MATHEMATIC LEARNING EVALUATION IN THE ENGINEERING FACULTY UNIVERSIDAD NACIONAL AUTONOMA DE MEXICO

REPORTE SOBRE EVALUACION
U N E S C O

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UNIVERSIDAD NACIONAL AUTONOMA DE MEXICO

1. INTRODUCTION

In this report a summary of researches, tasks and statistics concerning mathematics teaching and learning in the Engineering Faculty of the Universidad Nacional Autónoma de México (UNAM) is presented.

We tried to be as objective and simplified as possible, in order to obtain information that could be analyzed rapidly.

Some statistics and copies on informative material are included. That kind of material was distributed among the mathematics teachers months ago.

By now, it was not possible to include more complete issues in this short inform, but it is feasible to get supplementary information at:

Universidad Nacional Autónoma de México
Anexo de la Facultad de Ingeniería
Sección de Matemáticas
Ciudad Universitaria
México 20, D. F.
MEXICO

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1) Mathematics III seminary:

Students evaluation	Ing. Jorge Téllez S
Teaching evaluation	Ing. Enrique Ríos Ch.
Antecedents evaluation	Ing. Francisco González V.
	Ing. Eduardo Belaunzarán G

2) Mathematical courses, score scales.
Ing. Bernardo Frontana

3) Algebra questionary. — Ing. Eduardo Solar G.

4) Translation reviewing
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Ing. Enrique Ríos Ch.
Ing. Gerardo Weihmann I.

And the approval of Ing. Antonio Abaunza de la E. Coordinator of Propedeutical Courses.

September 27, 1976

A. Tristán

Ing. Agustín Tristán L.

2. MATHEMATICAL COURSES

In the Engineering Faculty the following mathematical courses are imparted:

ALGEBRA (Linear algebra, complex numbers, theory of equations)

MATHEMATICS I (Vector analysis, integral calculus)

MATHEMATICS II (Differential calculus)

MATHEMATICS III (Advanced calculus)

MATHEMATICS IV (Differential equations, Laplace transforms)

All the courses are semestral, and until october 1976 they have had the following distribution:

1st. Semester. = Algebra, Mathematics I and II

2nd. Semester. = Mathematics III

3d Semester. = Mathematics IV

That plan of the matters explain the variable distributions of students population shown in the statistics included in this report.

SCORE SCALES

1) Numerical scale. The range from zero to ten is used normally during the courses to mark examinations, homeworks, etc. Approval notes are from six to ten.

2) Literal scale. Used in the UNAM

MB (MUY BIEN)	- 10 (very good)	}	APPROVING
B (BIEN)	- 8 (good)		
S (SUFICIENTE)	- 6 (sufficient)		
NA (NO ACREDITO)	< 6 (Not accredited)		REPROVING

These letters are employed to assign the final grade of a course. The numerical equivalencies are used by the administration for computational purposes; but in fact teachers assign the letters according to their own criterion or characteristics of the students.

3. RESEARCHES OF EVALUATION

3.1 MATHEMATICS III SEMINARY

Background

A group of professors of Mathematics III was commissioned by the Engineering Faculty to realize a Seminary, dedicated to attain the following objectives:

1) To know problems, wishes and needs in all the aspects of scholar life of the faculty students.

2) To propose solutions at least to one of the detected problems.

That Seminary has two years of work on both lines and its task is very important among the academic life of the mathematical department. One of the themes treated by the seminary was students evaluation.

Investigation.

Three hypothesis were proposed about evaluation.

1) Evaluation represents for the student a constitutive part of the teaching-learning process.
2) Students are suffering a limited and reduced evaluation criterion, which represents to the students a negative pressure rather than an evaluation instrument.
3) The student is capable to propose new evaluation criteria or solutions, to decrease the limitations of the actual procedures of evaluation.

With the results of group dynamics with students of mathematics III it was possible to verify the first and last hypothesis, and the second was not proved. Conclussions of the group dynamics are given in the appendix 1.

