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New Mexico State Univ., Las Cruces.

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The experimental pilot project was conducted to determine whether students who take the laboratory phase of an engineering technology applied electricity course in a mobile laboratory at branch schools demonstrate proficiency comparable to students who take the applied electricity course in permanent facilities at the parent institution. The project design used the type of laboratory as the independent variable and an achievement test as the dependent variable. Analysis of co-variance was used with the pre-test scores held constant. The mobile laboratory was used 1 day each week at two branch schools and provided space for 16 students with equipment similar to the laboratory equipment at the parent institution. During the first operational period no significant differences were found between the final achievement test scores of students using the permanent laboratory and those using the mobile laboratory. However, during the second operational period final achievement scores of the students using the permanent laboratory were significantly higher, and it is inferred that the permanent laboratory facility makes for better proficiency in applied electricity than does the mobile laboratory facility. The appendixes present pictures of the mobile facility, a course outline for the applied electricity course, and a sample pretest, post test. (HC)

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BR-6-2238
PA-08

DEVELOPMENT AND TESTING OF AN EXPERIMENTAL MOBILE INSTRUCTIONAL FACILITY FOR APPLIED COURSES IN ENGINEERING TECHNOLOGY

PA 08

By

LOUIS W. KLEINE

OFFICE OF EDUCATION GRANT NUMBER OEG 4-6-062238-1521,
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NEW MEXICO STATE UNIVERSITY
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SUMMARY

GRANT NUMBER: OEG-4-6-062238-1521

TITLE: DEVELOPMENT AND TESTING OF AN EXPERIMENTAL MOBILE INSTRUCTIONAL FACILITY FOR APPLIED ELECTRICITY COURSES IN ENGINEERING TECHNOLOGY

INVESTIGATOR: Louis W. Kleine

INSTITUTION: New Mexico State University

DURATION: June 1, 1966 to April 30, 1968

PURPOSE:

In New Mexico and most other states in our nation there has developed a need for new educational programs, and the new vocational and technical technologies comprise a high percentage of this need. The nation and the states have passed legislation to initiate, maintain, extend, and improve existing programs; however, in New Mexico, funding is the major problem.

New Mexico State University at Las Cruces, New Mexico, has three branch colleges (two-year branches) at Alamogordo, Carlsbad, and Farmington. Since the inception of these branches, they have been housed in the local high school facilities with a predominate offering of night programs. However, only recently have facilities been completed at Carlsbad, and plans for the other two have been completed.

The parent campus initiated three two-year engineering technology programs (electronic, civil, and mechanical) in the fall of 1963. The initial equipment funds required for each engineering technology curriculum are approximately $50,000.00, but it should be emphasized that this is a minimum figure. Many technical courses require expensive laboratory facilities. Also, as in medicine and dentistry, this equipment must be kept abreast as the state of the art progresses.

Due to the relative high cost for equipment and the lack of storage area, the branch colleges were hesitant in offering any engineering technology courses. They did offer English, physics, mathematics, and other courses that were of the lecture type only. Discussions on technical education with the Director of Continuing Education and the branch directors over a period of two years failed to bring any solution, until the idea of a mobile laboratory unit was presented. The directors were most enthusiastic with a project of this nature and promised their full support and cooperation.

Since the civil, electronic, and mechanical curriculum each contain the GT 170 Applied Electricity course, this course was the logical one to be offered with the use of a mobile laboratory.

Originally, the Mobile Laboratory Facility plan consisted of a pilot or experimental program, with very little consideration given to research. Public school systems have for some time used portable-type classrooms and, although not necessarily desirable from several aspects, they have solved over-crowding problems. Of course, with time these units are usually replaced by permanent type facilities, but quality education has not been questioned.

With a portable classroom or laboratory on wheels, several educational institutions may be serviced each day or week, but the primary purpose of this study was to determine the differential net effects of teaching applied electricity with a mobile laboratory facility.

Procedure:

A 40-passenger military bus was obtained from the surplus equipment office in Santa Fe, New Mexico. This unit was selected over other units primarily because of the internal dimensions and the rear double door.

The selection of the electronic, electrical measuring equipment, and the laboratory experiment equipment was made with two major objectives for consideration. The equipment must be identical, for all practical purposes, with the existing equipment at the parent campus, and the equipment must be so designed and constructed to withstand the vibrations and shocks expected during vehicle movement.

A very important factor in the selection of the mobile unit and the test equipment was to design a compatable safe unit. An improperly designed unit could expose personnel to a very dangerous electrical hazard.

Instructors for this program were selected to minimize a variable that is difficult to measure. By requiring a Master's degree, with at least one degree in the electrical-electronics area and considerable electronics experience for qualifications, it was assumed that the instructor's ability would not be an intervening variable.

Planning sessions were held with all instructors and supervisors prior to program initiation and during the grant period. Each participant, excluding students, was informed of the purpose and the scope of the program.

The time schedule for the operation consisted of the facility preparation and instructor orientation period, followed by a two semester operational period.

Since this plan did not involve the movement of the instructor with the facility, three instructors comprised the operational staff; they were located at the Carlsbad branch, the Alamogordo branch, and at the parent campus.

The applied electricity course was offered in the fall of '66 in the permanent facility at New Mexico State University, and the mobile unit was used for the course offering at Carlsbad and Alamogordo.

A transportation company at Alamogordo moved the mobile facility each week between Carlsbad and Alamogordo. This distance is approximately 140 miles, and the route of travel was along a twisting, paved highway through the Sacramento Mountains. The strain of climbing the mountains was too much for the engine, and the one fear for the project -- engine failure -- occurred. The impossible was accomplished in a few days and the unit resumed the weekly trips.

Outside of the one engine failure, the unit operated satisfactorily for the entire semester. Mother Nature cooperated for the semester by snowing only during non-travel days, and by keeping the ambient temperature above the critical one for the small electrical heater used in the facility.

A final exam (see Appendix C) was given to each student at Carlsbad, Alamogordo, and at the parent campus during the final exam week in late January, 1967. The exams were forwarded to the New Mexico State University campus for grading and evaluation.

Each branch college instructor provided suggestions at this time for operational improvement. Since the suggestions were minor and included only instrument placement and storage in the facility, they were deferred for consideration.

Plans for the 1967 spring semester were identical with the preceding semester, with the Alamogordo and Carlsbad branches to participate as before. Future operations for the project included the possible use of the facility at the White Sands Missile Range in the summer of 1967, and at the Farmington branch for the 1967 fall semester.

The unit was designed for a maximum of 16 students, with two people at each of the eight work stations.

