Physics

Part 2: C00-415-1042

QUARTERLY TECHNICAL PROGRESS REPORT

October, November, December 1964

DEPARTMENT OF COMPUTER SCIENCE · UNIVERSITY OF ILLINOIS · URBANA, ILLINOIS

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Department of Computer Science
University of Illinois
Urbana, Illinois

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1. CIRCUIT RESEARCH PROGRAM

(Supported in part by the Office of Naval Research under Contract Nonr-1834(15).)

1.1 Summary

The main effort of David Casasent, Michael Faiman and Ed Prozeller was directed towards the realization of the Paramatrix System (dicussed in previous Monthly Progress Reports). This system is based on the use of fast hybrid digital and analog circuitry and the principal goal is the design of a set of circuits capable of 100 ns rise-times which transmit and amplify signals with about 1 per cent accuracy. The set of circuits encompasses gates, gates with current gain, voltage amplifiers, comparison circuits, etc. Since the system has evolved over the last few months, most of Sec. 2 is devoted to the discussion of the systems design. Many of the more important circuits are, however, shown in detail.

Dick Koo designed some experimental gear for his study of the Franz-Keldysh effect and also looked into the theoretical background of absorption edge modulators. At the end of the period several junctions were obtained from Motorola and practical circuits will now be designed.

Chushin Afuso succeeded in building a Hot-Electron OR-Circuit using Guckel's coupled transmission line amplifier. Certain difficulties have, however, arisen because it appears that non-linearities in the characteristic of the Goto-pair cause a hitherto neglected bistable mode of operation.

1.2 Paramatrix System

The block diagram for the paramatrix system is shown in Fig. 1. The clock controls a 5-bit y counter. This 5-bit counter controls in turn an x counter. These counters will be used to scan the matrix. The x counter is stepped up by "1" each time the y counter completes its cycle of 32 steps.

The y control is a 5-bit binary decoder which has the 5 flipflop outputs as inputs and one and only one of the 32 outputs is a one depending on the number in the y counter. The x control is similar.

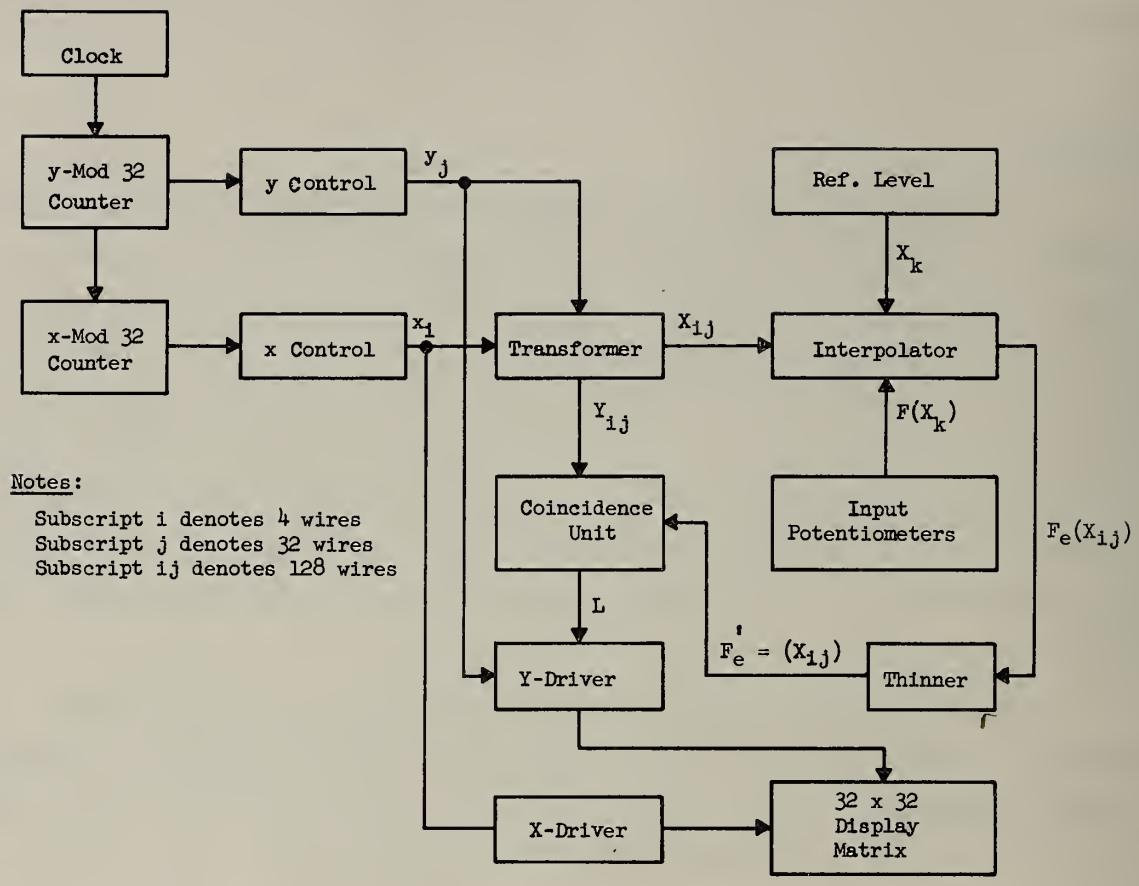


Figure 1. Block Diagram for Paramatrix System

The 32 y control outputs go to 64 diamond gates, and the 32 x control outputs to another 64 diamond gates as shown in Fig. 2. The $\pm$ 8 sin θ and $\pm$ 8 cos θ are obtained from a sine/cosine potentiometer as shown in Fig. 3.

The transformer must form the quantities:

$$X_{ij} = (x_i \cos \theta + y_j \sin \theta + a)m$$

and

$$Y_{ij} = (-x_i \sin \theta + y_j \cos \theta + b)m$$

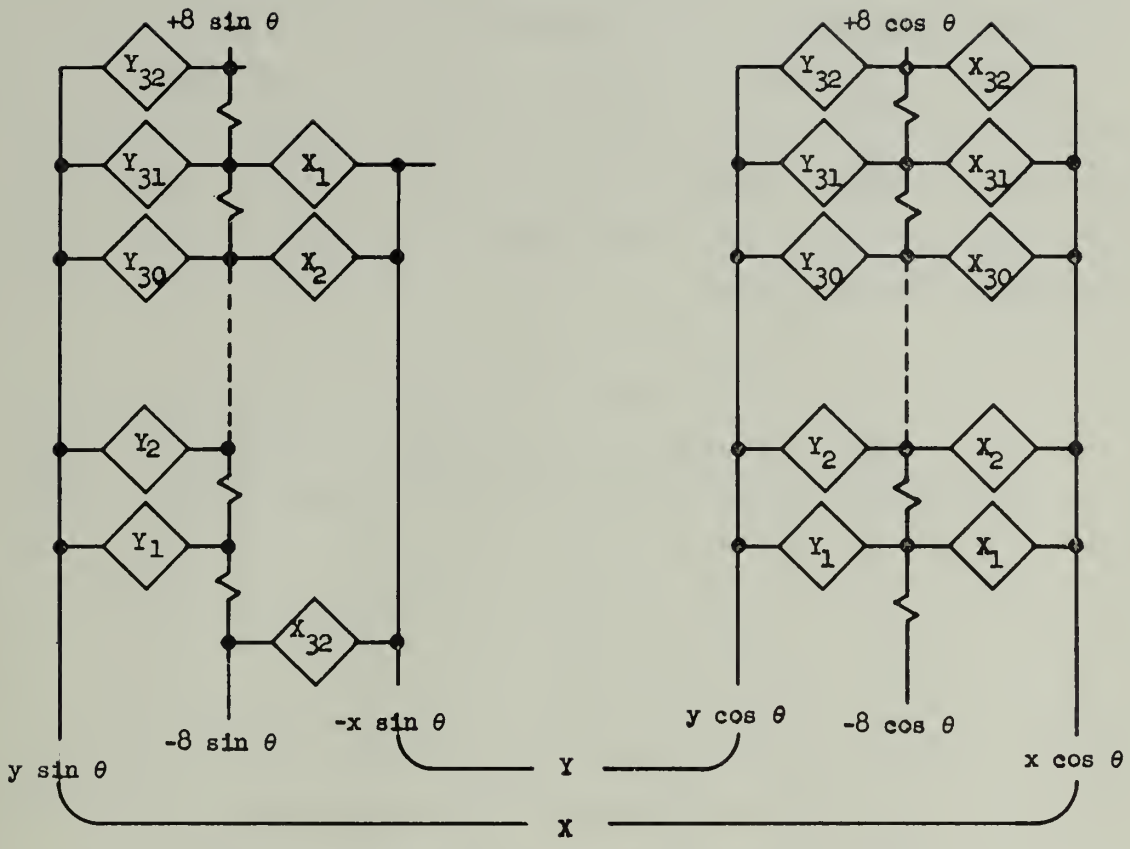
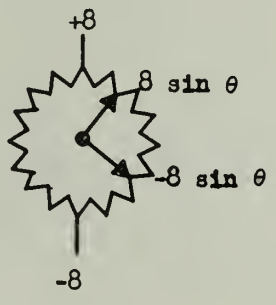
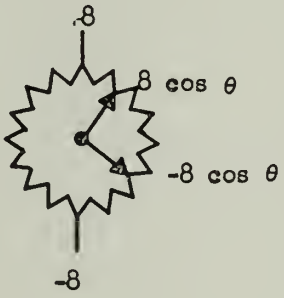


Figure 2. Diamond Gates in Transformer



(a, sin pot to generate ±8 sin θ



(b) cos pot to generate ±8 cos θ

Figure 3.

The arrangement of the diamond gates shown in Fig. 2 makes it possible to form X_{ij} and Y_{ij} by simply adding 2 voltages instead of subtracting two voltages. (These 2 voltages may be positive or negative!)

The voltages $(x_i \cos \theta + y_j \sin \theta + a)$ and $(-x_i \sin \theta + y_j \cos \theta + b)$ are applied to a resistor adder and then to a linear amplifier with variable voltage gain which makes possible the magnification m desired. The X_{ij} output of the transformer, which is the new transformed coordinate value, is the input to the interpolator shown in Fig. 4.