3.2 NEW TEACHING METHODS COMMISSION RESEARCHES

The New Teaching Methods Commission (Comisión de Nuevos Métodos de Enseñanza) is an institution of the UNAM consecrated to research in new aspects of teaching and to impart actualization courses for teachers.

Unfortunately, their investigations are very superficial and, in fact, are just summaries from several authors instead of original tasks. Nevertheless, they greatly influenced some other researches in this field since they were the first publishers of organized information.

The Commission has two sets of Didactical books:
1) Teaching Systematization
("SISTEMATIZACION DE LA ENSEÑANZA")
Objective formulation, learning experiences. and evaluation design
2) Scholar profit evaluation
("EVALUACION DEL APROVECHAMIENTO ESCOLAR")

3.3 RECENT RESEARCHES IN THE ENGINEERING FACULTY

In order to propose an evaluation model feasible to be applied in the Engineering Faculty, a Commitee is working in the study and revision of the actual evaluation literature.

Until now there have been some advances in recommendations for better evaluations and, using original own procedures, the creation of formulas and norms for item difficulty and discrimination value (appendixes 2 and 3)

We worked with a random group of students to know their wills and needs. The results are very interesting (appendix 4).

3.4 EVALUATION PROBLEMS WITH NON FULL-TIME TEACHERS

In this aspect the facts are:

1) Most teachers are not dedicated full time to teach but impart just one or two classes.

2) They have not enough time to make a good and frequent evaluation yielding improvised evaluations.

3) They have no time to prepare themselves in evaluation matters then their exams are not reliable nor valid.

4) It is not possible to think about the use of conscious self evaluation to improve their task.

3.5 PROBLEMS WITH STUDENTS' MOTIVATION AND HONESTY

It happens that:

1) Students valuntarily get more matters than those they can pass.

2) They study lightly during a course, and only increase - their rythm a few days before an exam.

3) Generally they only want to pass and do not mind about how much have they learned.

4) They feel that subjects are useless for their future professional life, translating this fact in a lack of interest in the courses.

5) It is not possible to think in a conscious self-evaluation of the students.

4. EXAMINATIONS

4.1 DEPARTMENTAL EXAMINATION

Background:

1) Chaos in the evaluation systems even between teachers of the same course

2) Different advance in the groups, with cases of groups which have not completed the program

3) Impossibity of comparing teaching, as well as learning, between different groups.

SOLUTION:

Departmental examinations; that is each matter coordination staff prepares an exam to be applied the same hour and day to all the students of the respective matter.

Exams dates are fixed when the semester starts, as well as subjects to be examined. The basis of departmental examinations formulation are included (appendix 5)

DIFFICULTIES:

1) Subjectivity in the topics sample. Since there is not a systematic procedure, then a real random sample of subjects is not made. So each semester, the same subjects are evaluated the same way.

2) The same subjects are proposed to all the students, but the difficulty rate is not equal for all the groups, because the teaching process. is free and variable as the teacher can choose it voluntarily.

3) Mark criterion is variable, since some professors are more strict than others.

4) Concluding: The objectives of departmental examinations have been attained in approximately a 50%.

Final Scores:

1) Generally speaking, teachers get final qualifications taking into account:

- Departmental examinations (Three in a semester)
- Homeworks and others tasks.
- Participation in class.

2) Finally there are:

. Final examinations. Two opportunities at the end of the semester for those pupils who have not yet approved. - Their importance in the qualification is more subjective and variable than in the other examination. Sometimes it occurs that this final examination is the most-important evaluation in a course.

4.2 OBJECTIVE EXAMINATIONS

Background.

1) Excessive student population in a group or course

2) Subjectivity in evaluations, producing strong variations in the appreciations of the students

3) Wishes to try new types of evaluation

Objectives:

1) To have an objective evaluation

2) Possibility to get statistics about the performances of the student

3) To assign qualifications in an easy way

Observed Results

1) Inclussion of one or two objective items in an exam of - five or six problems. The objective items generally used are multiple choice or relating columns.