Enrollment figures for the applied electricity course at Alamogordo in the spring of 1967 did not warrant the course offering, but the course was offered, with the research of the mobile facility continued, at the Carlsbad branch. The summer program at White Sands Missile Range was not offered. This equipment was utilized during the 1967 fall semester at Carlsbad, although this report does not reflect data for this period.

Results and Conclusions:

It had been assumed that one reason for students previously entering other areas of education upon leaving the Branch Colleges, could possibly be the lack of engineering type laboratory experience. At the completion of this study only 6 per cent of the branch student participants had transferred to other institutions. Although these students have entered engineering programs, the numbers at this time are not significant.

A major portion of this study was made to determine the proficiency of the mobile facility students as compared to their counterparts on the parent campus.

For the fall semester 1966, through the analysis of co-variance technique, it was found that no significant differences were found between the final achievement test scores of students using a permanent laboratory and for students using the mobile facility. However, for the additional study period it was found that the final achievement scores of permanent laboratory students were significantly higher than the final achievement scores of the mobile facility students.

One could conclude that, possibly, with more students available for participant selection and by using one instructor, meaningful variables could have been minimized.

To compare the costs for an educational course as offered in a mobile facility and in a permanent facility, one would have to consider the initial cost for the facilities, maintenance, depreciation, distance for mobile unit movement, and the use factor (the number of hours per day of actual use).

The comparative cost ratio for a new bus type mobile unit and a permanent facility would be in the order of four or five to one, and a cost ratio of two or three to one would be expected by using a mobile house-trailer type facility.

With permanent type facilities unavailable, with equipment funds at a minimum, and with a low use factor, it can be reported that for this study the mobile facility was most economical.

Mobile instructional facilities will be used to initiate programs, to offer workshops, and to serve some school districts with a permanent program. At this time, the unit for this study is being used in Northern New Mexico. High school type electronic instructional equipment was installed in the unit, and with one instructor, also acting as the driver, the facility moves 20 miles each day between Mosquero and Roy. Another unit is operating in the Estancia, Mountainair, and Moriarity school districts.

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PROBLEM

The rapid growth and critical needs of technical education in New Mexico pose an unprecedented challenge to educators of the state. These educators must cope with increasing demand for graduates, a constantly changing technology, sizable capital outlay for equipment (which will soon become obsolete), and restrictions on classroom space caused by stationary laboratory equipment which is not used throughout the school day or school year. At the same time, the educators have an obligation to provide the students with the most realistic and meaningful experience, utilizing the best training equipment obtainable.

With full realization that this same set of circumstances faces vocational and technical education in many parts of the country, facilities, techniques, and procedures must be devised to adapt whatever resources and facilities might be obtainable to make them more flexible and to increase their student capacity. Hopefully, these demands can be met without undue additional expense or dissipation of educational standards.

Administrators at New Mexico State University are acutely aware of the above mentioned problems. New Mexico State University is the parent institution for three branch colleges, located at Alamogordo, Carlsbad, and Farmington. These branch colleges did depend upon full cooperation with the public schools of the towns in which they are located. Without this cooperation, the branch schools would not have access to physical facilities, for there was not enough available revenue (until this past year) to meet the critical needs of the rapidly growing parent institution and to develop physical plants at the branch colleges. A new plant has been completed at Carlsbad.

Especially hampered was the development of programs at these branch centers which required laboratory experiences that did not conform to the existing facilities. As mentioned above, there was a heavy dependence on classroom space provided by the local public schools. Obviously, these public schools do not have adequate laboratory facilities for college level and technical courses unless such courses are included in the secondary curriculum. (In the case of engineering technology, no secondary school has such curricula offering). Furthermore, these public schools did not have adequate space for storing such laboratory equipment if it were made available by New Mexico State University.

The implications mentioned above are quite critical for the engineering technology program at New Mexico State University. In keeping with the designed purposes of the branch schools, the students of these schools should be able to enjoy quality educational experiences near their homes and subsequently transfer these experiences, without discount, to other institutions for further educational effort. By conducting a pilot-experimental program using a mobile unit, the administration wished to design a program that would offer an educationally sound, economically feasible curriculum.

OBJECTIVE

The Department of Engineering Technology offers three separate areas of specialization -- civil engineering technology, electronic engineering technology, and mechanical engineering technology. The programs are concerned with the training of the engineering technician in planning, testing, operating, and servicing devices designed and developed by scientists and engineers.

Although these programs are two years in length, they have a common curriculum for the first year. The second year of activity, in which a specialty is developed, is conducted on the campus at New Mexico State. (See Engineering Technology Curricula, Appendix A.)

It is within the context that the Engineering Technology Department conducted an experimental pilot project to determine the economic and educational feasibility of a mobile facility for the instruction of an applied electricity course at the branch colleges.

The purpose of the study was to determine the differential net effects of teaching applied electricity with mobile laboratory facilities. Three salient questions were considered worthy of consideration in this study:

1. Is there a higher incidence of curricular program change in the groups of students who take the course which utilizes the mobile laboratory?
2. Do the students who take the applied electricity course in the mobile facility demonstrate comparable proficiency?
3. Is there a difference in weighted educational expenditures?

PROCEDURE

The study was considered as being comprised of five phases, which included (1) acquisition of equipment, (2) orientation and planning by the instructional staff, (3) conducting the training programs, (4) making the comparative evaluations, and (5) interpreting and reporting the results.

Acquisition of Equipment

A surplus bus with inside dimensions of 7 1/2 ft. wide, 30 ft. long, and

6 1/2 ft. high, and double rear doors, was selected as a unit with the most potential for the mobile facility (see Appendix B). Enclosed vans were also considered as an alternative. Within approximately 6 weeks after the 1 June 1966 grant period initiation date, the Physical Plant Department of New Mexico State University had completed the facility remodeling. Work benches, instrument shelves, fluorescent lighting of 70 footcandles, and 115 volt AC electrical outlets were installed, the engine was given a minor overhaul, and the unit was painted during this period. The overhead luggage rack of plastic-covered metal link construction was installed as the work bench. Since this gave a somewhat flexible table, it was ideal for dampening vibrations during transportation periods.

Adequate space was provided for 16 students in the unit with 8 work stations for laboratory practice. For each two students there were provided 18 square feet of work and equipment space, and approximately 24 square feet of floor space.

The equipment and instruments provided for each work station consisted of the following:

TABLE I

WORK STATION EQUIPMENT LIST

1 Knight KG 2000 Lab Oscilloscope	$300.
1 Knight Model KG 625 6" VTVM	54.
1 Simpson VOM Model 270 RT	74.
1 Hewlett Packard Model 200 CD Oscillator	201.
1 Philco Fundamental Lab Circuit Analysis Unit No. 463	225.
1 Heathkit IP-32 Variable Voltage-Regulated Power Supply	58.
2 Kit - electronic technician	20.
Cost per station	$932.
Cost for 8 stations	$7,456.