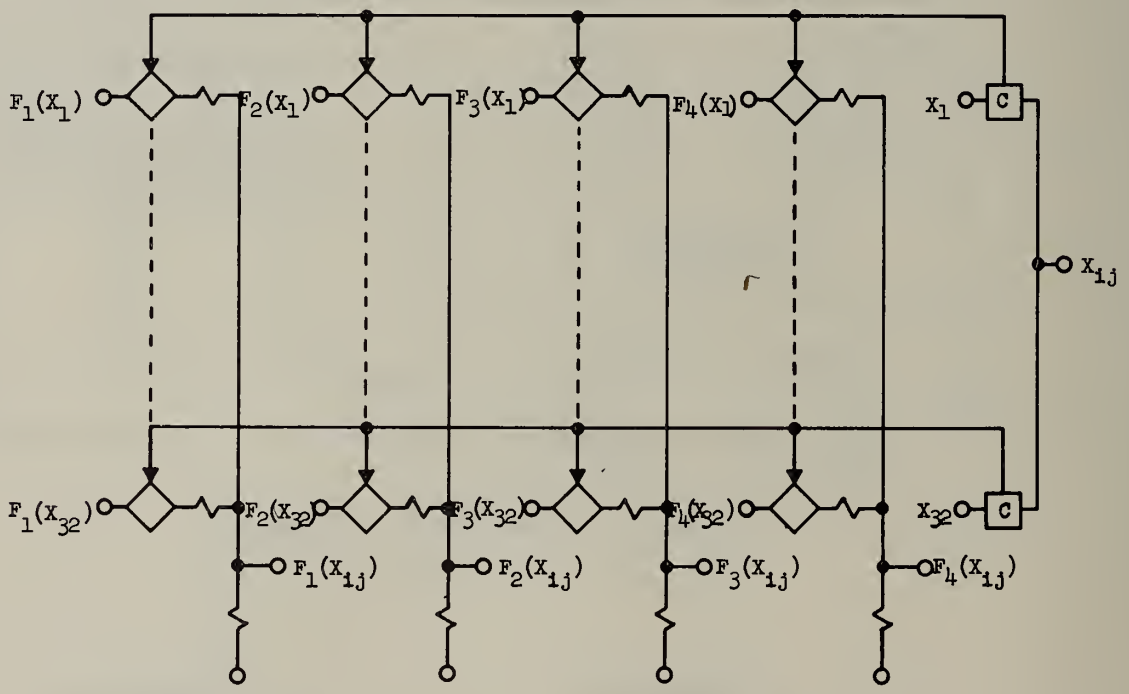


Figure 4. Interpolator with 1 → 4 Outputs

The Interpolator was modified from previous designs in order that thinning of the display on the matrix might be possible. The X_k inputs in the interpolator are the reference levels of the 32 X-lines. These levels have been chosen as -7.5 to +8 v. in 0.5 volt increments. The $F_1(X_k)$, $F_2(X_k)$, $F_3(X_k)$, $F_4(X_k)$ are the voltages that are on the X_k line. Up to 4 voltages have been allowed, corresponding to up to 4 intersections of a line drawing with a parallel

to the Y-axis. The comparison circuits are denoted by C in Fig. 4. At least 1 and at the most 2 of these comparison circuits will have a "one" output. By resistive "mixing" we obtain interpolated values $F_1(X_{ij})$ ... $F_4(X_{ij})$. The 128 potentiometers shown in Fig. 1 as inputs are the $F_e(X_k)$ where k = 1 ... 32, e = 1 ... 4.

The thinner circuit produces from 1 to 4 "thinned" voltage levels. This thinner will contract from 1 to 4 voltage levels into 1 depending upon how close together they are: This improves the definition of the display on the matrix by thinning thick lines. This circuit is still in the development stage.

The coincidence unit consists of 4 comparator circuits and an OR circuit as shown in Fig. 5. The comparator circuit itself is shown in Fig. 6. One comparator input is the Y_{ij} output from the transformer, the other input is one of the 4 possible thinned voltages $F_e'(X_{ij})$. The output of the comparator will be a "1" if the 2 input voltages are within the desired margin. The sensitivity of the comparator is controlled by the voltage E: As E swings from +11 v to +22 v, the sensitivity varies from 0.2 volts to 2.5 volts. The ORed output of the 4 coincidence circuits drives the "light matrix point x_i, y_j" line denoted by L in Figs. 1 and 5.

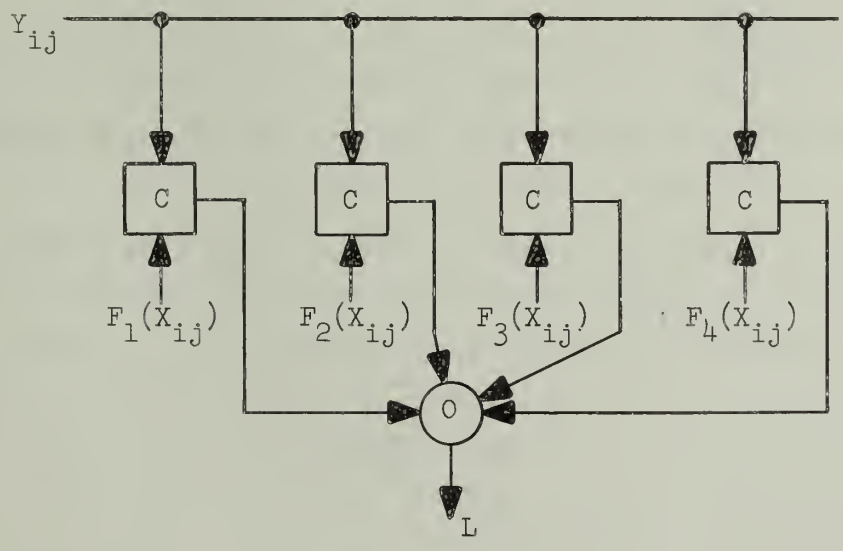


Figure 5. Coincidence Unit

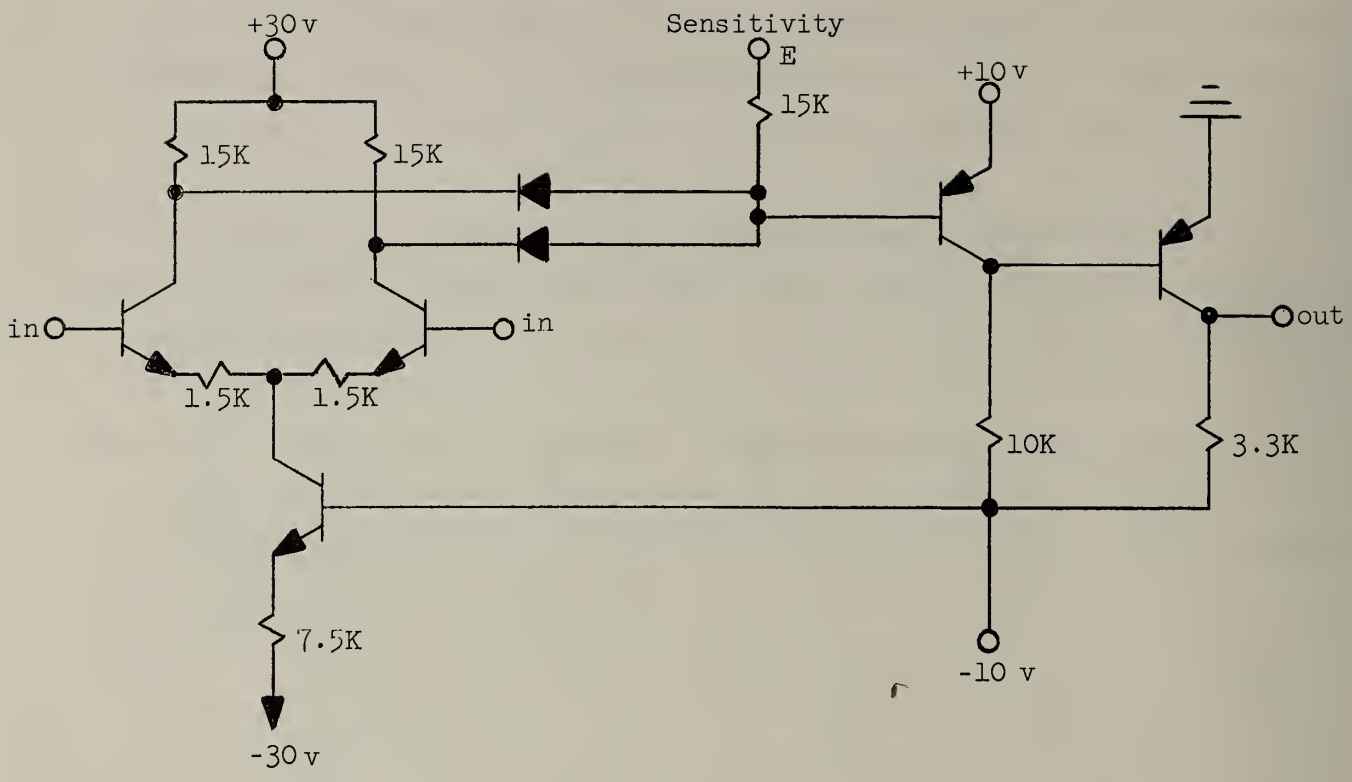


Figure 6. Comparator Circuit

The 32 comparison circuits present in the interpolator of Fig. 4 are of the same design. Their sensitivity will be set to 0.25 volts, the voltage difference between coordinates being 0.50 volts. In all cases the inputs to the comparator will be in the range of -9 volts to +9 volts.

The L output of the coincidence unit goes into 32 AND gates whose other inputs are the 32 y_j's, only one of which will be a "1". These outputs and the 32 outputs of the x-control go to the flipflops on the matrix. One such flipflop is shown in Fig. 7. If the 2 inputs, (y_j, x_j), are both 1, the lamp at that point will be activated. The lamp requires 15 volts and at the most draws about 17 ma. Thus a current driver is needed to drive the collectors of the flipflop. This problem is being investigated.