2) Since the rate of objective questions is small, subjectivity in evaluations is not completely eliminated.

3) There are only a few well fundamental examinations (an Algebra exam is included appendix 6).

Objective tests marked by computer

Background: There were notices about succesful examinations reviewed by a computer in the Medical Faculty of the UNAM.

Observed results

1) Just a couple of experiments in this way were done, with-exams composed by simple multiple choice quiestions (it is included the exam of Matematics III, the most complete until now, appendix 7)

2) Good validity and reliability, because they were tested - before their application to the groups. Using this proce dure the item's bank will be created.

3) It was possible to get adecuate and complete statistics - useful in the evaluation of students.

4) It was not possible to evaluate high order objectives.

5) To solve the problem of marking time this type of exam is excellent, but useless to feedback students learning.

6) It is necessary to complete this evaluations with other - kind of procedures.

4.3 NEW EVALUATION TRENDS

Objetives:

1) To have a complete, reliable and valid evaluation

2) To translate evaluations into students learning feedback.

3) To achieve that exams be another learning element fot - the students.

Procedure followed in two experimental groups of Matematics III:

1) Examinations every three weeks with open and objective- questions, in order to evaluate different capabilities - of the students.

2) Item analysis (Difficulty and discrimination) to know - the learning level of each group and also the characte - ristics of the exam.

3) In those items with anormalities, investigation with the group to know the causes of such results. In cases of - bad preparation of students, homeworks, classroom-work - etc. are proposed to improve their knowledge.

4) Inclussion of at least one completely new problem to im- pulse the creativity of the pupil; including data and in formations necessary to have a learning instrument also.

The total results are in phase of analysis which will be finished at - the end of the present scholar semester.

5. TEACHING EVALUATION (MATHEMATICS III SEMINARY)

Background:

As one activity of the seminary an objetive questionary was printed - and applied at the end of 1975.

Objetives

1) To know pupils' opinions concerning Mathematics III professors, with multiple choice questions.

2) To have an instrument to feedback teaching in particular topics, with open questions.

Statistical outputs:

The following results over the first objetive are preliminary, and must be submitted to a more complete analysis.

Percentages indicate the option with highest frecquency in every topic. (outputs of the second objetive are just interesting for teachers).

1) Knowledge of the matter:

Professor have good skills, teach themes with certainty and answer - questions with clarity.	80%

2) Didactic background:

Impart a conventional course, but- produce interest in the pupils.	62%

3) Punctuality and requirements to the group:

Start on time the class but is tolerant with the puntuality of the- pupils.	46%
Assist constantly to the course	73%
Is tolerant when marks the exams	45%
Does not require homeworks but stimulate the students who work at home (that reoresents a benefit for the- pupils).	60%

4) Rapprochement with the group:

The teacher is only vexed with - the passivity of the pupils	64%
The professor has never used his authority in an inadequeted form. Treats the students with a coope- rative spirit. Is interested on students learning and sincerly - wishes to know the pupils.	56%

5) Academic topics:

Always prepare the themes to be imparted	53%

Factors teachers take into account for the evaluations:

Examinations	89%
Homeworks	70%
Problems and exercices	44%
Classroom-work	47%
Other factors	12%

Consider each factor adecquately	90%
Relates theory with exercices	57%
Participation of students in class is motivated	41%
Participation of students is voluntary	44%
Professor and pupils participate in - topics' developements and lectures	48%
Students have not participated becau- se there is not enough familiarity in the class or because there is a lack- of interest on the topic	45%

6. LEARNING PERCENTAGES

6.1 APPROVED, FAILED AND DESERTED STUDENTS

The student's population is variable each semester depending the distribution presented in point number 2 (MATHEMATICAL COURSES). In appendix 9 of this report are presented the statistics in Algebra and Mathematics III, about students:

1) Registered
2) Examined
3) Approved
4) Failed
5) Deserted

} in percentage of examined

It is important to remark

1) The high number of deserted students
2) The tendency of failed and approved pupils in Mathematics III (which is a coordination in continuous evaluation and teaching improvement) compared with Algebra.