This equipment was similar and, for most items, identical with the equipment at the parent institution. At the end of each semester all of the instruments were checked and calibrated. Only three fasteners were found loose during the entire grant period. Calibration was minor, and this work did not exceed the expected realignment for regular laboratory equipment.

Shock and vibration to the instruments was held to a minimum by placing all units on the non-rigid type work bench for vehicle movement and securing them with 3/8 inch elastic shock cords. Each cord was terminated with open hooks for ease in fastening.

Orientation and Planning

The orientation and planning phase was held with the participating instructors and the directors of the branch colleges.

Due to a distance of 70 miles between the parent campus and the Alamogordo branch, 140 miles from Alamogordo to Carlsbad, and 210 miles from the parent campus (University Park, Las Cruces) to Carlsbad, three instructors were engaged as the instructional staff.

The instructors' qualifications were scrutinized and interviews were held to select the instructors with abilities suitable for such a program. As a Master's degree, with at least one degree in the electrical-electronics area, and considerable experience were required of the instructional staff, it was assumed that the instructors' abilities would not be an intervening variable.

Each instructor and college administrator were briefed on texts, course outline, and mobile facility schedule. Emphasis was made that the same text would be used and that the course outline must be followed and completed on schedule.

Operation

For the fall semester 1966, starting in September, the program was offered at the two branch colleges and at the parent university, with a weekly schedule as follows:

	Monday	Tuesday	Wednesday	Thursday	Friday
Alamogordo Branch	Theory	Theory	Theory	Mobile Laboratory	
Carlsbad Branch		Theory	Theory	Theory	Mobile Laboratory
NMSU Campus	Theory	Theory	Theory	Permanent Lab. Facility	

Since the instructor did not accompany the mobile laboratory, it was necessary to contract with a transportation company in Alamogordo to move the unit each week. With an organization well experienced in bussing students, this arrangement proved most satisfactory. In fact, only experienced drivers should be used for heavy equipment, and this is most important for surplus equipment. On a particular trip through the Sacramento Mountains, the engine lost an intake valve. An inexperienced driver would probably have not noticed the difference in engine performance; however, the unit was stopped, towed to New Mexico State University, repaired, and put back in operation in only a few days.

A pre-test and post-test (See Appendix D) was given to all participating students at Alamogordo, Carlsbad, and University Park.

Plans were made during the first operational phase (Fall Semester, 1966) to duplicate the procedure for the second phase. However, the enrollment figures at the Alamogordo branch did not justify a class for this period. The same instructors were again used at Carlsbad and University Park, with pre-tests and post-tests being administered to the new participants.

Evaluation

Dr. Richard DeBlassie of the New Mexico State University College of Education, served as a consultant for this project.

The problem was one of attempting to answer the question, do the students who take the applied electricity course at the branch schools demonstrate proficiency comparable to that of students who take the applied electricity course at New Mexico State University, the parent institution.

More specifically, the problem was one of testing which method produced superior results in measured achievement during one semester of instruction: the permanent laboratory method (NMSU campus students), or the mobile laboratory method (NMSU branch college students). The design of the study was a relatively simple one in that the independent variable was the type of laboratory facilities used (permanent vs. mobile), while the dependent variable was an achievement test. Analysis of co-variance was used in that the pre-test (the achievement test administered before instruction began) scores were held constant. This design permitted the testing of the following null hypothesis:

> With pre-test scores held constant, students taught at NMSU using permanent laboratory facilities, did not differ in achievement in Applied Electricity from the students at NMSU branch colleges taught by the mobile laboratory method.

In order to secure necessary data for a statistical test of the null hypothesis, an equivalent set of achievement tests (parallel forms) was constructed by faculty members from the NMSU campus and NMSU branch colleges. The pre-test was administered after instruction had been completed. All of the tests were graded by the principal investigator.

RESULTS AND CONCLUSIONS

Twenty-nine students participated in the first study, with distribution as follows:

NMSU Campus (permanent lab. facility)	....	11
Branch College A (mobile lab. facility)	....	8
Branch College B (mobile lab. facility)	....	10

Table II presents the scores for the students involved in the first study. Only those students with pre- and post-test results were used in the study.

TABLE II

TEST SCORES OF TWENTY-NINE STUDENTS

BRANCH COLLEGE A N = 8		BRANCH COLLEGE B N = 10		NMSU N = 11	
X_1	Y_1	X_2	Y_2	X_3	Y_3
32	56	10	26	2	38
24	38	6	21	8	20
29	57	11	24	8	23
13	31	13	16	14	35
40	59	11	42	6	59
9	39	5	54	11	33
33	55	6	30	13	37
35	64	10	46	14	30
		7	17	18	32
		7	27	5	23
				6	47

X = pre-test
Y = post-test

For all three groups

$\Sigma X = 406$ $\Sigma Y = 1079$

$\Sigma X^2 = 8486$ $\Sigma Y^2 = 45775$

$\Sigma XY = 17565$

The data in Table II were used to obtain the sums of squares, or SS's, which appear in the Analysis of Co-Variance, Table III.

TABLE III

ANALYSIS OF CO-VARIANCE FOR 29 STUDENTS

Source of Variation	df	SSx	SSy	SSxy	SSy.x	Vy.x(M.S.)
Among Means	2	1836.	1855.61	1821.57	175.04	87.52
Within Groups	25	1126.	3773.15	637.43	3412.31	136.49

$$Fy.x = \frac{87.52}{136.49} = .64$$

F at .05 level = 3.38

F at .01 level = 5.57

∴ F = .64 is not significant

Table IV presents the scores for those students who participated in the second study.

TABLE IV

SCORES OF TWENTY STUDENTS

NMSU (N = 13)		BRANCH COLLEGE (N = 7)	
X_1	Y_1	X_2	Y_2
22	48	11	32
38	66	7	40
16	37	8	46
15	48	7	30
17	44	8	23
23	63	6	19
9	43	13	31
14	61		
9	58		
18	51		
22	52		
17	71		
6	36		

X = pre-test

Y = post-test

For the two groups

$\Sigma X = 286$ $\Sigma Y = 899$

$\Sigma X^2 = 5270$ $\Sigma Y^2 = 44305$

$\Sigma XY = 14232$

The data in Table IV were used to determine whether or not a variation in laboratory facilities would influence the proficiency of students at NMSU and the branch college in an applied electricity course. These data were used to obtain the sums of squares, or SS's, which appear in the Analysis of Co-Variance Table V.

