

## OPEN SOURCE SOLUTIONS TO AUTOMATIC GENERATION OF TESTS AND EXAMINATIONS

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### **Abstract**

One obvious challenge in any learning institution is testing and examining learners with standard papers. Many are the times that the examiners have little time to think through questions based on the provided course outlines especially if they have never taught the subject before. Availability of a database of past questions with expected answers can be very useful in orienting both the tutor and the students. This paper explains a system that provides an open source solution to dynamic generation of examinations through pre-set templates. The generation is achieved by integrating the capabilities of open source software to perform random selection of testing questions from a database of questions stored in a LaTeX file. The idea is to have a single file containing every approved question and accompanying answer and let the system randomly pick pre-specified number of questions on each request through a link. The selected questions are compiled into a Portable Document Format (PDF) output file, which can be printed or be saved for future administration. The system allows any type of question with excellent graphics when drawn using pstricks. The tutor can edit the existing template of questions by adding or deleting questions, modifying the answers and resetting the parameters such as the numbers of questions per exam. It is also possible to switch on and off the generation of the marking scheme. The system can be used by the exam processing office or just to support learning as a library support system. The main challenge is to convert all current and previous questions into latex as question-solutions format which must be as specified and thus the examiner requires initial training on use of Latex to typeset.

**Key words:** Random generation, latex, examinations, database

## 1.0 Introduction

The core business of learning institutions is to train and examine their clients who are students. Colleges and Universities have to set many examinations every semester and now, with self sponsored programmes, the examination processing units have become a beehive of activities as draft examinations are submitted, typeset, proof read and packaged. A pool of copy typists is ever busy converting handwritten exam scripts into printable examination question papers, which in most cases are just re-organized questions from past papers. There are other times when an examination is required and the typesetting is not yet done or the examiner is not even available to provide the original copy for typesetting. Special and Supplementary examinations creates another nightmare especially when notice is too short.

Many are the times when examiners are not able to prepare standard papers due to their busy schedule. Sometimes they are out of reach and a person who may not have taught the subject is called upon to provide a draft examination. This paper gives an overview of the main design, working and possible implementation of a DYNEXAM software system, which was developed, with the aim of addressing the issues described above. Some illustrations are also provided based on existing templates.

## 2.0 Background Information

Many attempts have been made to automate exam generation but success has been limited to electronic versions. By electronic we mean examinations that must be done on the computer with minimal typing of any answers. Examinations such as the ones based on Cisco and Microsoft certifications are mostly of this nature. Since the learner is only supposed to pick the correct answer from a given set of options, most learners only visit question dump sites ([www.ciscoexams.org/passguide-cisco-exam/](http://www.ciscoexams.org/passguide-cisco-exam/)), ([www.examsguide.com/mcse/mcsemockexams.html](http://www.examsguide.com/mcse/mcsemockexams.html)) and access the questions prior to their examinations. With repeated runs, one is assured of coming across some of the pre-available questions. With subjective questions for the traditional setup, such sites may not prove very useful, as the learner may be required to tackle essay type of questions. A good number of software tools exist online. For example Takshila Software for examination is ideal software to process examination related activities, (<http://www.takshila.org/software.htm>). A recent attempt has been made by Bettina and Zeileis (2009) to automatically generate exams using R software but most of the examinations so generated are not for print.

## 3.0 Design

The proposed system is an integration of several Information Technology Tools and principles to create an examination generation engine or system. The system can run on a stand alone computer but an intranet in an examination office could be ideal. The main software tools required are:

At processing phase

- (i) LATEX (Scientific open source typesetting software)
- (ii) YACAS (Yet Another Computer Algebra Software)-free
- (iii) JAVA

At output phase

- (i) The Acrobat reader which acts as the viewer for the generated PDF papers
- (ii) Web Browser-Mozilla for the online version

At both phases

- (i) One can use the system with Windows system or Linux
- (ii) Operating systems (Linux is free)
- (iii) XAMPP which brings with it Apache Web Server and MySQL database for the online version.

The main input by the user is the typesetting of the questions together with their answers and then placing them in a database (questions bank). The database is either a large latex file containing all the possible questions covering the whole syllabus or small latex files each containing one question. The small file could have more than one question if it they must always appear together be together in any given examination paper.