6.2 ANTECEDENTS KNOWLEDGE OF STUDENTS

There have been done two antecedents examinations in the Engineering-Faculty.

1) Examination of pre-universitary knowledge

The available outputs from 1975 are:

Total of students in the examination..... 953
Approved..... 599 = 62.8%

Mean Scores:

Algebra	74.3%
Logarithms and Trigonometry	62.1%
Analytic Geometry	61.4%
Differential Calculus	20 .3%
Integral Calculus	4.2%
Physics	55.4%
Chemistry	64.7%

2) Examination for Mathematics III about the knowledge of the antecedents of the first semester.

Mean scores:

Algebra	
Mean	37%
Standard deviation	30%
Mathematics I	
Mean	37%
Standard deviation	18%
Mathematics II	
Mean	45%
Standatd deviation	18%

(Copies of the distributions are included in the appendix 8)

7. CONCLUSIONS

It was shown, in the present report, a great deal in topics on evaluation studied at the Engineering Faculty (UNAM). We think that it is necessary to analyse the results and to continue the existent researches in order to accomplish interpretations and reccomendations.

At the moment we can propose the following interpretations:

1) Students antecedents knowledge is not satisfactory

2) If antecedent courses are not improved students learning cannot be improved

3) Teaching is acceptable. Nevertheless it must be improved by succesive evaluations of teachers and teaching techniques.

4) Examinations are not satisfactory. Departmental and objective examinations must be further and more profoundly revised.

And our opinion on evaluation perspectives are:

1) Researches on evaluation must be developed because they are a good instrument to obtain reccomendations to have a better teaching-learning process.

2) Evaluation proceedings in other countries are not completely useful in the Engineering Faculty (UNAM). Nevertheless they represent a way to attain an original solution.

3) Collaborations of evaluators from other countries and their opinios about our tasks and researches are desirable.

   All kind of collaborations are welcome at the same address included in the introduction of this report.

4) It is necessary to continue our investigations on the following present topics:

   a) Creation of an original evaluation model considering all the characteristics of our scholar system (including our objectives, purposes and Philosophy of Education). Besides it must consider statistic results and item analysis.

b) Creation of a computer's program to mark objective examinations and obtain interpretative results.

c) Creation of an item's bank correctly based on our-original evaluation model, properly valid and re - liable.

APPENDIX 1.- CONCLUSSIONS FROM THE MATHEMATICS III SEMINARY CONCERNING EVALUATION.

Hypothesis 1.- Evaluation represents for the student a constitutive part of the teaching-learning process.

Results: An evaluation of the teaching-learning process must be:

- The acknowledgment of the skills obtained in a course, which will be applied in later courses.
- A way to compare the responses obtained in learning produced by different kinds of teaching methods. A way to determine the efficacy of every teaching method employed.
- A motivation tool for the student.

By these reasons it was concluded that the hypothesis was verified

Hypothesis 2.- Students are suffering a limited and reduced evaluation criterion, which represents to the students a negative pressure rather than an evaluation instrument.

Results: For the students our existing criteria or methods of evaluation have the following positive parts:

- Are a motivation to attain the skill level proposed in their studies
- Help to determine better teaching methods
- Frecquent examinations help to study constantly
- Departmental examinations compel professors to impart complete courses
- Help students to know their learning level
- Propiciate good relations among professors and pupils

And the following negative parts:

- Just serve to give a score and are not a learning measure
- Departmental examinations evaluate all the themes of the course, even when they have been treated superficially by the teacher.

By these reasons it was concluded that the second hypothesis was not confirmed, as there are possibilities of utility and non-utility at the same time.

Hypothesis 3.- The student is capable to propose new evaluation criteria or solutions, to decrease the limitations of the actual procedures of evaluation.