TABLE V

ANALYSIS OF CO-VARIANCE FOR 20 STUDENTS

Source of Variation	df	SSx	SSy	SSxy	SSy.x	Vy.x(M.S.)
Among Means	1	353.92	1927.53	825.34	689.92	689.92
Within Groups	17	826.28	1967.42	550.96	1600.05	95.06

$$Fy.x = \frac{689.92}{95.06} = 7.26$$

F at .05 level = 4.45

F at .01 level = 8.40

∴ F = 7.26 is significant at the .05 level.

Through the analysis of co-variance techniques, it was found, for the first operational period, that no significant differences were found between the final achievement test scores of students at the NMSU campus using a permanent laboratory facility and students at NMSU branch colleges using the mobile laboratory facility with pre-test scores held constant. This technique (analysis of co-variance) permitted the investigators (the researchers involved in the study) to assume equality of groups initially.

On the basis of the statistical results, for the first group, it would seem reasonable to infer that the students at the branch colleges are comparable in proficiency in applied electricity to students on the NMSU campus. From this, one could surmise that the mobile laboratory facility used with students at the branch schools is just as effective as the permanent laboratory facility used on the NMSU campus. However, from the analysis of co-variance for the second operational period, it can be inferred that the final achievement scores of students at the NMSU campus are significantly higher than the final achievement scores of the branch college students, and it would seem reasonable to infer that the permanent laboratory facility makes for better proficiency in applied electricity than does the mobile laboratory facility.

It is possible to conclude that, probably, with more students available for participant selection, and by using one instructor for both the permanent and mobile facilities, meaningful variables could be minimized. However, due to low enrollments and distances between colleges, this was an impossibility.

Although there are many reports covering vocational and technical educational expenditures for the nation and individual states, the ERIC organization in Ohio reports that they do not have any information regarding the unit cost for a technical education program or course.

For the study, the mobile facility expenditures were as follows:

Operational Costs The operational costs for a mobile facility using a U. S. Government surplus bus designed for 16 students included maintenance, transportation, and supplies, but not instructor's salary.	50 cents per mile
Modification Costs	$1000.
Equipment Costs	$7456.

The comparative cost ratio for a new bus type mobile unit and a permanent facility would be in the order of four or five to one. The higher cost for the mobile unit is due primarily to mobile unit depreciation figures.

The comparative cost ratio could be improved for a mobile unit to the order of two or three to one by using a mobile house-trailer type facility. For mobile facilities to be used at one location for at least one week or longer, this type unit would be most logical.

Many students who had initially attended the branch colleges entered other areas of educational effort once they were on the campus at NMSU. It had been assumed that this attrition was caused largely by the lack of interesting laboratory experience at the branch colleges. As a part of this study, a survey was made on those students who utilized the mobile laboratory to determine their present major. At the completion of this study only 6 per cent of the branch student participants had transferred to other institutions. Although these students are enrolled in engineering programs, the numbers are not significant to complete the study at this time.

Mobile instructional facilities will be used to initiate programs, to offer workshops, and to serve some school districts with a permanent program. At this time, the unit for this study is being used for high schools in Northern New Mexico, and another unit is operating in Central New Mexico. The

State Supervisor of Trade and Industrial Education reports that student interest has been excellent, and the School Superintendents are amazed at the progress in learning. They also report that their spring registration for next fall indicates over twice the number of requests that could be accepted. Parents, faculty, and students have given full support to the program at Mosquero, New Mexico, and have indicated to the School Superintendent that they feel it is one of the best programs made available recently.

LIST OF APPENDICES

APPENDIX A

NEW MEXICO STATE UNIVERSITY
ENGINEERING TECHNOLOGY CURRICULA

First Year

Common to All Curricula

First Semester

Math	105	Technical Math I	4
Chem	110	Chem. in Our Times (3-3P)	4
ME	105	Engineering Graphics (1-4)	3
Eng	101	Freshman Composition	3
GT	160	Industrial Organization	3
GT	101	Intro. to Technology	1
			18

Second Semester

Math	106	Technical Math II	5
Phys	110	Intro. to Physics	4
Eng	105	Report Writing	2
GT	170	Applied Electricity I(3-3P)	4
MECH. & ELECT. TECH. ONLY:			
GT	115	Industrial Processes I(1-3P)	2
CIVIL TECH. ONLY:			
CE	222	Plane Surveying (1-3P)	2
			17

Second Year - Civil Technology

Third Semester

GT	230	Applied Mechanics (4-3P)	5
Econ	161	Economic Geography	3
CT	206	Detailing I (1-6P)	3
CT	252	Applied Surveying (2-8P)	5
GT	262	Engr. Materials (1-3P)	2
			18

Fourth Semester

Govt	201	Intro. to Political Science	3
Spch	253	Public Speaking	2
GT	115	Industrial Processes I(1-3P)	2
CT	254	Specifications, Estimating & Construction Tech (3-3P)	4
CT	256	Detailing II (2-3P)	3
CT	258	Water Technology (2-3P)	3
			17

Second Year - Electronic Technology

Third Semester

GT	230	Applied Mechanics (4-3P)	5
Econ	161	Economic Geography	3
ET	224	Circuit Theory (3-6P)	5
ET	272	Electronic Circuits (3-6P)	5
			18

Fourth Semester

Govt	201	Intro. to Political Science	3
Spch	253	Public Speaking	2
GT	268	Control Systems (3-3P)	4
ET	274	Electrical Machines (3-3P)	4
ET	276	Electronic Comm. (3-3P)	4
			17

Second Year - Mechanical Technology

Third Semester

GT	230	Applied Mechanics (4-3P)	5
Econ	161	Economic Geography	3
MT	240	Mech. Detailing I (2-6P)	4
MT	241	Ind. Processes II (2-3P)	3
GT	262	Engr. Materials (1-3P)	2
			17

