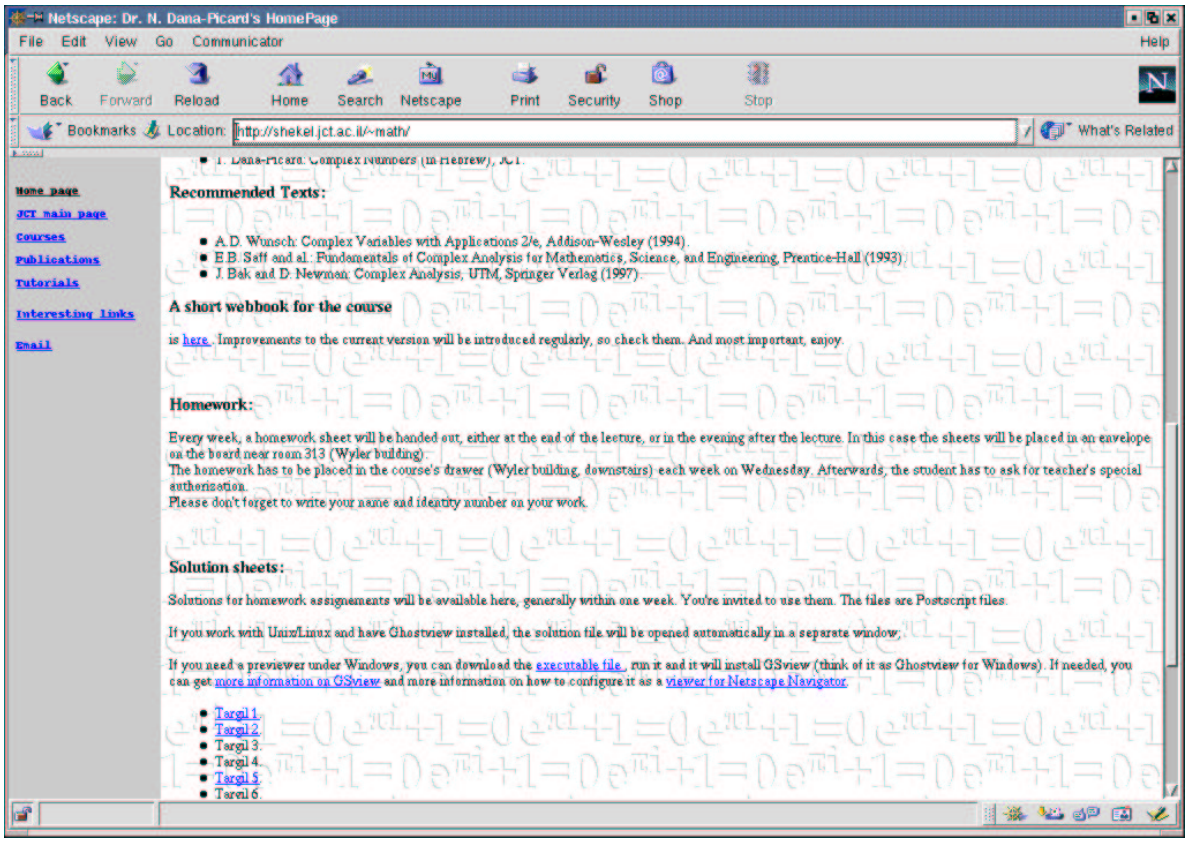


Figure 2: Part of a course homepage.

2. TUTORIALS for the course, i.e. a hypertext book, containing the course material. This neither replaces completely a textbook nor lecture notes (we included definitions, examples, theorems, but very few proofs; detailed lecture notes are given as hand-outs).

3 Advantages.

The tutorial is a help material for the student who takes the course, but it does not totally replace either a textbook or lecture attendance. For example, we include into the tutorial various examples for each topic, different from the examples described in classroom.