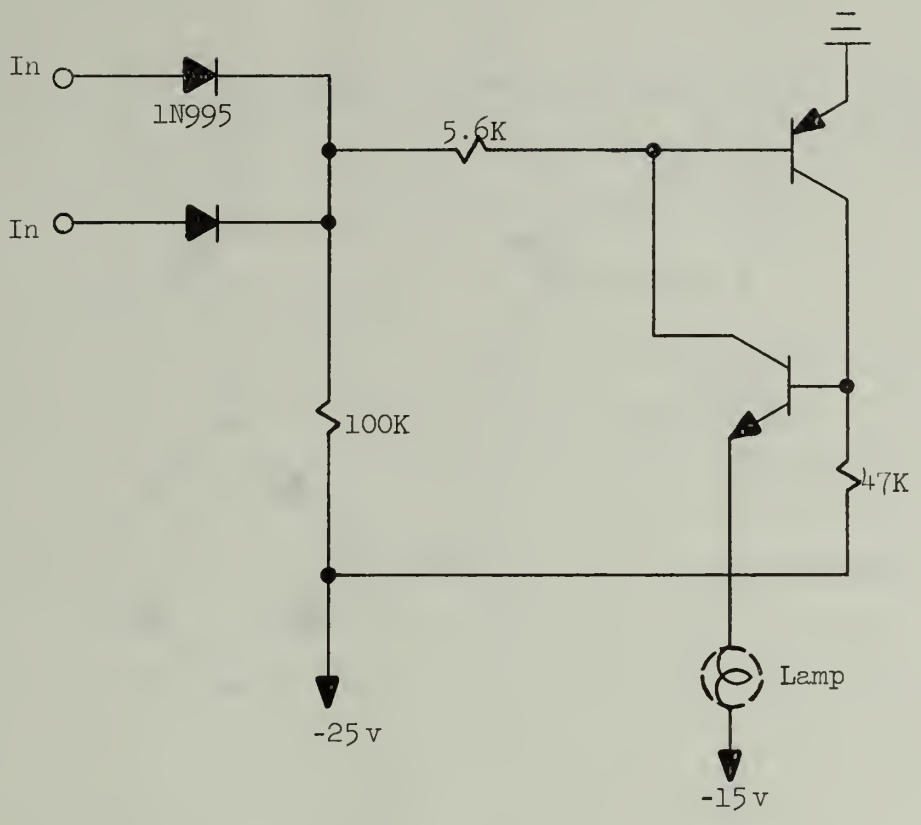


Figure 7. Matrix Flipflop

The diamond gate used in Fig. 2 and 4 is shown in Fig. 8. The input levels to the gate vary as its application in the systems varies: For the transformer the "gate-signal" is the y_j or x_i signal from the y-control or the x-control. These signals come from NOR circuits whose output levels are .0 v. for "1" and -5 v. for "0". This is sufficient to operate the built-in difference amplifier: With "gate" at ground the output equals the input.

The figure to be represented will be a line drawing. Initially, potentiometers will be employed to set the various voltages necessary to represent the line drawing: Given 32 levels X_k we shall "dial in" 128 levels $F_e(X_k)$.

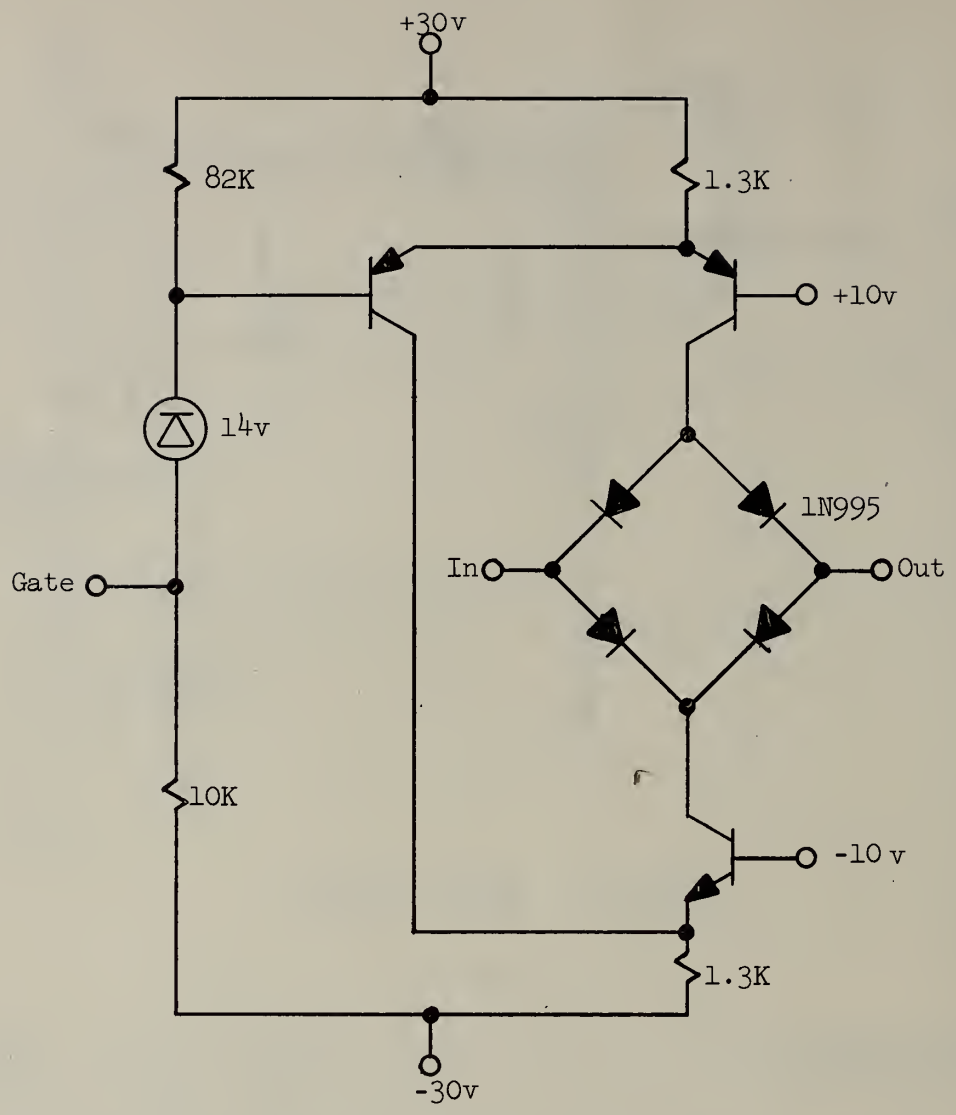


Figure 8. Diamond Gate

1.3 Light Modulation

1.3.1 General Comments

In order to use a light beam as the carrier of information it is necessary to develop fast modulator systems. Two different methods of amplitude modulating a beam in the infrared region have been proposed by different authors. One [1] is sending the infrared beam through a germanium prismatoid so that the beam is reflected internally several times. The beam intensity becomes modulated if the space charge layer along the reflecting surfaces are changed by means of an external electric field. The other one, proposed by A. Frova, P. Handler [2] and G. Racette [3] takes advantage of the Franz-Keldysh effect by sending the beam perpendicularly through a thin p-n junction. The absorption coefficient at

the junction will be changed when the reverse bias voltage on the junction is modified. The latter method appears more promising because the modulation can be as high as 90 per cent if the conditions are properly chosen.

1.3.2 Theory of the Franz-Keldysh Effect

In 1958, W. Franz [4] and L. V. Keldysh [5] theoretically predicted that the absorption edge of an intrinsic non-conducting crystal will be shifted if an external field is applied. A complete theory of the changing of absorption coefficient as a result of the external field has been derived by D. S. Bulyanitsa[6].

A physical picture of such a phenomena can be given by using a conventional one dimensional energy band diagram of an insulator as shown in Fig. 9. The tilt of the band is due to the external field $\vec{E}$. An electron in the filled band at point A has available to it states of the same energy in the conduction band but spatially to the right of B. Free electrons moving from A to B are prevented from reaching B by the potential barrier. But there is a finite electron density at a point such as D in the forbidden band due to tunneling or more precisely the "tail" of the distribution. Light may be absorbed by such electron and the transition from the forbidden band into conduction band accomplished. A quantitative analysis can be achieved by considering both interband transitions and forbidden band transitions.

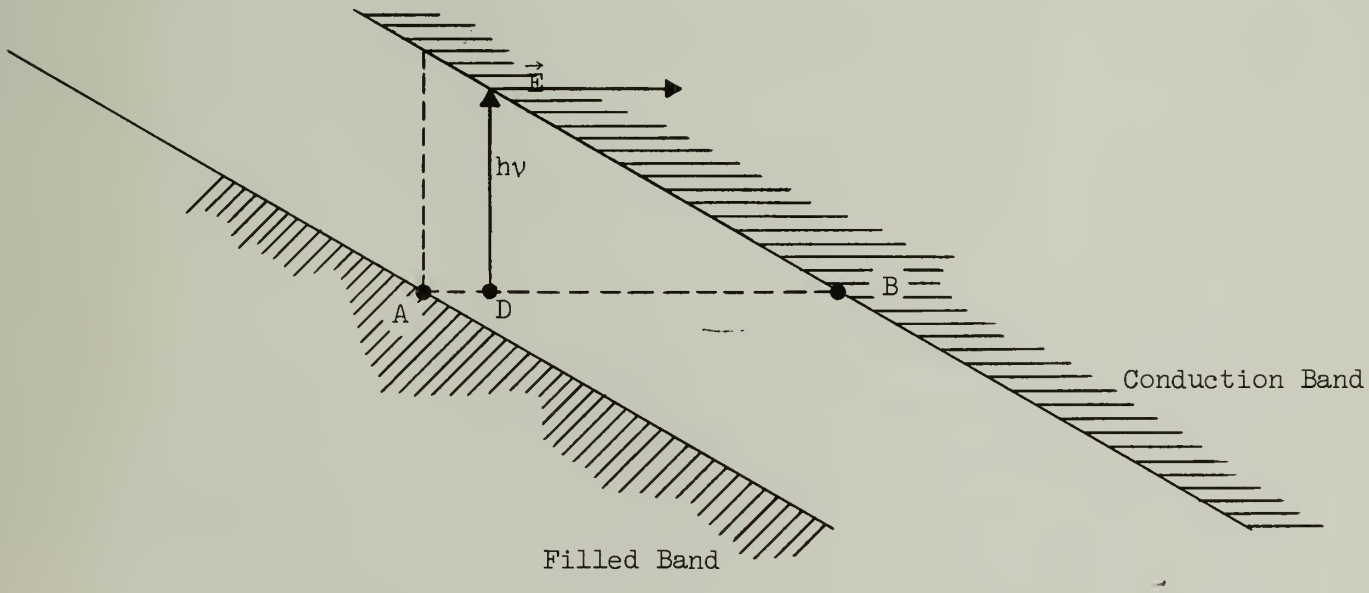


Figure 9.