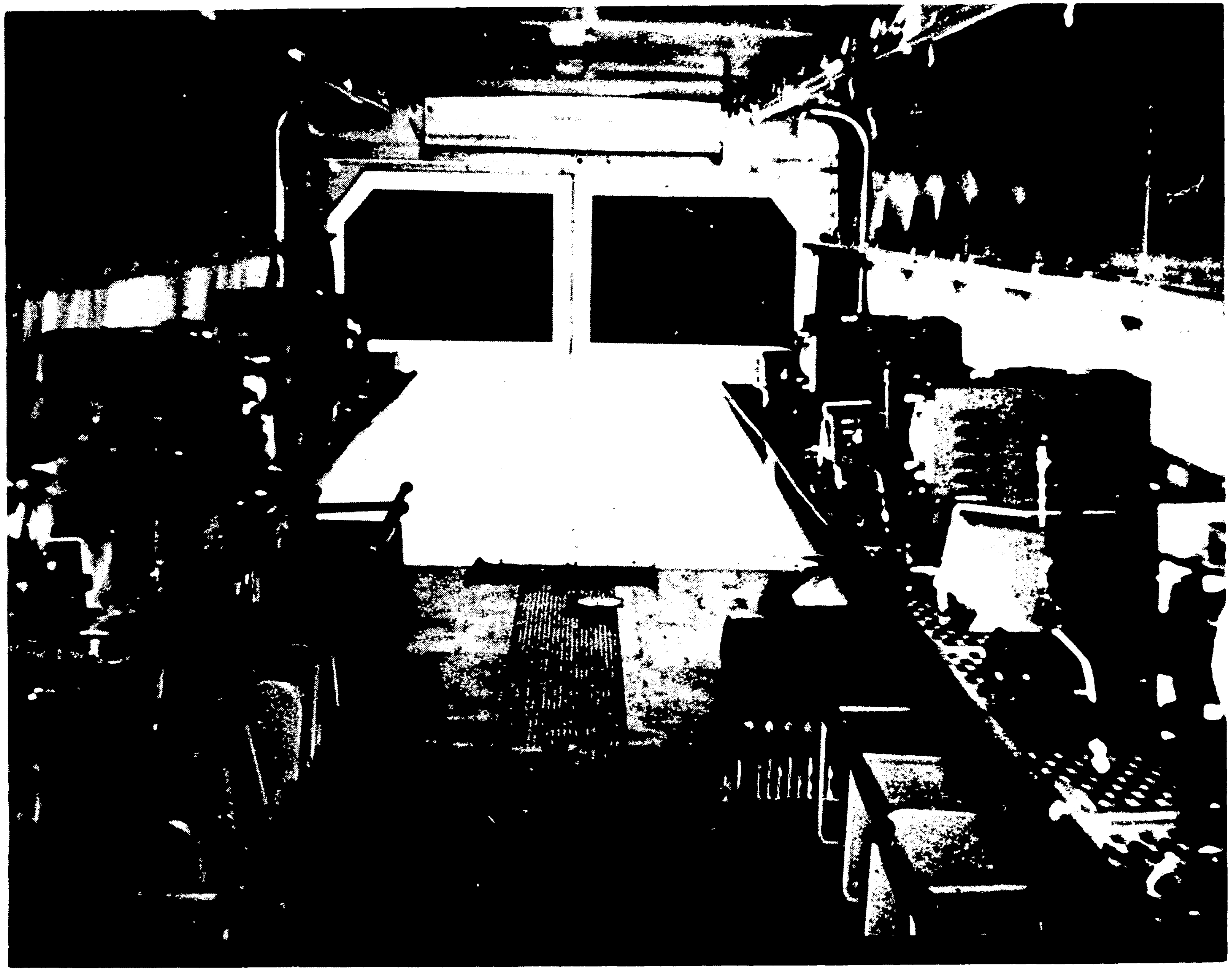
Fourth Semester

Govt	201	Intro. to Political Science	3
Spch	253	Public Speaking	2
GT	268	Control Systems (3-3P)	4
MT	294	Thermal Power (3-3P)	4
MT	296	Mech. Detailing II (1-3P)	2
MT	298	Fluid Technology (2-3P)	3
			18