The web material has been written using LaTeX and LaTex2html: the cross references are automatically transformed into hyperlinks. Updating the tutorial requires a new compilation of the file, but this is generally not so time-consuming, and can be done as a background process.

Let us now list the principal virtues of the internet usage for our courses:

1. Availability: the material is always available (with the exception of very short interruptions for computer maintenance purposes). Moreover the possibility given to students to contact the teacher(s) directly by e-mail enables him/her to be in touch at any time, and to get prompt answers; of course this depends on the teacher(s), but if he (they) become accustomed to working this way, they usually respond quickly... A by-product of such a quick communication is that students can suggest modifications (i.e. improvements) of the material on display. They can also ask their teacher to add extra sections, new examples, etc. Of course, an educator engaged in this way of teaching must be ready to fulfill quickly these requests.

   Availability is a crucial feature for those students coming back from a long army duty or other absences (weddings, sickness, etc.).

2. Flexibility: both for in-campus students and for students working at a remote place [1] , the flexibility offered by an internet based course is a worthy feature: they can browse through the tutorials at their own pace, and the hyperlinks allow jumping from one page to the other, from one theorem to another, from one example to the involved theorem's statement, and more important, moving backwards is easy. The usage of Java applets make examples more expressive, and adding interactive features to the tutorial makes it more useful, and more "visited".

3. Focusing possibility: the student can focus on the topic (s)he wants to learn, contrary to what happens in a regular classroom, where the teacher makes the choices and imposes the pace.

4. Possible multi-tasking: the student can take advantage of the simultaneous opening of at least three windows: one for reading the tutorial, another one for writing (and saving) his own documents. In the third window, he can either run a CAS, if available as a local installation, or logon a remote site running interactive features (like Wims at the University of Nice [10]).

[1] Remarks and improvements are sent frequently by students. Moreover, the author has been contacted by students from North America, India, etc, about the the material in his tutorials.

5. Acquaintance with English reading and writing: most of our students are non-native English speakers. The easiest way for them would have been to provide Hebrew websites for their use. Nevertheless, we decided to write our websites in English. One of the main reasons is that Engineering Education does not consist only of teaching/learning subject matters. An important part of engineering education is to prepare the student to his/her professional life. Almost all the professional literature, including web documents, is in English, no matter which country it comes from. Similarly, JCT uses the MatLab software, as it is the most convenient for problems in Applied Mathematics.

6. Available solutions: in Mathematics, exercises are a major part of a student's work and the acquiring problem-solving techniques is important. As says M. Artigue in [2]:

   > "*A technique is a manner of solving a task and, as soon as one goes beyond the body of routine tasks, for a given institution, each technique is a complex assembly of reasoning and of routine tasks. Techniques do not have only a pragmatic value which permits them to produce results, they have also an epistemological value, as they are partly made up of the understanding of the objects, and are also a source of new questions*".

   See also Lagrange's analysis in [7].

   Generally printed books provide answers either to odd-numbered or even-numbered exercises. From time to time they provide full solutions. Even when the teacher follows a specific textbook, he/she delivers his/her lectures in a different fashion, not identical to the printed material. Moreover, the assignments can be composed not only from book exercises, but from ad-hoc exercises composed by the teacher himself/herself. At least, we hope so.

   For each course, we organized a mailing list, and students know about the posting of solutions to new exercises, as soon as this has been done. They can check their solutions and ask questions. The same can and should be done with mid-terms and final exams (see [6]).

7. Graphical features: the quality of illustrations is much better than in print, and we mention only for the sake of completeness the hand-made drawings on the blackboard (or the white board); the most gifted teacher never achieves the drawing quality of computerized drawings. In printed textbooks you can present only fixed pictures; in a web document, you can either display such fixed pictures, or present animations (cf. [5]). For example, such an animation can emphasize the convergence or the divergence of Taylor series towards a given function. Another example, displayed in [8], consists in presenting a box decomposition of a volume in space, for the sake of computing integrals.