### 3.1 Typesetting the Questions for System

LaTeX is a document markup language and document preparation system for the TeX typesetting program developed by Leslie Lamport (1980). The term LaTeX refers only to the language in which documents are

written, not to the editor used to write those documents. In order to create a document in LaTeX, a .tex file must be created using some form of text editor such as WinEdit, LyX, TexnicCenter. Latex works with special instruction files called packages. A good reference to the typesetting rules can be found online, see Roberts (2009). One such package is the Answer.sty, which is standard latex package, which specifies the rules and environments for typesetting questions with solutions after the document. For example: For every question provide the answer placed between the codes `\begin{solution}` and `\end{solution}`. A code that governs the random selection is placed just before the particular question. The code is written using YACAS programming language which when passed through JAVA interpreter is executed to determine whether the question is picked or not. The format for typesetting is



Example

CODE Who is the first president of Kenya `\begin{solution}` Mzee Jomo Kenyatta `\end{solution}`.

The code, question and answer must be in one line or paragraph otherwise the same code must be placed in each line which is a part of the question.

The coded file will normally contain latex deactivated questions. If an attempt is made to compile it without following the standard link, a blank PDF file is produced (it could contain the caption but no questions). When the processing is requested by clicking a batch (.bat) file or a link to it, new file is created in which all the selected questions are activated. The randomness is ensured by use of time difference in re-computing the random seed using server time in milliseconds. The new file is then compiled using latex builder in the standard way to give a portable document format (PDF) file, which is viewable using freely provided acrobat viewer. In the case of the online version, a download link becomes available at the users side once the processing is complete. On clicking it, the PDF file so produced opens.

#### 4.0 Implementation

The Chief Examinations Officer administers the system by ensuring that only authorized persons (examiners) have user accounts. A unit examiner walks in to the examination office, logs in, clicks the link to the unit examination unit and peruses through the generated test/examination. If he/she is not satisfied by the exam questions randomly selected, he clicks on the link again and another set of questions is generated. When satisfied with the generated exam, he/she sends it to the printer and fills the proofreading forms. He/she carries a copy of the examination answers (marking scheme) leaving the question paper being processed.

The screen capture in Fig 1 below displays the front page of the system. After user log on, basic user information and a log file for data control are saved in a database on the web server.

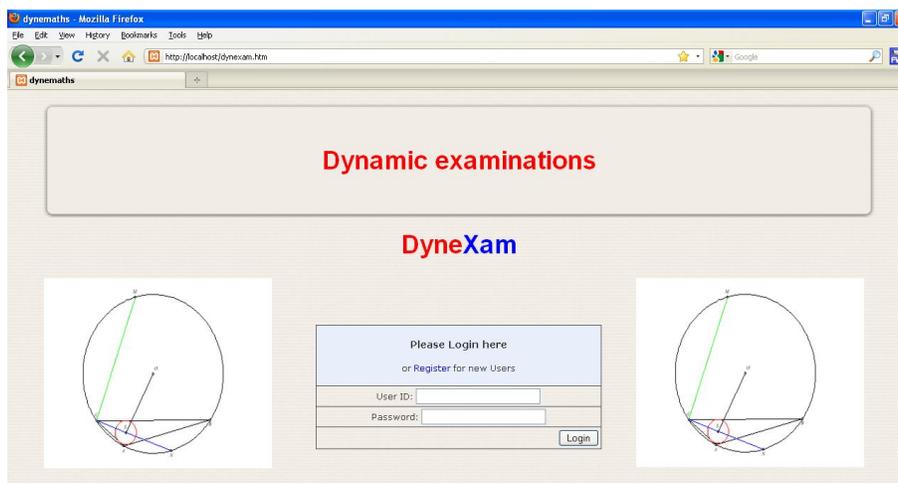


Figure 1: Login page

After some few seconds, the following screen appears. It contains the links to all the questions, which can be quizzes, CAT's 1-3 or the Main Exam. The current sample system has five units, up to three CAT's and the examinations for each. A user can choose the testing option by weakness of a topic or generally for revision.