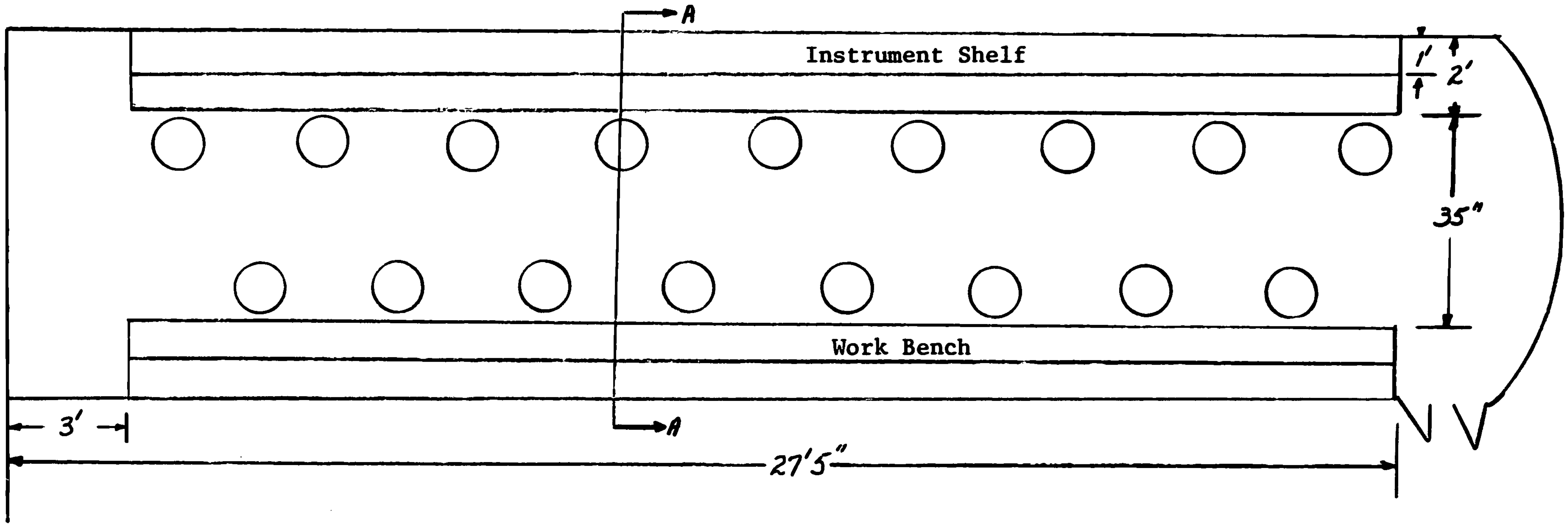
APPENDIX B

NMSU Mobile Instructional Facility, Before renovation

NMSU Mobile Instructional Facility, After renovation



NMSU Mobile Instructional Facility, showing interior arrangement



NMSU Mobile Instructional Facility Work Station Layout

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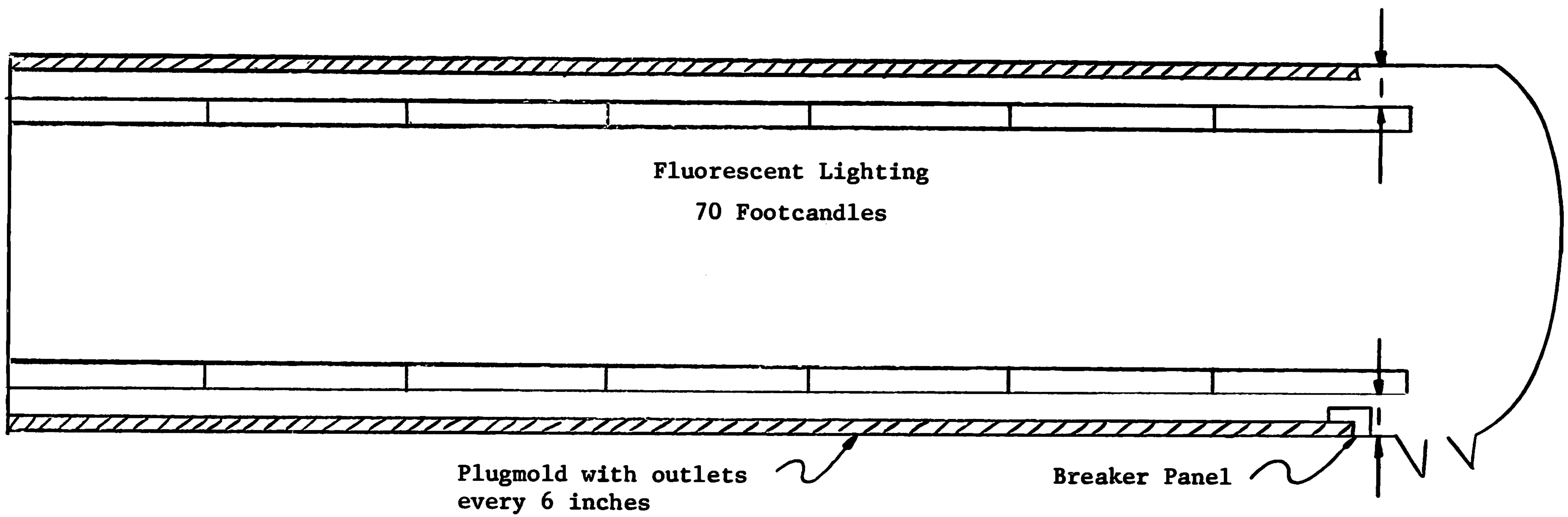

NMSU Mobile Instructional Facility Electrical Layout

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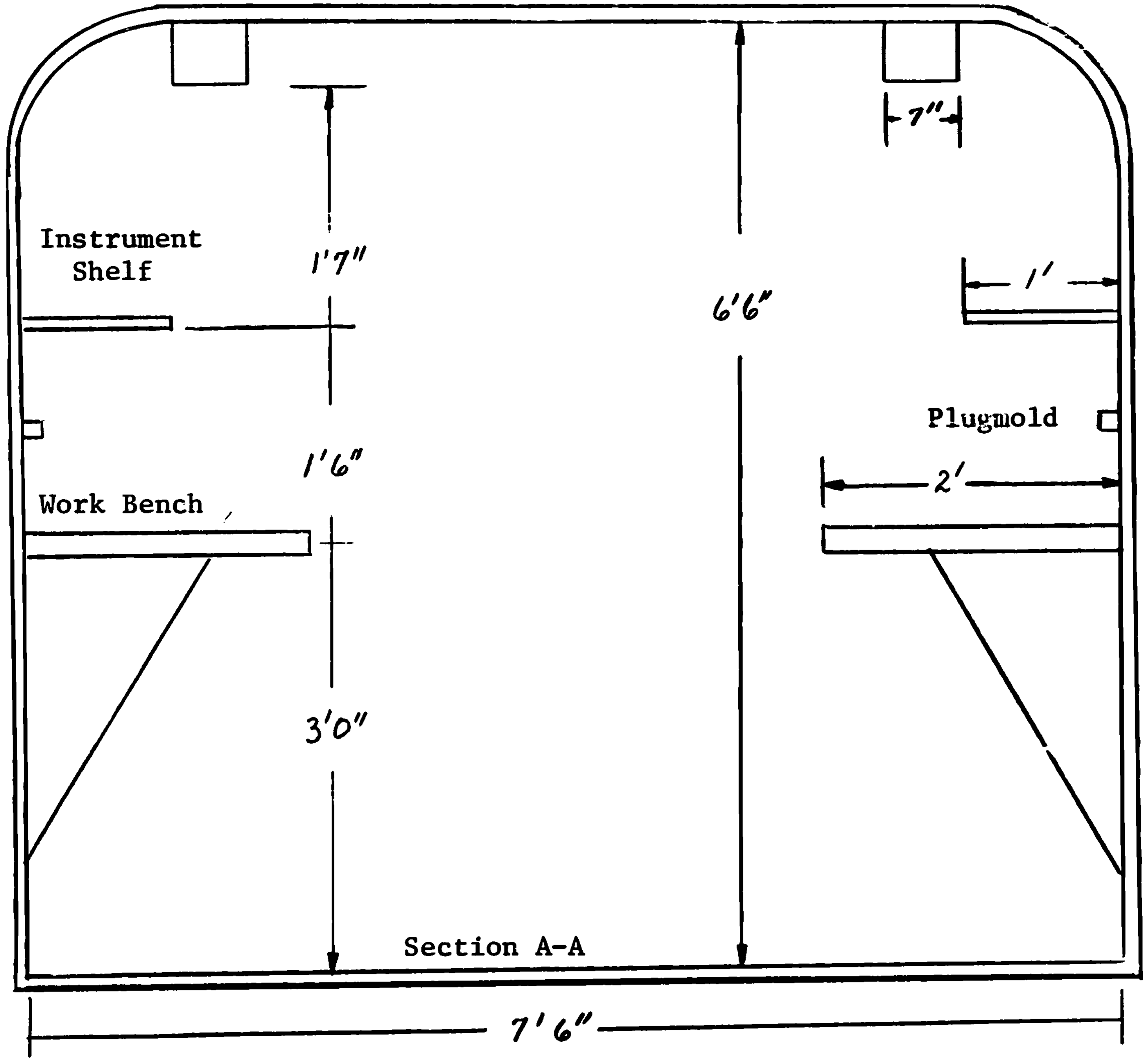

NMSU Mobile Instructional Facility Section
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APPENDIX C

APPENDIX C

COURSE OUTLINE

APPLIED ELECTRICITY I

GT 170 — 4 credits (3-3P)