Results: Solutions proposed by the pupils to complete or improve the evaluation criterion actually used are:

- Departmental examinations should not be the most important element of evaluation.
- Professors must do frecquent examinations in class.
- To give scores professors take into account: Departmental - - examinations, classroom works, homeworks, assistance to the courses, investigation tasks, home examinations and classroom exams.

Therefore the third hypothesis was verified.

APPENDIX 2.- RECOMMENDATIONS FOR EXAMINATIONS:

1) Preferably the exams must be frequently done.

2) Questions or items shall be of different types in order to evaluate different students' capabilities.

3) The total number of questions must be congruent with the objectives to be evaluated.

4) The solution time for the students must be previously obtained, multiplying by a minimal factor of 3 the time spent by the teacher in the solution of the exam.

5) The questions or items shall be marked like a dichotomy (0,1). In open questions any value in that interval is accepted. Using those results the questions must be analysed.

APPENDIX 3.- ITEM DIFFICULTY AND DISCRIMINATION VALUE

1) Index of difficulty (in percent)

$$G.D. = \frac{\text{Correct answers*}}{\text{total of students}} \times 100$$

* Values in the interval (0,1)

2) Discrimination value

$D = CS - CI$

CS = correct answers superior class

CI = correct answers inferior class

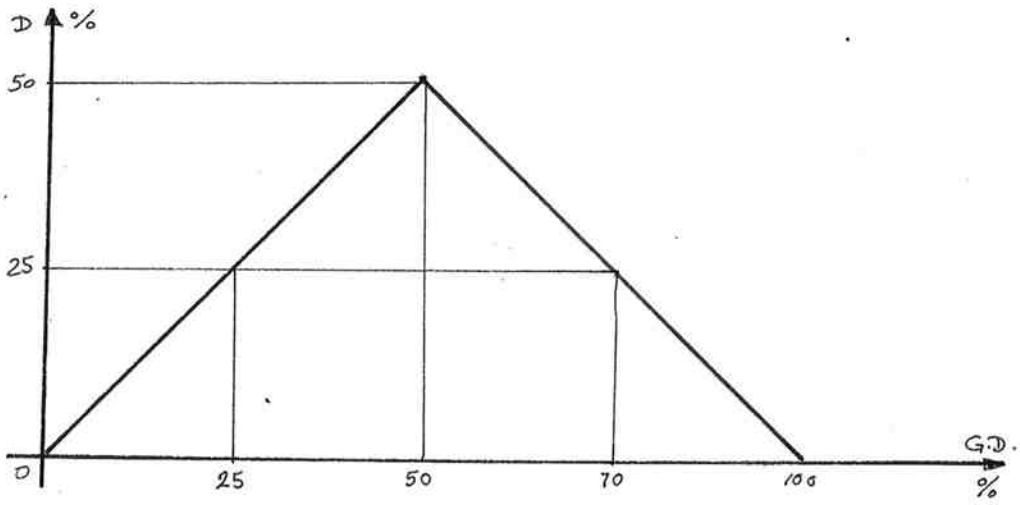
Superior and inferior classes are defined over and under the median of the distribution.

or in percent:

$$D = \frac{CS - CI}{N} \times 100$$

N = total of students

3) Difficulty and maximal discriminations value are functionally related. Graphically:



4) In accordance to that graphic it was proposed a discrimination norm function of the index of difficulty, considering areas under the straight lines.

We define:

- Optimal interval of difficulty

  $27 < G.D. < 73 \quad (\%)$

- Discrimination norm

  $N = 0.3 \times G.D. \ (\%)$

Both values are practical to use in the item analysis of an examination.

APPENDIX 4.- RESEARCH WITH A RANDOM GROUP OF STUDENTS

The ideas expressedwere:

1) About the foundations of evaluation:

- An evaluation must include not only exams, but also developing models, practical works on graphic and material representations, etc.
- Exams must include several kinds of questions to measure different mental processes and capabilities.
- Departmental examinations do not fulfill their purposes, because students of different groups and teaching-learning systems are measured with the same instrument.
- It is preferably to assign just a promotion to the next level, instead of our qualification system.
- Evaluation must be learning help.
- It is desirable to propiciate the self-evaluation.
- Aspects to be evaluated must be defined according to the real perspectives in Engineering.
- It is necessary to prevent that students with a bad preparation have an examination, just because it is a requisite.