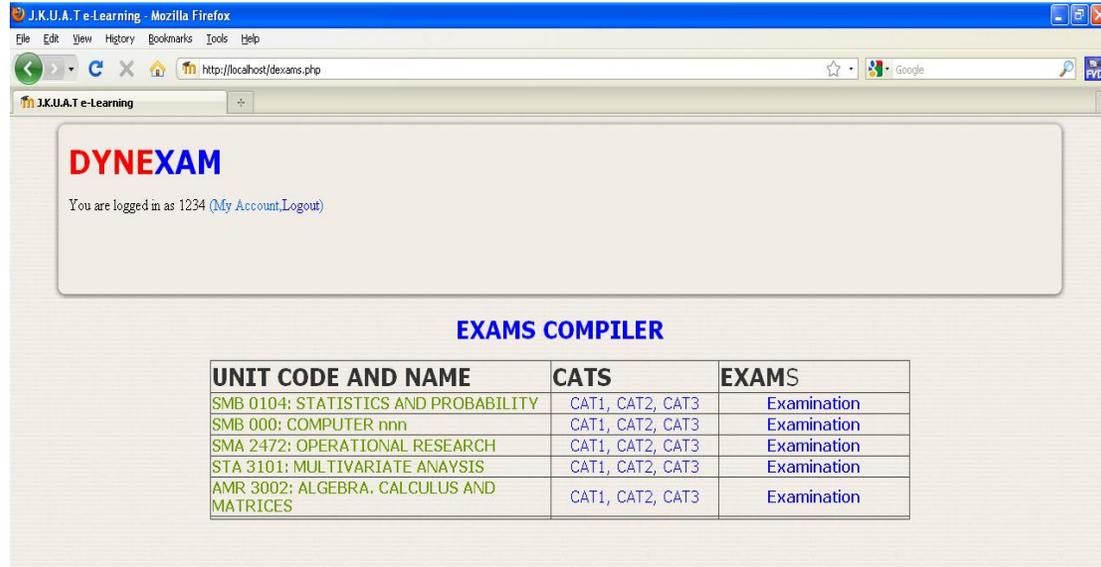


Figure 2: Page with links to examination

The next thing is to click on the selected exam and wait for it to be compiled. This is where the system engine is engaged since it randomly calls the questions from a Latex file and then compiles them and outputs them together with the solutions in a PDF file. A page appears which has only a tab, which is linked, to the PDF file that has been generated.

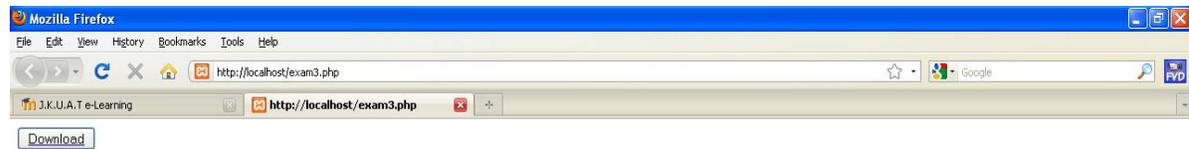


Figure 3: Page that has the download linked tab

After clicking on the link, a page opens on the same window which displays the date and time the exam was generated.