The optical absorption coefficient is defined [7] as:

$$\alpha = 4\pi\hbar\omega W/ncE^2$$

where

ω: light frequency

W: probability of an optical transition in unit volume and unit time

n: refractive index of the material

E: the electric field

The transition probability W can be found by applying perturbation theory. The optical absorption coefficient is then found as:

1.3.2.1 When $\omega < \omega_o$: where ω_o is $2\pi f_o$. f_o is the frequency at which the absorption edge exists when no external field is applied.

$$\alpha = \frac{4\mu e^o}{\pi m^2 c\omega} |\vec{e} \cdot \vec{M}_o|^2 \frac{(\mu eE)^{1/3}}{(3h)^{2/3}} \int_{x_o}^{\infty} \xi^{1/3} k_{1/3}^2 (\xi) d\xi$$

where

$$x_o = (2\sqrt{2\mu}/3heE)(h\omega_o - h\omega)^{3/2}$$

$k_n(\chi)$: MacDonald function

$\vec{e}$: Polarization vector of light

E: External electric field

$\vec{M}(\vec{\kappa}) = \int u(\vec{\kappa},\vec{\lambda}) \Delta u(k,\lambda) d\tau$

u, u, are the periodic factors of the Bloch function of the valence and conduction's band.

1.3.2.2 For $\omega = \omega_o$

$$\alpha_o = \frac{d}{\pi} \frac{\mu e^2}{nm^2 c\omega} |\vec{e} \cdot \vec{M}_o|^2 \frac{\mu e E^{1/3}}{(3h)^{2/3}} \int_o^\infty \xi^{2/3} K_{1/3}^2(\xi) d\xi$$

1.3.2.3 For $\omega > \omega_o$

$$\alpha = \alpha_o + \frac{4\pi}{3} \frac{\mu e^2}{nm^2 c\omega} |\vec{e} \cdot \vec{M}|^2 \frac{(\mu e E)^{2/3}}{(3h)^{2/2}} \int_o^{y_o} \xi^{1/3} [J_{-2/3}(\xi) + J_{2/3}(\xi)]^2 d\xi$$

where

$$y_o = [2\sqrt{2\mu}/3heE](h\omega - h\omega_o)^{3/2}$$

1.3.3 Effect of Impurities

The conclusion reached about the absorption edge modulation by an external field applies only when the material is a pure non-conducting crystal. In the case of a doped semiconductor, the results have to be reformulated because of the following fact: Although a doped semi-conductor appears neutral in a macroscopic sense, there exists local "charged points" due to the presence of impurities. These "charge points" will introduce a local electric field and produce the Franz-Keldysh effect although no external field is applied. Also, when an external field is applied, the field experienced inside the material will be a varying function instead of a uniform one.

The probability distribution function for a field F due to impurities is found to be

$$W(F)dF = \frac{3}{2F} \left(\frac{F_o}{F}\right)^{3/2} \exp\left[-\left(\frac{F_o}{F}\right)^{3/2}\right] dF.$$

While the absorption coefficient for a doped material without an external field should be:

$$\alpha' = \int_o^\infty \alpha(F) W(F) dF$$

where $\alpha(F)$ is the result in Sec. 3.

1.4 Hot Electron Diodes

The circuit in Fig. 10 is simply a parallel connection of two outputs of diodes which are driven by the intercoupled transmission amplifier. The observed wave-forms are shown in Figs. 11 and 12.

The small spikes appearing on the input pulse is the voltage induced by the pulse on the secondary line of the amplifier. As seen in the figures, an 80 mv input is large enough to drive this amplifier. In fact the amplifier works with 60 mv inputs. Therefore, the output of this circuit can drive another amplifier and the time delay is seen to be about 3ns.

After the tunnel diodes switch, we have to wait some time for the pulse to arrive at the other terminals of the secondary lines. By reducing the length of the line this time delay can be reduced.

When using Rexolite 2200 as dielectric of the lines, the time required to travel 1 cm is 0.055 ns by calculation, whereas 0.056 ns/cm was observed: The agreement is good. However, as the lines become shorter, the edge effect becomes important and thus there is a limitation to shortening the array.

It should be noted that under certain circumstances the non-linearity of the negative impedance can cause bistable operation of the circuit. This has also been reported in the "Journal of the Institute of Communication Engineers of Japan." One of the main problems is therefore the selection of very linear Goto pairs. The best pair found so far gives a voltage swing of 100 mV with -27 Ω.

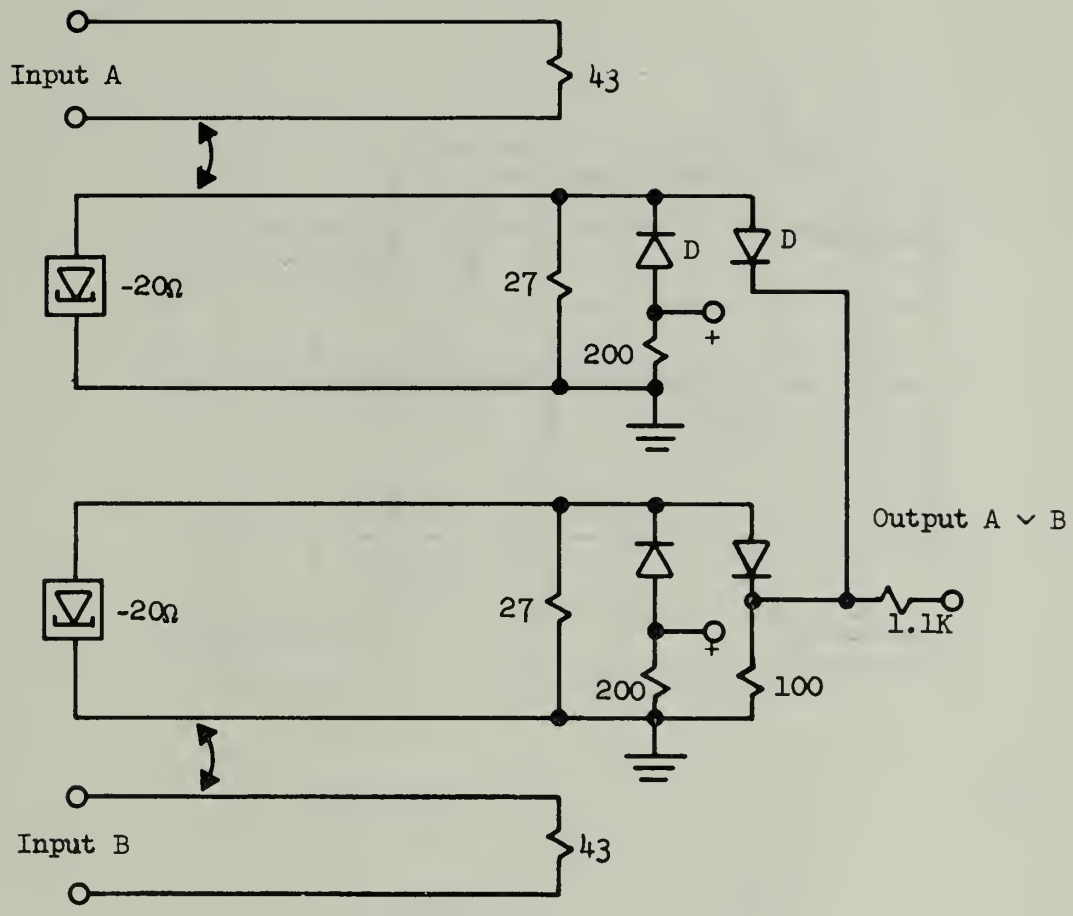


Figure 10. Hot Electron OR-Circuit

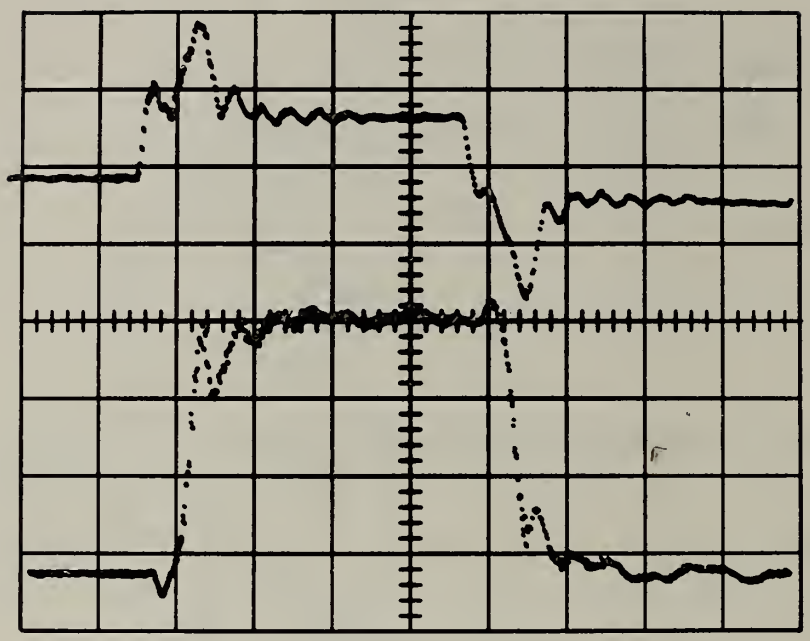


Figure 11. A = 1, B = 1
Upper trace = input 100 mv/div
Lower trace = output 50 mv/div
Time = 5 nsec/div
Tunnel diodes = RCA 1N3847
Hot electron diodes = hpa 2103

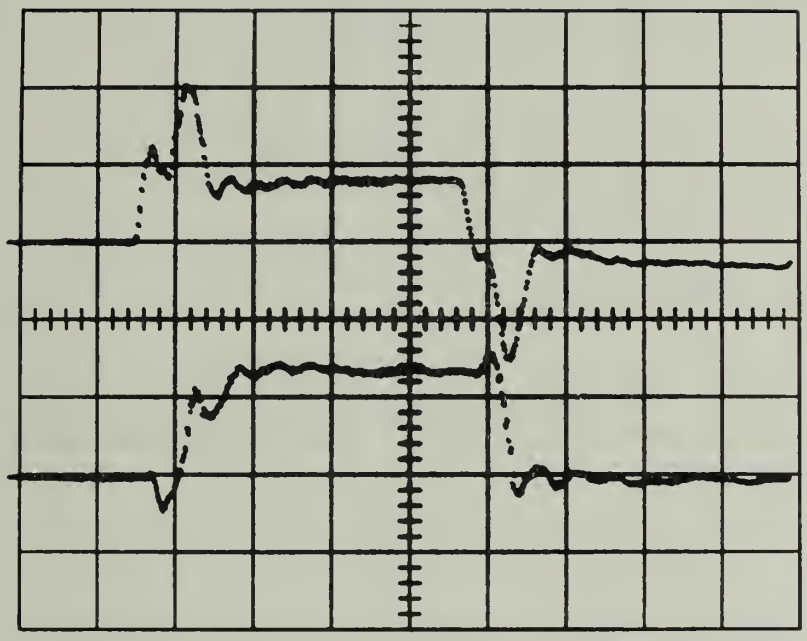


Figure 12. A = 1, B = 0
Upper trace = input 100 mv/div
Lower trace = output 50 mv/div
Time = 5 nsec/div
Tunnel diodes = RCA 1N3847
Hot electron diodes = hpa 2103

BIBLIOGRAPHY

[1] B. O. Seraphin and D. A. Orton, "Field Effect Light Modulation in Germanium," J. of Appl. Phys., Vol., 34, No. 6, June, 1963, pp. 17 pp. 1743-1748.