2) About the items

- A good measuring is independent of the type of test
- Open questions are preferably since they can measure reasoning.
- Simple multiple choice questions are good to measure concepts, as they are easier than open questions.
- The order of solution involved in simple multiple choice questions could help the student to remember the solution procedure.
- Simple multiple choice questions could limit the mental process
- Since students do not read the instructions completely or they try to guess the answers, objective questions produce great mistakes in the solving process.

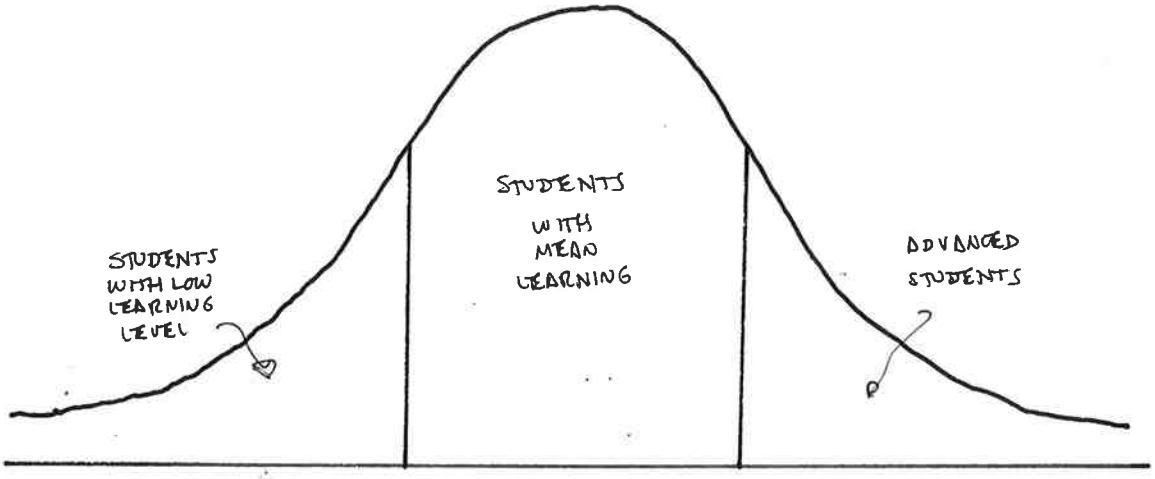
3) About the presentation of questions it is necessary:

- To have more specific and easier instructions

- To induce the students to solve the problem first and then to look for the options that could be, for instance, in another page.

4) About learning levels

- A curve representing learning levels in a group was proposed as follows:



- According to this curve it was expressed that it is desirable:

- To have examinations for each level.

- The creation of special groups for each level or to have regularization groups to obtain the required antecedents knowledge level.

- To adequate teaching for each level

- To propose in the same examination questions for all the levels

- The existence of those levels is impossible to avoid because there are vocational problems in the pupils.

- In just half an hour (!) it was proposed by the group of students the following list of learning levels:

1) Information (to know that something exits)
*2) Memorization (ideas' retain)
*3) Comprehension (to know implications and uses of an idea)
*4) Application (to solve a problem correctly)
*5) Generalization (insight)
6) Creation of something new

Levels marked with * correspond exactly to bloom's Taxonomy, unknown by that group of students.

- Concerning the evaluation of those levels it was proposed:

  1) To evaluate all the levels involved in a matter.

  2) To propose more frecquent and shorter measurements (five or six minutes each class, or fifteen minutes a week, or each topic, etc.)

  3) To propose antecedent examinations in order to inform the students which are the starting points of the course.

  4) Trying to decide which levels are more important than the others (as well for the evaluation as for the teaching-learning process) opinions were divergent.