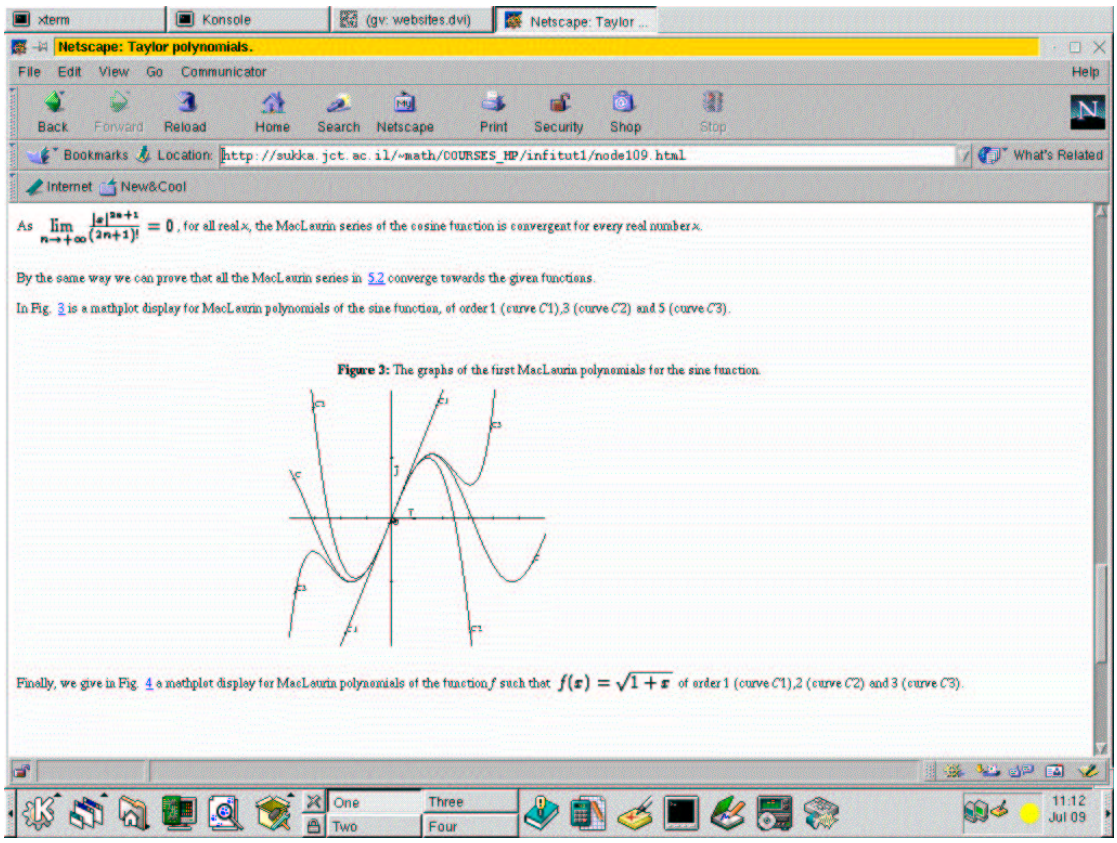
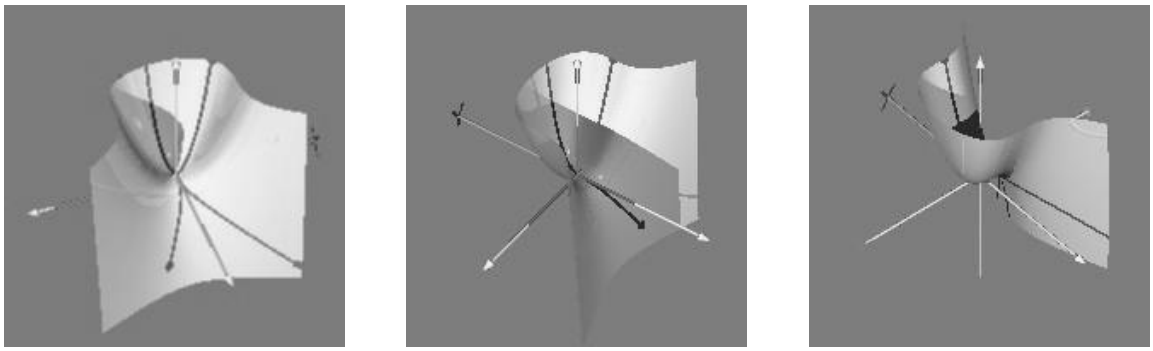