Test: Introduction to Electric Circuits. Second Ed. Pub. 1965 Prentice Hall

Period		Material	Lab
1 week	(1	Introduction	
	(2	Current & Voltage Art. 1-5	#1 Resistor Color Code
	(3	Current & Voltage Art. 6-10	
2 week	(4	Resistance Art. 1-4	
	(5	Resistance Art. 5-9	#2 Color Code & Series Hookup
	(6	Hour Exam. #1	
3 week	(7	Energy & Work Art. 1-2	
	(8	Energy & Work Art. 3-7	#3 Hookup of Parallel Circuits
	(9	Hour Exam. #2	
4 week	(10	Series & Parallel Resistance Art. 1-2	
	(11	Series & Parallel Resistance Art. 4-8	#4 Series Parallel Circuit Hookup
	(12	Series & Parallel Resistance Art. 9-11	
5 week	(13	Hour Exam. #3	
	(14	Magnetic Circuits Art. 1-7	#5 Ammeter & Volt Meter Hookup & Reading
	(15	Magnetic Circuits Art. 8-15	
6 week	(16	Magnetic Circuits Art. 16-20	
	(17	Magnetic Circuits Art. 21-24	#6 Ohmmeter & Multimeter Reading & Hookups
	(18	Hour Exam. #4	
7 week	(19	Electrical Measurement	#7 Magnetic Fundamentals, Electro Magnetism, Self Inductance, Mutual Inductance
	(20	Resistance Measurement	
	(21	Ammeter	
8 week	(22	Voltmeter	#8 Basic Ammeter Basic Voltmeter Basic Ohmmeters
	(23	Inductance	
	(24	Inductance	
9 week	(25	Inductance	#9 DC & AC Fundamentals Introduction to Vectors A-C Voltage Measurements
	(26	Inductance	
	(27	Capacitance	
10 week	(28	Capacitance	#10 Inductive Reactance Series & Parallel L - R Circuits
	(29	Capacitance	
	(30	Hour Test #5	

Course Outline - Applied Electricity I GT 170 4 credits (3-3P)

Period		Material	Lab
11 week	(31	Alternating Current	#11 Capacitive Reactance Series Parallel R-C Circuits
	(32	Alternating Current	
	(33	Reactance	
12 week	(34	Reactance	#12 Series & Parallel R L C Circuits Comparison
	(35	Vector Algebra	
	(36	Vector Algebra	
13 week	(37	Hour Test #6	#13 Series Resonant Circuits Q & Bandwidth
	(38	Power in A.C. Circuits	
	(39	Power in A.C. Circuits	
14 week	(40	Impedance Network	#14 Transformer turn ratio, Impedance Matching & Reflected Impedance, Transformers Types and Application
	(41	Impedance Network	
	(42	Impedance Network	
15 week	(43	Impedance Network	
	(44	Resonance	#15 Final
	(45	Hour Test #7	

APPENDIX D

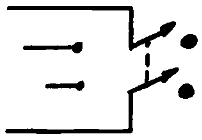
APPENDIX D

SAMPLE TEST

APPLIED ELECTRICITY

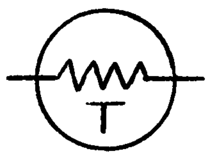
1. What device does each of these symbols represent?

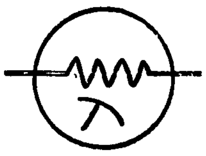
A.  ______________________

B.  ______________________

C.  ______________________

D.  ______________________

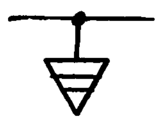
E.  ______________________

F.  ______________________

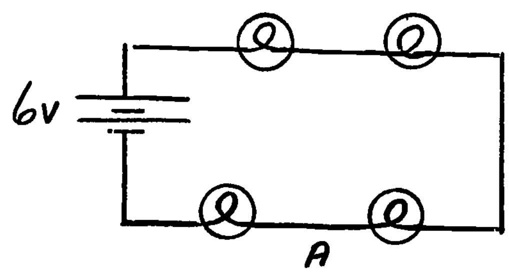
G.  ______________________

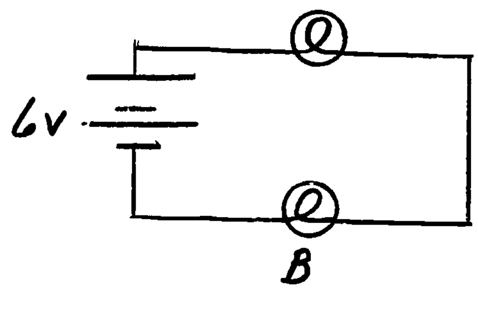
H.  ______________________

I.  ______________________

J.  ______________________

2. A. In which of these two circuits will the bulbs be brighter? A. /_/ B. /_/





B. If maximum current in either circuit is no higher than 50 microamps place the Simpson V.O.M. in the circuit. State how the meter control settings and placement of lead connections are made to record 50 microamps of current. ______________________