APPENDIX 5.- BASIC RULES IN THE PROPOSAL OF DEPARTMENTAL EXAMINATIONS IN THE COORDINATION OF MATHEMATICS III.

In accordance with the oppinions expressed in the Coordination meeting, it is presented a basic initial scheme (feasible to be depurated) to be followed in the proposal of departmental examination:

1. FUNDAMENTAL SUGGESTIONS:

  1) All the examiners shall do their examination proposals based on the matter "Common Objective".

  2) Since the examinations are just a part of a total evaluation, and for many of our teachers it is a relevant part, all possible attention and care must be attempted.

  3) Supported by point 1, all kind of algebraic, trigonometric or antecedents complications shall be avoided.

  4) It is desirable that students develope their capability and ingenuity, to apply the acquired mathematical knowledge in physical problems. That does not mean that conceptual or habitual operative questions must be eliminated.

  5) Clarity of state ments is necessary. Specially, when a physical application problem is proposed, some hints will be given to help the student in the construction of the Mathematical model representing the problem.

  6) It is required to practice point 5 in the class; this procedure will avoid confusion of the students in the exam.

  7) The proposition must be made in such a way that the mean student needs 2.5 hours to solve a partial exam and 3.5 hours for final or extraordinary examinations.

8) It must be kept in mind that the examinations are just a part of the evaluation in the teaching-learning process, there fore teachers need to consider some other judgement elements, to attain a correct appreciation of the students.

2) FORM SUGGESTIONS

1) Examination proposals shall be given up at the dates indicated in the calendar of activities for each semester.

2) All proposals must be delivered completely solved.

3) Points 1 and 2 are necessary specially to:

- Review statements to prevent lack of data, wrong redaction, etc.
- Check the solutions
- Analyse possible difficulty of questions.
- Since there are three questionaries for each examination (to prevent cheating) they must be homogeneous.
- Write properly statements and solutions for teachers.
- Get on time the printing of questionaries and solutions.
- Distribute the different types of questionaries according with the number of students by group.

4) It is suggested that the last information of the exam be made by matter's coordinators with the colaboration of the examiners.

5) The presence of the teachers in the examinations is fundamental, because:

- According to the teachers thaught it is important that students realize the interest and support that professors can afford - them.
- The Coordination is also supported when professors are present
- We lack of assistants to help in every group beeing examinated

This communication was prepared on November 23d, 1974.

APPENDIX 6.- ALGEBRA EXAMINATION

A L G E B R A . PRIMER EXAMEN PARCIAL FILA (B)

PROFESOR: _____ GRUPO: _____

NOMBRE DEL ALUMNO: _____

Este examen ha sido diseñado para conocer la medida en que has alcanzado los objetivos esenciales del programa, correspondientes a los primeros dos capítulos y medio del curso.

Antes de contestar a cada pregunta, lee detenidamente su contenido. Los problemas marcados con un * debes resolverlos en las hojas adjuntas, en éstos se calificará procedimiento y resultado. El tiempo para resolver el cuestionario es de 2 horas 45 min.

(1) 10 pts. Escribe en el paréntesis de cada una de las operaciones de la izquierda, la letra que corresponde al resultado en la columna de la derecha:

( ) $Q \cup Q$

( ) $(R \cap Q) \cup Q'$

( ) $(N \cap I) \cap (R - Q)$

( ) $(R \cap N) \cup (I - N)$

( ) $(Q \cap I) - (N \cup \emptyset)$

a) $\emptyset$
b) N
c) $\{X \mid X \in I , X \geq 0\}$
d) $\{X \mid X \in I , X \leq 0\}$
e) I
f) Q
g) Q'
h) R

(2) 10 pts. * Demuestra por inducción matemática la siguiente proposición:

$$3^n > 3n \quad , \quad \forall\, n \geq 2$$

(3) 5 pts. Marca con una X en el paréntesis, aquella proposición que completa correctamente el siguiente enunciado:

Una operación binaria definida en un conjunto S es ...