Figure 3: A page of a tutorial.

A regular student needs a long time before he/she begins to visualize surfaces in space, integration domains, and so on. A computerized environment, especially with animations, helps him much. Moreover, a reasonable collection of pictures of the same surface, with different points of view, helps to visualize maxima, minima, saddle points (In Fig. 4 are displayed three different views of the same surface; you can imagine how more powerful is an animation showing this surface from "all" directions.).

In addition to these animations, Java applets are an excellent tool for visualization and dynamical learning. During the first launch, links to applets already available on the web can be given in the homepage. Later applets illustrating the material taught in the course should be provided by the teacher and his/her staff. These applets have their importance, not only for the asynchronous learning, but can be used in classroom in order to help the students to formalize the dynamic process of convergence (for example) and to obtain a deeper understanding.



(a) (b) (c)

Figure 4: The surface with equation $z = x^2 - y^3$.

4 Difficulties and tentative solutions.

We list some of the main difficulties that a student can encounter, when taking an internet-aided course. Of course, some of them are irrelevant for students working in an in-campus lab.

1. The first barrier on the student's road is the physical access to Internet. If he/she works from outside, he/she must be granted permission to connect; this limitation exists when connecting to the main frame through a modem. Even when working from within the campus, there can be physical limitations: sometimes only specific labs have an Internet access, sometimes there are specific lab hours for Internet connections, and so on. This issue is relevant to the general policy of the Institution and has been studied extensively by Fleck and McQueen in [4].

   It happens that a student decides to make a hardcopy of the tutorial. This is surely allowed and cancels the problem of physical access to the net. Nevertheless, two features are lost:

   a. the flexibility offered by the hyperlinks;

   b. the interactivity, since it transforms a "dynamic" tutorial into a "static" document.

2. A great amount of mathematical material is available on the Web in PostScript format. When using a version of Unix, the software needed to read PostScript documents is usually already installed, and the documents are opened by the browser. Students working at home use often a version of the Windows operating system; for this system, there exists appropriate free software for reading PostScript documents (named GSview; see

[11]). Nevertheless, students don't generally think about looking throughout the net for this software. They can download it via a link on the course's homepage.

3. Despite the fact that JCT is an Engineering School, students are sometimes reluctant to use technology for their homework in Mathematics. Here we deal with Internet-aided/Technology-aided courses, not pure Distance Learning. Therefore student's pathway into this kind of learning should/could be smooth enough.

4. From the teacher's point of view, the website is always "under construction", because of constant additions and revisions. Hence, a huge amount of extra work has to be performed by the teacher, at least during the initial "launch". In order not to be overwhelmed, the teacher has to compose a small staff of good former students; they will help not only for the technical part (html programming, Java applets programming, cgi programming, and other tasks), but they can be active associates in pedagogical discussions. They can develop for themselves new computing and programming skills which they could not develop within the frame of a classical course on these topics. However, this team work needs a financial support; some institutions either cannot or do not want to give such support. The Program for Excellence at JCT enables gifted students to become active in such an endeavour (see [12]).

5. The mailing list is an important component of an Internet-aided course. As already noted, students can be in touch with their teachers at any time, ask questions, get answers, solutions to problems, etc. The mailing list increases the interaction among the students, without prodding by one of the teachers. But the more the students ask their teachers by electronic means, the more the teachers must spend time at their keyboard. If the number of students involved in a specific course is large (and this has to be defined by the teacher), help should be provided by specific teaching assistents. We are back to the financial support needed from the institution.