[2] Andrea Frova and Paul Handler, "Franz-Keldysh Effect in the Space Charge Region of a Germanium P-N Junction," Material Research Laboratory Report, University of Illinois, Urbana, Illinois.

[3] G. Racette, "Absorption Edge Modulator Utilizing a P-N Junction," Proc. of IEEE., June, 1964, p. 716.

[4] W. Franz, Z. Naturforsch, 13a, p. 484, 1958.

[5] L. V. Keldysh, "The Effect of a Stronger Electric Field on the Optical Properites of Insulating Crystal," Soviet Physics: Solid State. Vol 5, No. 5, pp. 988-994, November, 1963.

[6] D. S. Bulyanitsa, "The Effect of an External Electric Field on the Shape of the Intrinsic Absorption Edge in Non-Conducting Crystal," Soviet Physics, JETP, Vol. 11, No. 4, pp. 868-870, October, 1960.

[7] Bardeen, Blatt and Hall: Photoconductivity Conference, Atlantic City, New Jersey, November, 1954.

2. COMPUTER SYSTEMS RESEARCH

(This work is supported in part by Contract No. AT(11-1)-415 of the Atomic Energy Commission and in part by the University of Illinois.)

2.1 Summary

Work continues on the final stages of ILLIAC II hardware additions. Included has been the installation of 8192 words of commercial core memory, the completion of the 65,536 word drum and the preliminary checkout of the first disc file channel.

Increasing emphasis is being placed on various aspects of time-shared computer operation. These efforts include connection of remote inquiry stations, writing of compilers suited to time-shared use, and investigation of commercial peripheral processor capability.

2.2 Magnetic Core Memory

An 8192 word core memory was received from Indiana General Corporation, August 28, 1964, 17 months after the original order was placed. Preparation had been completed to connect either half of this memory with the existing 4096 word core to provide 8192 words of storage interlaced onto two memory buses.

Initial acceptance tests were made on the memory connected this way from September 13 to 15. Several 8-hour error-free runs were made during this period under ideal environmental conditions. Subsequently, marginal behavior at high and low line voltage and increased temperatures was corrected and some accessory components were replaced or improved. Final acceptance was given September 26. A memory cycle of 1.8 μsec was achieved.

The acceptance test was for the most part uneventful except for a short circuit caused by overheated resistors unsoldering themselves and falling into the works. Sixty-four driver transistors were replaced as a result of this slip.

Operation since acceptance has been tolerable, though imperfect. Intermittently open wiring in one of the stacks has been a major source of difficulty. Some trouble has also been found with Read/Write driver noise due to large variations in the speed of transistors of the same registration but different manufacture. The fact that during this period only half the IGC memory was essential to system operation has helped a great deal.

2.3 Magnetic Drum Memory

The drum memory is completely operational with very low error rates. The completed memory has a capacity of 65,536 words of 52 bits using two independent rotating machines. Facilities are provided to monitor individual drum rotation, thus allowing the most expeditious of a group of memory accesses to be made at any given moment. Each drum machine rotates at 3600 rpm providing 52 bit words at a 125 kc rate after access is made.

The second drum machine was converted to flying heads by the drum manufacturer, Vermont Research, beginning in May, 1964, and reinstalled in the drum memory frame on August 24, 1964. (The first drum had been in use with flying heads since January 20, 1964.) There were few difficulties during checkout. Bit clock tracks were erased accidentally with an ohmmeter, but they were successfully rewritten from spares. On August 29, the full 65,536 drum memory ran a random number random-address drum test for 5:35 hours without error. On September 16, counters were installed to monitor the flying head actuator cycles. Since that time, drum 0 has been turned off twice briefly, and drum 1 has run continuously.

During the fall, the read-only bands were moved from the low end to the high end of the drum addresses, and were used for a bootstrap program and some test routines. Since the drum memory is used by the system programs and by the NICAP and FØRTRAN translators, it services almost every ILLIAC II user. Drum errors have been quite few, and have been caused largely by random component failures in the electronics. No systematic errors have occurred, and there has been no need for adjustment or modification of the drum mechanisms or the read-write electronics.

2.4 Drum Operating System

The various operating systems which have been in use on ILLIAC II (NICAP, CREST, STRIPE, Paper Tape), have been partially consolidated into the Drum Operating System. The high-order band of Drum 1, consisting of drum blocks 248-255, has been locked out (placed in a read-only status) and contains the Drum Bootstrap program and two critical engineering test programs: TTC, which tests the first magnetic tape channel, and BTC, which tests the IBM 1401 Channel. The operating experience to date, under this system, has been extremely pleasing.

It is further planned that AEC, the most general engineering test of ILLIAC II so far generated, will occupy drum blocks 224-247; this portion of Drum 1 will then become locked out. Entry to AEC will be obtained via an existent linkage with the common Drum Operating System.

2.5 Disc File Interplay Channel

The first Disc File Interplay Channel, connecting ILLIAC II to the IBM 1301 via the IBM 7631, is built and is presently undergoing checkout off-line. The design philosophy and the order code are discussed in:

> "Programming Aspects of the Disc File Channels," by R. E. Willard, File No. 620, Digital Computer Laboratory, University of Illinois, Urbana, Illinois, August 4, 1964.

2.6 Multiplexing Special Register System

The Multiplexing Special Register System, designed to enable simultaneous communications with many slow Input-Output devices, is currently being de-bugged off-line. The hardware employed in the system, and the software implied thereby, are described in:

> "Multiplexing Special Register System," by M. J. Pisterzi, File No. 620, Digital Computer Laboratory, University of Illinois, Urbana, Illinois, July 28, 1964.

The first Multiplexed Special Register to exist under this system, the Engineering Inquiry Console, is being checked out along with the parent system.

2.7 Computer Simulator

Increasing usage of ILLIAC II forced a decision to create a piece of hardware to enable off-line de-bugging and repair of Interplay Channels and Special Registers. This apparatus, known loosely as ILLIAC V, has become operational; it is described in a forthcoming report. ILLIAC V is currently being used to assist in checking out the Disc File Interplay Channel and the Multiplexing Special Register System.

2.8 CLIC--A First Generation Console-Compiler Language

The basic form of the compiler and the detailed language structure have been defined and major portions are coded and checked out on ILLIAC II. The specialized loader needed to load, reconcile the program to core, and link the specialized structure of this compiled-by-statement language* has been specified and is in the process of being coded.

At the present time a single input statement, typed for checkout purposes on the console typewriter, will produce usable machine code output. In addition, a file system (using tape until the disks are available) stores both the input statement and the machine code so that they can be retrieved whenever needed.

Currently only very basic statement types are available. However, the structure is such that simple subroutines need be written to add additional statement types. It is anticipated that the first compiler-generated program will be loaded and executed early in 1965.

2.9 Computer Search Group

The needs of the Department of Computer Sciences have recently increased in three major areas, all of which lie within the range of available small computer systems. These areas are:

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* "Remote Consoles for ILLIAC II," by Edwin B. Hassler, Jr., and T. A. Murrell, File No. 605, Digital Computer Laboratory, University of Illinois, Urbana, Illinois, July 6, 1964.

a) Real-time, multiplexed, communications, with remote terminal services.

b) Media conversion: punched card-to-magnetic tape, and magnetic tape-to-hard copy.

c) Incremental plotting.

A Computer Search Group has been formed to investigate the feasibility of using one or more commercial computers to facilitate the department's growth in these three areas. Principal members of the group are: C. Carter, K. Law, K. Smith and R. Willard.

2.10 SPECTAR--A Semiconductor Tester

A data logger for the high volume testing of semiconductor devices is in the final stages of checkout. The device dubbed SPECTAR--Semi Programmable Externally-Controllable Tester and Recorder, will assist in acceptance testing of new devices as well as providing a convenient means of logging life test data of components installed in the ILLIAC II System.

The readout consists of a single HP 3440--DVM coupled to a Soroban paper tape punch. Some classes of error in test setup have been minimized by use of plugin control cards to define test conditions. A total of eight dc tests may be run on any one device with sequences for a given device being automatically or manually controlled.

A statistical program written for ILLIAC II will be used to process the data from SPECTAR and other sources. This operating program has several options including:

a) Input from paper tape or cards.

b) Facilities to handle any number of paper tapes or decks without program reload.

c) Preparation of distribution graphs for any or all parameters.

d) Output on punched cards or printer.

The program has the following limitations:

a) A maximum of twelve tests per device is allowed.

b) If punch card output is desired only nine tests per device are allowed.

c) (Number of tests per device +1)*(Number of devices) $\leq$ 5000.

d) The number of measurements used to make a distribution graph is automatically truncated at 500.

3. ILLIAC II SERVICE USE AND PROGRAM DEVELOPMENT

3.1 Progress

This quarter has seen a closer integration of the ILLIAC II service facilities with those offered by the IBM 7094. The introduction of a basic operating system in July, 1964, with characteristics similar to those used on the 7094 and the completion of Version I of FØRTRAN II in September, made this feasible. FØRTRAN was first placed in use on October 15th, when a 5 o'clock shuttle run was initiated via the 7094 routing room in addition to the five regular code checks via the ILLIAC II routing room. On November 18th, Math 195 homework problems were first run on ILLIAC II, initially by reading the cards on line, and by later loading onto tape in ERL and moving the tape to DCS.

Currently the user may submit decks for processing on ILLIAC II, 7094 or either machine by means of color coded ID cards.

In this quarter the NICAPS System Manual has been issued. It describes the system programs in detail. A major revision of the ILLIAC II Manual has been started and a new Operators Manual has been started. The latter will be used for the training of new operators on the equipment and as a reference for the use by operators of standard diagnostic programs and procedures in the event of failures.