( ) una regla que asocia a dos o más elementos de S un elemento único, al que se llama resultado de la operación.

( ) una regla que asocia a dos conjuntos con un elemento de S al que se llama resultado de la operación.

( ) una regla que asocia a cada dos elementos de S un elemento único, al que se llama resultado de la operación.

( ) una regla que asocia a cada elemento de S un elemento único, al que se llama resultado de la operación.

( ) una regla que asocia a cada dos elementos de S varios elementos, a los que se llama resultado de la operación.

(4) 15 pts.

* Identifica la estructura algebraica que tiene el sistema formado por el conjunto:

$$S = \left\{ \frac{m}{n} \mid m,n \ I \ , \ n \neq 0 \right\}$$

y las operaciones:

$$X * Y = 2XY$$

$$X \triangle Y = X + Y + 2XY \ , \quad \forall \ X,Y \in S$$

si sabemos que se cumplen las siguientes propiedades:

La operación $*$ es cerrada y conmutativa, y la operación $\triangle$ es asociativa.

(5) 10 pts.

* Determina para que valores de $X \neq 2$ se satisface la siguiente desigualdad:

$$\frac{X + 5}{-2 + X} > 3$$

(6) 5 pts.

Marca con una X en el paréntesis, aquella proposición que completa correctamente el siguiente enunciado:

A diferencia de otros sistemas numéricos, el sistema de los números complejos proporciona soluciones a la ecuación...

( ) $4X - 7 = 0$

( ) $4X + 7 = 0$

( ) $4X^2 - 5 = 0$

( ) $4X^2 + 5 = 0$

(7) 10 pts.

* Calcula los valores de $Z \in C$ que satisfacen la siguiente ecuación:

$$\frac{1}{2} Z^{2/3} = -1 + i$$

(8) 15 pts.

* Dados los números complejos: $Z_1 = 1 + i$, $Z_2 = 2 e^{-\pi i}$, $Z_3 = \text{cis } 90^\circ$, obtén la forma binómica del número complejo:

$$\frac{Z_1(\overline{Z}_1 + Z_2^2)}{Z_3^3}$$

(9) 10 pts.

* Dados los siguientes polinomios: $h(X) = 2X^3 + X^2 - 4X + 7$, y $k(X) = X + 2$, obtén dos polinomios $q(X)$ y $r(X)$ tales que:

$$h(X) = k(X)\, q(X) + r(X), \qquad \text{donde } gr(r) = 0$$

(10) 10 pts.

* Demuestra el teorema del factor.

Tiempo para resolver el cuestionario: 2 horas 45 min.

APPENDIX 7.- MATHEMATICS III EXAMINATION

UNIVERSIDAD NACIONAL
AUTÓNOMA DE
MÉXICO

FACULTAD DE INGENIERIA
DIVISION PROFESIONAL
MATERIAS PROPEDEUTICAS
SECCION DE MATEMATICAS

ESTIMADO COMPAÑERO:

Está entre tus manos un examen novedoso. Es nuevo desde el momento en que todo va a realizarse por medio de preguntas de opción múltiple, nuevo porque lo va a calificar una computadora. Es diferente a los exámenes anteriores porque en su elaboración se ha empleado más de un mes, se ha validado con un grupo de alumnos para evitar fallas y se ha revisado ampliamente. Confiamos que con él evaluaremos más objetivamente tus conocimientos y reduciremos los errores en la calificación . . . ese objetivo persigue este examen.

El examen está dividido en tres secciones. La primera evalúa los conceptos que tengas, la segunda revisa los procedimientos que habitualmente llevas a cabo en un ejercicio de la materia y la tercera evalúa la aplicación. Recuerda finalmente que un examen no es más que un elemento de evaluación, así que toma tranquilamente lo que aquí se te pregunta para que conozcas qué tanto sabes de nuestra materia.

Ahora pasa a leer las instrucciones de cada sección, esperando junto contigo que realmente cumplamos con el objetivo que nos propusimos en un principio.