____

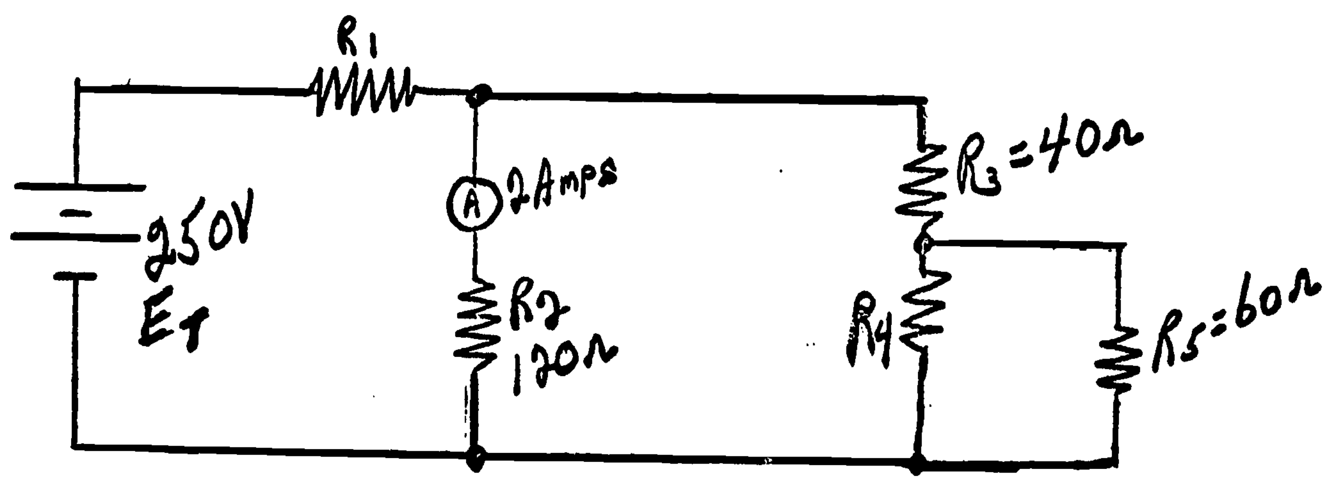
____

____

3. A. What are some of the major differences between the V.T.V.M. and the V.O.M.?

B. Draw up a circuit to use the 50 microamps meter movement of an V.O.M. as a Wheatestone Bridge Circuit. (Explain)

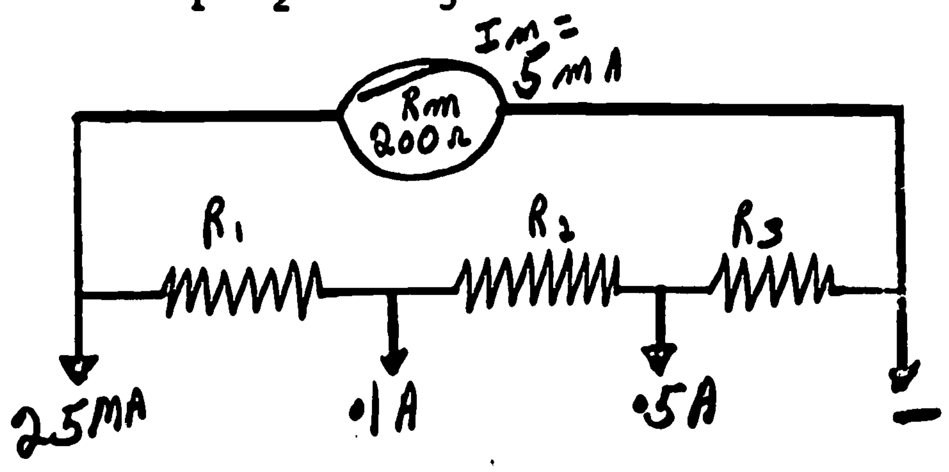
4.



Fill in the Blanks

ET = 250V	IT =	RT =	WT =
E1 =	I1 =	R1 =	W1 =
E2 =	I2 = 2 Amps	R2 = 120	W2 =
E3 =	I3 =	R3 = 40	W3 =
E4 = 120V	I4 =	R4 =	W4 =
E5 =	I5 =	R5 = 60	W5 =

5. Find R_1, R_2, and R_3 for shunt circuit.



I_m = 5 MA.

R_m = 200

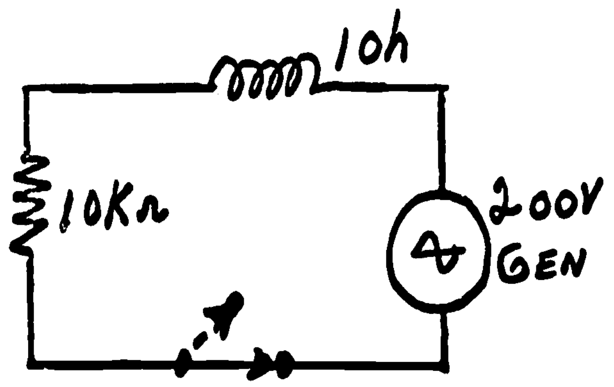
R_1= ____________

R_2= ____________

R_3= ____________

6. In a 2 wire ungrounded A-C 110 volt system how can you tell if two pieces of test gear are hot? Explain method used to check for hot units and also how to remedy the situation.

7.



At the instant the sw. is closed what is the rate of change of current in this circuit?

A. ____________

____

B. How much time will it take for the voltage across the coil to drop to 036.8% of total voltage input?

____

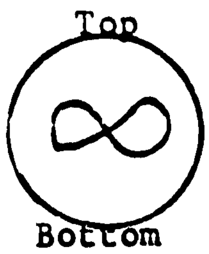
____

C. If the sw. is only closed for 2.5 mil seconds what is the voltage across the resistor?

____

____

8. A. From the given wave shape on the face of a scope what can you tell about it?



A. ______________________________

____

____

B. If the horizontal frequency input is 1 Keps what is the vertical frequency input?

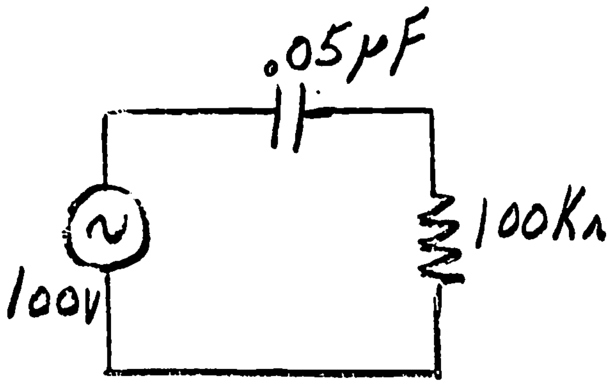
____

____

C. If the vertical input is 5 Keps what is the horizonal frequency input?

____

9.



A. After 20 mil seconds what is the voltage across the resistor?

____

B. After 5 Time constants what is the voltage across the capacitor?

____

10. When reading A-C voltage on a V.T.V.M. do you read A. RMS Values, B. Peak to Peak Voltages, C. Peak Voltage, D. Overage Voltage? (Underline answer or answers).

11. How can one show proof with the use of a scope that frequency has an effect on capacitive reactance or on inductive reactance? Explain method used to show proof. ______________________________

____

____

____

12. A. If the time of a 100 V sine wave is 100 μ seconds long what is its frequency?

______________________________.

B. What is the amplitude of this wave at the end of 8-1/3 μ seconds?

______________________________.

13. A. An A-C line input has 440 RMS. What is peak to peak voltage of this line?

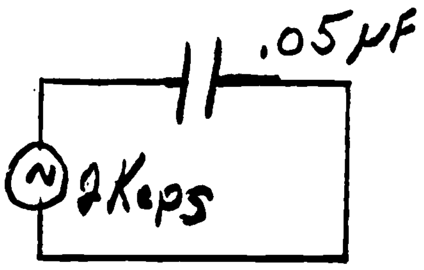
______________________________.

B. If in question A the peak current is in 10 Amps what is the RMS power output?

____

______________________________.

14. A.



From this figure find the capacitive reactance of this circuit?

B. A coil has an inductive reactance of 15,000 Ω. The input frequency is 1 K c.p.s. What is the value of inductance?

15. A solenoid (Relay) having an inductance of 10 h and a resistance of 10 Kohms are connected to a 50V, 400 cps source of Energy.

A. What is the apparent power input to the solenoid?

a. ______________________________.

B. What is true power of the solenoid?

b. ______________________________.

C. What is the power factor of the solenoid?

c. ______________________________.

16. You have 6 heat lamps rated at 300 Watt 60 Volt to be connected to a 120 V; 15 amp source.

A. How would you connect them for proper operation?

____

____

____

____

____.

B. Will this excede the rated load for the source?

____

____

____.

C. Add:

$$40\ V \angle 20^\circ + 50 \angle 60^\circ$$

Answer in polar form = ________________________________.

A laboratory proficiency examination will be given during the final lab period. This exam will cover use of meters, circuitry and components.