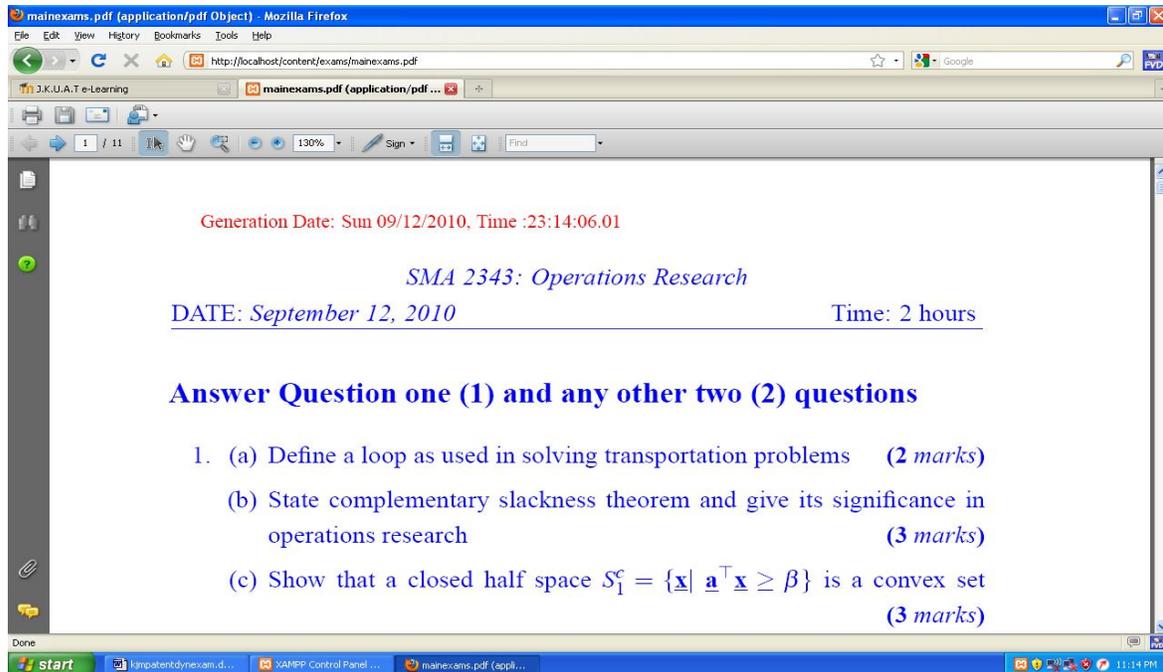


Figure 4: The downloaded examination in PDF

Every time the Download Tab link is clicked, it generates a different set of questions.

Generation Date: Sun 09/12/2010, Time :7:48:01.53

*SMA 2343: Operations Research*

DATE: September 12, 2010

Time: 2 hours

**Answer Question one (1) and any other two (2) questions**

1. (a) State the optimality and feasibility conditions as used in simplex algorithm of solving LP problems (2 marks)
  - (b) Define a convex combination of points  $x_1, x_2, \dots, x_n$  in a convex  $C \in \mathbf{R}^n$  and show that a set of convex combinations is also convex (4 marks)
- a)

**Answer Question one (1) and any other two (2) questions**

1. (a) Define a loop as used in solving transportation problems (2 marks)
- (b) State duality theorem and explain briefly its significance in operations research (3 marks)
- b) (c) State the optimality and feasibility conditions as used in simplex al-

Fig. 6 (a) & (b): Two different screen captures of exam questions, the 2<sup>nd</sup> one having been generated after 7 seconds after the 1<sup>st</sup> one.

The answers will appear at the end of every question paper as shown below

**Solutions to the Exam**

**1b.** A point  $X$  is said to be a convex combination of  $X_i (i = 1, 2, \dots, n)$  if  $X = \sum_{i=1}^n \alpha_i X_i$  where  $\sum_{i=1}^n \alpha_i = 1$  and  $\alpha_i \geq 0 \quad \forall i$

Let  $\bar{C}$  be the set of all convex combinations of  $X_1, X_2, \dots, X_n$ , let  $Y_1$  and  $Y_2$  be two points in  $C$ , then  $Y_1 = \sum_{i=1}^n \alpha_i X_i$  and  $Y_2 = \sum_{i=1}^n \beta_i X_i \quad \sum \alpha_i = \sum \beta_i = 1 \quad \alpha_i, \beta_i \geq 0$ . Let  $X_0$  be any point on the line segment joining  $Y_1$  and  $Y_2$ , then  $X_0$  can be written as  $X_0 = \lambda Y_1 + (1 - \lambda) Y_2 \quad \lambda \in (0, 1)$

a)  $\Rightarrow X_0 = \lambda Y_1 + (1 - \lambda) Y_2$

**Solutions to the Exam**

**1a.** A loop is a sequence of cells such that;

- (i) each pair of consecutive cells lie in either the same row or the same column;
- (ii) no three cells lie in the same row or column;
- (iii) the first and the last cells of the sequence lie in the same row or column and
- (iv) no cells appears more than once in the sequence.

b) **1b.** *Duality theorem:* If an optimal solution exists to either the primal or sym-

Figure 7 (a) and (b): Two different screens capture solutions of the exam questions in Fig. 6 above

**6.0 Conclusion**

DYNEXAM is comes in time to solve real problems especially with the advent electronic learning, which operates, with the slogan of learning from anywhere anytime and any pace. This could mean demand for standard examination papers at anytime depending on the learners pace. All what an academic institution need to do is to place moderated questions in DYNEXAM and the rest will be a click away.

The issue of security concerns need not worry anybody because access to the system is password controlled in a local area network. Even if the system was to be accessible online, the only sure way that the learner has the leak to attempt all the questions in the database which is equivalent to covering the syllabus.

## References

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