   The mailing list can be upgraded to a web-forum, increasing the interaction between the students. And, further,

   > "*...web forums provide an opportunity to establish a frequently asked questions (FAQ) database for first year mathematics subjects. This will be a valuable resource for students to enhance their learning and for lectures to deliver their subjects efficiently.*" (Altas and al., [1]).

5 Final remarks.

There exist packages for Computer Assisted Learning, generally commercialized as CD-Roms. Despite their intrinsic qualities, they are not as flexible as the

triple function model "homepage-tutorial-mailing list" that we describe in this note. Moreover, the fact that these "triple-model" are freely available (copyrighted, but free) on the web is a plus. Note that the dual-model "homepage-tutorial" is useful for students from all over the world, but this is generally not a sufficient motivation, neither for the teacher, nor for the institution... . As examples of such pairs "homepage-tutorial, see [13] for Calculus and [14] for Advanced Calculus.

A byproduct of what we describe in this note is the following achievment: a prospective student can check whether a course is either compulsory or just interesting, from a personal point of view, for his education program. This remark is particularly relevant to optional courses; for main courses with parallel teachers, websites (at least home pages) can help this student to decide where to go.

References

[1] Altas I., Louis J., Yazici A. : *An Analysis of a Web Forum in Distance and Face to Face Teaching of a First Year Mathematics Subject*,http://www.math.uoc.gr/ ictm2/Proceedings/pap104.pdf

[2] Artigue, M.: *Learning Mathematics in a CAS Environment: The Genesis of a Reflection about Instrumentation and the Dialectics between Technical and Conceptual Work*, CAME Symposium 2001, http://ltsn.mathstore.ac.uk/came/events/freudenthal/ 1-Presentation-Artigue.pdf

[3] Brandt, D. and Henning,K. : *Perspectives of information and communication technologies for engineering education*, Eur. J. Eng. Educ., Vol 26 n^o 1 (2001), 63-68.

[4] Fleck, R.A. and McQueen, T. : *Internet Access, Usage and Policies in Colleges and Universities*, First Monday, Vol. 4 n^o 11 (1999), URL: http://www.firstmonday.dk/issues/issue4_11/fleck/

[5] Kidron, I. and Zehavi, N.: *The Role of Animation in Teaching the Limit Concept*, Int. J. of Comp. Alg. in Math. Educ. Vol 9 n^o 3 (2002) 205-228.

[6] Krantz, S. G.: *How To Teach Mathematics: a personal perspective*, American Mathematical Society, Providence RI, 1993.

[7] Lagrange, J.B.: *L'intégration d'instruments informatiques dans l'enseignement: une approche par les techniques*, Educ. Studies in Math. 43, 1-30, 2000.

[8] Murphy, T.J., Goodman, R.E. and White J.J. : *Using the WWW in Multivariable Calculus to Enhance Visualization*, Int. J. of Eng. Educ. Vol 15 n^o 6 (1999), 425-431.

[9] Teri Murphy, Jonathan White, Andrea Stone, Angela Beauchamp: *Using Web-Based Interactive Graphics to Enhance Understanding of Parametric Equations: Lessons Learned* , http://www.math.uoc.gr/ ictm2/Proceedings/pap154.pdf

[10] URL: http://wims.unice.fr/∼wims

[11] URL:http://www.cs.wisc.edu/∼ghost/

[12] URL: http://gematria.jct.ac.il/∼naiman/pfe/

[13] http://sukka.jct.ac.il/∼math/COURSES_HP/infi1.html, http://sukka.jct.ac.il/∼math/COURSES_HP/infitut1/index.html

[14] http://sukka.jct.ac.il/∼math/COURSES_HP/infi2.html, http://sukka.jct.ac.il/∼math/COURSES_HP/infitut2/index.html