ILLIAC II LOG SUMMARY

October, November, December, 1964

		October	November	December	Totals
I.	ENGINEERING				
	General Engineering	218:22	245:37	270:22	734:21
	Core Engineering	70:59	20:38	7:16	98:53
	Drum Engineering	5:08			5:08
	Typewriter Engineering	2:10	:52	7:38	10:40
	1414 Engineering	11:20	:30	10:20	22:10
	P. A. U. Engineering	4:05	7:32		11:37
	1050 Engineering	1:10			1:10
	Interplay Engineering	1:20			1:20
	I/O Engineering		19:55	:05	20:00
	Interrupt Engineering		:35		:35
	1401 Engineering		1:30		1:30
	Sub Totals	314:34	297:09	295:41	907:24
II.	ENGINEERING TESTS				
	RNRADT	5:00	42:32	:10	47:42
	Mastic	57:07		18:02	75:09
	DAMN	11:50	17:15	62:41	91:46
	AEC			55:20	55:20
	BTC		4:20	2:05	6:25
	Duplex Memory	1:08	11:15	1:00	13:23
	Stripe	:48			:48
	Crest	15:10	7:37	37:37	60:24
	TTC	1:13	3:10	4:45	9:08
	Cross Talk		4:20		4:20
	Drum Test		:05		:05
	Divide		12:00	1:00	13:00
	PAU Test			:10	:10
	MEC			25:10	25:10
	Memory Reversing		:25		:25
	Sub Totals	92:16	102:59	208:00	403:15

ILLIAC II LOG SUMMARY (CONT'D)

October, November, December, 1964

		October	November	December	Totals
III.	CODE CHECKING				
	Regular Code Checking	249:53	81:48	85:12	416:53
	Special Code Checking		23:25	9:57	33:22
	Math 195		17:00	25:58	4 42:58
	Sub Totals	249:53	122:13	121:07	493:13
IV.	USE BY INDIVIDUALS IN DCS		145:40	100:52	246:32
V.	DEMONSTRATIONS		1:10	:45	1:55
VI.	IDLE	56:57	46:43	1:45	105:25
VII.	POWER OFF	:10	4:06	1:20	5:36
VIII.	DOWN	8:30			8:30
IX.	UNKNOWN			14:30	14:30
X.	PRODUCTION (Not listed as individual	21:40			21:40
	Grand Totals	744:00	720:00	744:00	2208:00

ILLIAC II LOG SUMMARY (CONT'D)

October, November, December, 1964

XI. ERROR ANALYSIS ILLIAC II	October	November	December	Totals
Flow Gating	0	0	2	2
Typewriter	7	4	0	11
Power Supplies	15	*13	12	40
1414	11	5	4	20
Delayed Control	1	1	0	2
Advanced Control	2	1	1	4
SRDP	0	1	2	3
Drum	4	2	1	7
Interplay	1	0	0	1
Console	1	3	0	4
Unknown	2	** 8	4	14
Core 0	6	***20	5	31
Core 1	3	3	5	11
Interrupt	1	0	0	1
Interlock	1	0	0	1
1401 Channel	0	4	0	4
Fans	0	1	0	1
Main Arithmetic Unit	0	0	3	3
Tape Problem	0	0	1	1
	55	66	40	161

* NJE, bad capacitors and channel fuses

** Involved with operator difficulty

*** Parity errors in this core to be expected for some time.

ILLIAC II LOG SUMMARY (CONT'D)

October, November, December, 1964

		October	November	December	Totals
XII.	IBM Equipment Requiring Services of C.E.				
	1401	1	1	3	5
	1402	4	7	2	13
	1403	2	4	5	11
	Tape Drives	5	8	8	21
	Selectric Typewriter	0	2	4	6
	Subtotals	12	22	22	56
XIII.	Key Punch Equipment C.E. Calls				
	026 (Punches)	4	3	6	13
	557 (Reproducer)	4	0	0	4
	Interpreter	1	0	1	2
	Subtotals	9	3	7	19

3.2 New Problem Specifications Submitted

A. Incomplete Gama Functions, James Neill, State Water Survey.

Method used to complete value of the incomplete gama function is

$$I(u,p) = \frac{1}{\Gamma(p+1)} \int_0^{u\sqrt{p+1}} e^{-t} t^p dt; t = \mu\sqrt{p+1}$$

may also be expressed in form of an expansion, which will be the equation that will be programmed

$$I(u,p) = \frac{t^{p+1}}{\Gamma(p+1)} \left[\frac{1}{p+1} - \frac{t}{1!} \frac{1}{p+2} + \frac{t^2}{2!} \frac{1}{p+3} - \frac{t^3}{3!} \frac{1}{(p+4)} \cdots \right]$$

Values will be determined for all combinations within the range of $-0.999 \leq p \leq 5.0$ and $0.0005 \leq u \leq 5.0$.

B. Self Organization, Alex Andrew, Electrical Engineering

To study algorithm by which a system can improve its own operation of a task as a result of experience. A system and a task environment will be simulated in the program. Self improvement results partly from the adjustment of parameters, but the system also undergoes changes which are more readily described as alterations in its structure than as parameter adjustments. Parallel computations in a set of essentially similar units will be simulated, with means for insertion or removal of units according to prearranged criteria. Program will allow experimental changes in these criteria and other features of the system.

C. Wire Check, John Schwebel, Department of Computer Science

Program will analyze data on paper tape which is the output of a self contained wire tester and punch unit. Data represents connectors between electrical terminals on some piece of hardware of the ILLIAC II. The program will obtain the minimal set of connected sets of points.

Output will be partially printed and punched and also saved on magnetic tapes which will be the subject of further analysis on the 7094.

3.3 Scheduled Diagnostic Engineering

A. Maintenance:

1.	Checking transistors	31 hours
2.	Systematic component replacement (Capacitors and bad semiconductors)	40 hours
3.	Marginal DC voltage tests	23 hours
4.	Checking collector, base bumps and zeners	65 hours
5.	Sensitivity checking --by using resistors, (adding or stealing current) and locating areas sensitive to scope probing	5 hours
6.	Component replacement tests (Trying new transistors, semiconductors, etc., to replace obsolete items)	16 hours

B. Component Failures:

1. Transistors in main machine (Main frame, core 1, Interplay, Drum and power supplies)

Main machine	40,121
Power supplies	3,592
Total	43,713
Transistors replaced	57

2. Semiconductors in main machine (Diodes, zeners, etc.)

Total	81,946
Semiconductors replaced	27

3. Number of printed circuit cards in I/O equipment

Total	1,655
Circuit cards replaced	69

C. Comments:

1. We have experienced many machine malfunctions causing lost time due to .1 µfd 75 v disc capacitors and .1 µfd 30 v disc capacitors shorting out. These capacitors are used in the DC filtering system. Because of this we are systematically replacing these with .22 µfd 50 v capacitors manufactured by a different company.

2. The transistor GF45011 is no longer obtainable. By our periodic transistor checking we are finding that they are gradually deteriorating and a replacement is badly needed. An attempt is being made to find a replacement.

3. The transistor N250 is in a similar category.

D. During December an intensive program was begun to replace the capacitors mentioned in C(1) and to find the bad transistors mentioned in C(2). This accounts for a large amount of the regular maintenance which is higher than usual.

3.4 1401 Service Use

A number of service programs are now available on the 1401. These includes, in addition to those programs used for on and off-line ILLIAC work,

80 column list

132 column list

Sequence numbering reproducer

80-80 reproducer

Gang punch

(The above are part of the operating system and can be called by suitable control cards.)

In addition, the log summary is processed monthly and various records such as the staff directory and inventories are maintained by card records.

3.5 System Program Development

A. The basic work done in the systems division during this quarter has been the development of a complete off-line processing monitor system for the ILLIAC II. This has consisted of four basic parts as follows:

1. Development of an interrupt program to make use of the existing interrupt facility and provide automatic (rather than the present manual) run continuation after an attempted illegal operation or machine condition.

2. Revision of the existing SYSIO package to allow the use of tapes for input and output rather than the present on-line input-output scheme through the 1401 complex.

3. Revision of the Scheduler and the Batch Processor to allow for time and account keeping on all batch jobs, and to expand the pre-execution error information given to the user. The scheduler is also being revised to facilitate the eventual inclusion of a time-sharing system.

4. Development of a general error handling program for use by the systems programs to provide both on and off-line error messages, as required.

B. Present Status

1. The interrupt system is now completed but untested in its final form. A less sophisticated program was completed earlier and tested successfully on six of the eight interrupt conditions which are to be presently considered. These are

   a) Attempted access of the locked out system program core blocks (30 and 31) except through the allowed transfer vectors.
   b) Clock interrupt.
   c) Attempted execution of undefined orders.
   d) Attempted execution of protected orders.
   e) Attempted execution of a halt order.
   f) Accumulator overflow. (Unless overridden by the user. See below.)

   The remaining two untested conditions are

   g) Core parity error.
   h) Typewriter finished (TOK) interrupt.

   The conditions a) through e) inclusive and g) will cause the user's execution to be terminated with an appropriate error comment given. Condition g) will also produce an on-line error comment via the console typewriter. Condition h) causes a temporary transfer to a type-out program for the typewriter, and then a transfer back to the user. Accumulator overflow will cause termination by the system unless the user calls the program SETUP which will allow him to ignore the condition, trap to a particular location (quarter word zero) on the condition, terminate on the condition or to reset the overflow status to what ever it was before the last call to SETUP. (One level of resetting is allowed.) All of the conditions will produce a SYSERR dump along with an error message, except for clock and core parity interrupts.

2. The new SYSIO package is completed and tested successfully as a three card per tape record version. A newer version, which will ultimately be used, is under development and works with a two card per record format. The 1401 program to do the off-line processing is completed except for the accounting routine which will be made identical in operation to that used in the 7094 installation. Added facilities in the new SYSIO which were not available with the older version include an output record counter which makes an error message exit when the specified output maximum is exceeded.

3. The expanded Batch Processor and Scheduler are still under development. The expanded Batch Processor will allow execution in the event of a missing $ DATA card, unless otherwise deleted, and library tape searching in all cases to tell the user of missing subroutines. The ID card will be completely read, and all information used as is presently done at the 7094 installation. The Batch Processor will be assigned to reading and setting up the information as well as preparing the ID card for output on the on-line console typewriter. The Batch Processor will be run as another user, and it will be the job of the Scheduler to keep track of the immediate user and allow or disallow access to the system tapes and drum blocks. Batch will be the only user allowed access to these within the present system. Aside from the aforementioned, the Scheduler will also be required to set up the user's time allowance, and output record count, as well as to preparing and writing the accounting record and EOF at the end of each job's output file. The Scheduler facilities for keeping track of the present user and machine status will be sufficiently generalized to allow for the eventual inclusion of a time-sharing system.

4. The error handling program has been completed but not tested. The program will be available to all of the systems programs to supply messages for errors occurring at user execution time. Facilities will be provided to allow for an automatic SYSERR dump on error conditions where such would be useful to the programmer.

This is the present status of the system. These programs will be combined into a unified, minimal off-line batch processing system by January 31, 1965.

3.6 The ILLIAC II Assembler, NICAP

During the past quarter, final revisions of NICAP were incorporated into the system. These included expansion of the pseudo-operation vocabulary and implementation of several, heretofore undefined, mnemonics. At present, a prepass designed to handle MACRO instructions is being prepared.

NICAP is a 3 pass assembler. Pass I is a single core load which processes the source card images in order to extract a table of used or defined names. During this process the names are replaced by a 13-bit internal form, the address of the n table entry, which saves further table searching. The card is condensed into an internal form, an intermediate language in order to reduce the time of subsequent passes and stored on the drum. If the object deck is to be listed, the card images are also saved.

Pass II is primarily concerned with solving the name table and calculating the length of the object program when assembled. This can not be accomplished during the first pass because of the flexibility in address construction which allows the type of name in an address to dictate the final length of the card when assembled. Since the source deck is stored in an internal form on the drum, the time required for this pass is negligible compared to the times of Pass I and Pass III.

Pass III has as its main function the construction and output of the assembled program. If a listing is desired, card images and their octal object equivalences are output. A relocatable binary deck image is always prepared and copied onto tape to be used for the future loading of the program. If a hard copy of this is required, it is output for punching.

An additional program (called Pass IV, but in reality not a pass) lists the errors occurring in Passes I, II, and III and also lists the symbol table, as solved in Pass II.

A provisional time estimate indicates that NICAP will assemble about 2700 cards per minute, with a print object and 7000 cards per minute without, in both cases being I/O limited. Currently there is a 4-second overhead for system tape motion. This will decrease when the disk file is in use.

3.7 The FORTRAN II Compiler (Version I)

During the month of October, a one-pass FORTRAN II compiler which receives a source language of card images and outputs an object language which is the intermediate language of the NICAP assembler was made available to the users of ILLIAC II. This compiler is presently in the advanced debugging stage and producing positive results for its many daring users.

The compiler processes one statement at a time in a left to right scan producing as many error indications for the user as seems possible. The compiler is divided into five sections.

Part I scans the statements until one of the 43 types of FORTRAN statements is recognized. The statement is then separated into "atoms." (an atom is a name, operator, number, or BCD character) which are placed one per word into the statement buffer. Control is then transferred to the one of the other four parts which contains the generator for the statement recognizer.

Part II contains the generator subroutines for control transfer statements such as GØ TØ, DØ, etc., and subroutines to handle outside statement numbers and DØ closures. It maintains a table of all statement numbers used together with information concerning their type and previous use. With this table it can diagnose such errors as non definition, multiple definition, incorrect usage (e.g., transfer to a format statement) and transfers into and DØ closures ending inside DØ nests illegally.

If a number is present in columns 1 to 5 of a statement, Part I transfers to Part II for the number to be checked and entered into the table. Flags may be set indicating various requirements or restrictions. e. g., "The next executable statement must be numbered," "This must be an executable statement," "DØ closure label," etc. These are checked by Part I, and in the latter case, a transfer is made back to Part II after the generator subroutine has returned to Part I so that the DØ closure can be compiled.

Part III handles all the arithmetic expressions and statements, function definitions, SUBROUTINE, and RETURN statements. Basically a left to right scan is made until, considering a hierarchy of operators, some Intermediate Language can be generated. This code is output by a routine and the scan is continued until the statement is completed.

Part IV compiles the necessary Intermediate Language for the I/O subroutines to process the particular FØRTRAN I/O statement being compiled.

Part V checks the syntax, updates the tables and produces the Intermediate Language for the END, DIMENSIØN, CØMMØN, EQUIVALENCE, PAUSE and such statements.

After all of the statements have been processed by these sections a clean-up program checks the label table for undefined labels and assigns storage to variables in variable tables. At this time storage is also allocated to the commoned and equivalenced variables. Any errors noted throughout the compilation are now output with the appropriate message. Control then can be transferred to the final passes of the NICAP assembler to complete the translation from Intermediate Language to machine code.

Preliminary figures indicate that FØRTRAN handles about 7000 cards per minute without a print object and 900 cards per minute with a print object. Currently there is a 9-second overhead due to system tape motion. This will reduce to order 1/2 second when the disk file is used.

3.8 Program Investigations Compiler-Compiler

The ILLIAC II-ILLIAC III compiler-compiler group spent the last quarter working on a syntax checker which eventually is to be used in the syntax recognition section of a compiler-compiler on the ILLIAC II. Accepting syntax specifications written in Evans' card formated Floyd productions and source statements in the language so specified, the syntax checker finds the syntactic errors, if any, in the source statements. It is working at present in a crude form and has been used to check out a set of arithmetic expression optimizing productions.

These optimizing productions, which will be described in more detail in a file number, are designed to perform an extension of the kind of optimization done by the NICAP assembler in NICAP's address field; all constant terms which may be combined by addition or multiplication at compile time are so combined. This is done with only one pass at the source string and minimizes in some sense the amount of code necessary to calculate an arithmetic expression using formal syntactic techniques.

At present the Phase II of the compiler-compiler is being planned for the ILLIAC II. It will accept input generated from a source deck by a Phase I syntax analyzer now working on the 7094. This input will consist of tables and a machine independent code from which the Phase II will compile ILLIAC II machine code for the source program. We hope to get a version of this running by mid-January.

This section of the Quarterly Progress Report has been written by J. Aaron, E. Brower, C. Carter, C. Gear, L. Greninger W. Huffman, H. Lopeman, A Otis, F. Richardson, C. Shepard, T. Slivinski and J. Watkins.

4. IBM 7094-1401 SYSTEM

(Supported in part by the National Science Foundation under Grant No. NSF-GP-700.)

4.1 New Routines

M2-U0I-DAT1-62-SR

Conversion of SYSDAT to standard form. DAT1 uses a table lookup procedure to convert the date contained in the System location SYSDAT to the form of the name of the month, the day of the month, and the four digits of the year.

(Martin Minow)

D2-U0I-NOR1-56-SR

Floating-point Nordsieck-Method Integrator, for FØRTRAN, MAD, and SCATRE. IBM 7094 SCATRE program. The system of equations

$$\frac{dy_i}{dx} = f_i(x, y_1, y_2, \ldots, y_1) \qquad i = 1, 2, \ldots, n$$

is integrated by approximating each y_i by a polynomial--here taken to be of fifth degree in x. The process utilized for each value of i is defined by the following group of equations: (subscripts omitted).

$$y(x+h) = y(x) + h\,f(x) + a(x) + b(x) + c(x) + d(x) + \frac{95}{288}[f(x+h)-f_p]$$

$$a(x+h) = a(x) + 3b(x) + 6c(x) + 10d(x) + \frac{25}{24}[f(x+h)-f_p]$$

$$b(x+h) = b(x) + 4c(x) + 10d(x) + \frac{35}{72}[f(x+h)-f_p]$$

$$c(x+h) = c(x) + 5d(x) + \frac{5}{48}[f(x+h)-f_p]$$

$$d(x+h) = d(x) + \frac{1}{128}[f(x+h)-f_p]$$

$$f_p = f_{predicted} = f(x) + 2a(x) + 3b(x) + 4c(x) + 5d(x)$$

where h is the integration step size. The method of integration is presented in detail in a paper by A. T. Nordsieck, "On Numerical Integration of Ordinary Differential Equations", Mathematics of Computation, Vol. 16, No. 77, January, 1962, pp. 22-49. The method used here is that outlined and presented in the article, with appropriate modifications for floating-point.

The derivatives f_i are evaluated by a closed auxiliary subroutine which must be provided by the user.

(Ida Hassler)

N2-UOI-TDP1-63-SR

Binary or BCD Tape Dump Routine. This subroutine provides a very general tape dump by allowing prepositioning of the tape and the dumping of any number of files and records. By taking advantage of the channel trapping features of the 7094, these operations are performed with maximum speed and efficiency.

(John T. Bagwell, Jr.)
(Clinton W. Kennel)

N2-UOI-TDP2-64-SR

MAD and FØRTRAN Tape Dump Program for Binary or BCD Tape Dump (uses routine TDP1). This subroutine serves only as a link between programs written in MAD or FØRTRAN and the library subroutine TDP1. Because of the relationship of TDP1 and TDP2, the user should also read the TDP1 write-up in order to more fully understand the procedure followed by TDP1, and thus be able to take full advantage of all features offered by TDP1.

(Clinton W. Kennel)

Q1-UOI-FPT1-65-SR

Floating Point Trap Processor, for use with MAD, FØRTRAN, and SCATRE programs. This routine provides for complete programmer control over the processing of floating point traps.

(David Hutchinson)
(John Ehrman)

4.2 Problem Specifications

During the fourth quarter of 1964, 117 problem specifications were submitted to the IBM 7094 for computation. The following brief descriptions of these problems have been prepared for inclusion in this report by those submitting them. T indicates a calculation associated with a theses. * indicates that the work is paid for.

1103-4Ø001 Digital Computer Laboratory. Nodal Circuit Analysis. This problem involves the analytical solution of linear four terminal electrical networks. It is intended that each node in the network be given a number, after which the following information will be used for input: the type and value of each element in the network together with the numbers of the two nodes on either side of the element, and the value of the input voltage. From this information, the program will set up the coefficient matrices of the system of linear complex equations, solve the system of equations for the voltage at any node specified, and calculate the amplification, power gain, and phase shift of the output voltage with respect to the input voltage. If desired, the coefficient matrices of the system of equations can be recovered. (Bert Austin)

1104-4Ø005 T Aeronautical and Astronautical Engineering. Boltzmann Equation. A numerical solution of the Boltzmann Equation is attempted for the case of a plane shock wave. The computer will be used to calculate parameters involved in collision geometry, to compute numerical quadrature of the collision integral and to carry out numerical integration of the Boltzmann Equation itself. Also, programs will be written to compute various gas properties once the distribution through the shock wave function is obtained. (Eugene Chang)

1105-4Ø006 T Chemistry and Chemical Engineering. Rotation Matrices. The present models which successfully account for the non-vanishing rotational strengths of electronic transitions in organic and inorganic molecules, require the evaluation of two center one electron moment integrals

$$I = \int f'^{*}(r')X^{a}Y^{b}Z^{c}f(r)dxdydz$$

where f and f' are atomic orbitals centered on nucleus M and M' respectively, r and r' are position vectors for an electron, and a,b,c are exponents determining the desired moment. The orbitals may be expressed in terms of cartesian systems

x,y,z and x',y',z' centered on nucleus M and M', respectively. Finally the three systems XYZ, xyz, and $x'y'z'$ in general may have arbitrary orientations with respect to one another.

If the three cartesian systems have special relative orientations, confocal elliptical co-ordinates may be introduced and the integration performed more readily. However it may be shown that the general integral above may be expressed as a linear combination of integrals of the same type with the cartesian systems in special relative orientations.

Programs are available to evaluate the special case, and this work extends them to evaluate the case of the general integral. This will be accomplished by calculating rotation matrices which will carry the artibrarily oriented cartesian systems into ones having a special relative orientation. The programs for the rotations are hand coded and only the standard matrix multiplication library subroutines will be needed. Then the afore-mentioned models may be more thoroughly tested by calculation of the above type integrals for varied orientation of the co-ordinate systems as dictated by the particular molecule under consideration. (Joseph A. Stanko)

1106-4ø007 * Physics. Bootstrap Calculations. A bootstrap calculation of the vector (V) meson octet from the pseudoscalar (P) meson octet is attempted within the framework of unitary symmetry. A "Reggeized" form for the force is used with the pseudoscalar and vector meson masses respectively put equal. The consistency requirements of the bootstrap together with unitary symmetry demand, in the first approximation, that the Regge trajectories of the vector mesons be equal. Three coupled integral equations are obtained for the magnitude of the coupling constants γ^2, the P/V meson mass ratio μ, and the zero point of the vector meson Regge trajectory α:

$$1.5\ \gamma^2 A_1(\mu) = 1$$

$$1.5\ \gamma^2 \left.\frac{d A_1(x)}{dx}\right|_{x=\mu} = 12\pi F_1(\mu)$$

and $$1.5\ \gamma^2 A_\alpha(0) = 1$$

where

$$F_\ell(x) = \frac{\mu + x - 1}{2\pi(x-1)^{\ell+1}} Q_\ell(1 + \frac{2\mu}{x-1}) x^{\alpha-1}$$

and $$A_\ell(x) = \frac{x - 1 + \mu}{\pi} P \int_1^\infty \frac{(x'-1)^{\ell+.5} F_\ell(x')}{\sqrt{x'(x'-1+\mu)}(x'-x)} dx'$$

A second bootstrap calculation is performed for the ω meson, this time using the physical masses and coupling constants. Three coupled integral equations are obtained for the ρ and ω meson "zero point" trajectories and the coupling $\gamma^2_{\omega KK}$ of the ω to the $K\bar{K}$ system:

$$D_1(\mu_\omega) = 0$$

$$\gamma^2_{\omega KK} \left.\frac{dD_1(x)}{dx}\right|_{x=\mu_\omega} = -12\pi N_1(\mu_\omega)$$

and $$D_{\alpha_\omega}(0) = 0$$

where

$$\mu_V = \frac{m_V^2}{4m_K^2}$$

and $$N_\ell(x) = (\tfrac{1}{2}\gamma^2_{\omega KK} F^\omega_\ell(x) + \tfrac{3}{2}\gamma^2_{\rho KK} F^\rho_\ell(x)) + \frac{1}{\pi}\int_1^\infty \tfrac{1}{2}\gamma^2_{\omega KK} F^\omega_\ell(x') + \tfrac{3}{2}\gamma^2_{\rho KK} F^\rho_\ell(x')$$

$$- \frac{(x - x_o)}{(x' - x_o)} (\tfrac{1}{2}\gamma^2_{\omega KK} F^\omega_\ell(x) + \tfrac{3}{2}\gamma^2_{\omega KK} F^\rho_\ell(x)) \frac{(x'-1)^{\ell+.5} N_\ell(x')dx'}{\sqrt{x'(x'-x_o)}(x'-x)}$$

with

$$F_{\ell}^{V}(x) = \left[\frac{\mu_V + 2x - 1}{2\pi(x-1)^{\ell+1}}\right] \cdot \left[Q_{\ell}(1 + \frac{^2\mu_V}{x-1})x^{\alpha_V - 1}\right]$$

$$D_{\ell}(x) = 1 - \frac{x - x_o}{\pi} P \int_1^{\infty} \frac{(x'-1)^{\ell+.5} N_{\ell}(x')}{\sqrt{x'}(x'-x)(x'-x_o)} dx'$$

The purpose of the proposed computation will be to search for any consistent physical solutions of the above integral equations. (Melvin Month)

1107-4Ø012 Anthropology. Statistical Data Analysis. A statistical analysis (deviation, correlation, regression, and factor analysis) of data from anthropological population studies and anthropometric information regarding prehistoric and modern populations will be attempted. Some problems in the generalization and information retrieval of the material will be attempted. (M. Wolpoff)

1108-4Ø014 Psychology. Agression in Children. The research problem is a study of aggression using fantasy pictures and the peer nomination inventory as a measure of aggression. The computer will be necessary to compute a complex analysis of variance, several factor analyses, correlations and factor scores. (Merrilee Lewis)

1109-4Ø015 T Sociology. Epidemiology of Minor Health Problems. The analysis will be a medical-sort, in which various public health problems will be analyzed and compared with various sociologic and demographic variables.

These data are based on a sample survey of 375 families (about 1,000 interviewed individuals) in a small Illinois community. The analysis will consist primarily of multi-variate analysis and nonparametric procedures. Various plotting routines will also be used. (Sidney M. Stahl)

1110-4Ø016 * State Water Survey. Climatology, Crop Yield, Farm Management. Correlation, regression, and multivariate computer programs will be used to analyze yearly corn and soybean yields, rainfall, and temperature factors, and some farm management practices for the purpose of studying interrelationships among these variables.

Data plotting will be done by computer. This visual analysis will aid the mathematical analysis in determining what variables play a role in corn and soybean production. (Robert Sinclair)

1111-4Ø017 * State Water Survey. Isentropic Analysis. This program uses radiosonde data, i.e. temperature, pressure and relative humidity at various elevations, as input and calculates the Montgomery steam function, pressure, virtual temperature, relative humidity, mixing ratio, saturation mixing ratio and absolute potential temperature at standard levels of potential virtual temperature and at the surface. These standard levels are selected at five degree intervals of Kelvin temperature. In addition the program reads in reported wind data and interpolates in order to get values of wind speed, azimuth, and component velocities at these same standard levels of potential virtual temperature (isentropic levels). A table of the radiosonde data used as input, including the corresponding winds, is also included in the program's output. (Robert Sinclair)

1112-4Ø018 * Chemistry and Chemical Engineering. X-ray Studies of Molecular Structure. The calculation will involve summations of triple Fourier series and extensive least-squares calculations based on X-ray crystallographic data. (G. A. Sim)

1113-4Ø019 Electrical Engineering. Time Responses of Circuits. Solutions of electrical and electronic circuit problems will be carried out. Most of the problems will involve standard library routines. Printed graphs and tables of data will be common in output. (Raymond J. Carli)

1114-4Ø020 T Electrical Engineering. Complex Modes. The computer will be used to evaluate complex propagation constants that can exist in lossless open isotropic wave guides and open or closed anisotropic wave guides. To evaluate these propagation constants it is necessary to find the complex roots of a transcendental function of a complex variable. The problem will be solved initially by using a two dimensional binary chopping routine, and if a more effective routine is found it will be used. (Yuji Tamaru)

1115-4Ø021 T Theoretical and Applied Mechanics. Elastic Junction Reflections. The problem of studying the reflections from elastic junctions is a natural outgrowth of a general analysis of the flow of blood in arteries. The cardiac output to the arteral system may be described by the first six or seven terms of a Fourier expansion and the blood flow has been found to correspond quite nicely to a Bessel function expression. The changes in these expressions due to the pressure of an elastic junction will be the topic of this study. Analog data will be recorded and subsequently converted to digital form for analysis. (J. D. Martin)

1116-4Ø022 * Agricultural Engineering. Tillage Experiments. The data to be processed require a statistical analysis of variance for the results taken on tillage experiments relating to corn populations, corn lost in harvesting and corn yields. The first two years of data have been processed and two more years of results are to be analyzed and then combined with the previous two years data. (Bateman)

1117-4Ø027 T Mechanical Engineering. Boundary Layer Flow of Ionized Gas. A system of first order, non-linear differential equations will be solved to obtain functions peculiar to the flow of an ionized gas between two infinite flat plates.

It is expected that existing library routines will be extensively used. (S. Colburn)

1118-4Ø028 T Nuclear Engineering. Pulse Propagation. It is proposed to study the neutron pulse propagation in a multiplying medium. Use of the computer will be made in solving the pertinent integro-differential equations using standard library routines. (P. Doshi)

1119-4Ø031 * Astronomy. Radio Telescope Settings. The problem is to determine the setting of each of 276 elements of the radio telescope of the University of Illinois in order for it to be directed to a given position in the sky. The position is incremented by the desired amount and the setting for each element determined by incrementing the original settings accordingly. (John Dickel)

1120-4Ø035 T* Electrical Engineering. Absorbtion Coefficient Measurements. Two measurements of absorbance (M, M^1) are made with a spectrometer on two different thicknesses (D, D^1) of a crystal. Using the relations: $M = \log (\frac{1}{T})$ where T = fraction of transmission,

$$T = \frac{(1 - R)^2 e^{-KD}}{1 - R^2 e^{-2KD}} ;$$

the two unknowns; absorbtion coefficient (k) and the reflectivity (R), may be calculated. The $R^2 e^{-2KD}$ term is small, and ignoring this term for an approximation, the resulting equations are

$$K = 2.3 \left(\frac{M - M^1}{D - D^1}\right) ,$$

and $\log_{10}(1 - R) = .5 \left(\frac{D^1 M - D M^1}{D - D^1}\right)$. Using these values of K and R, a new T and T^1, (thus M and M^1) are obtained by using D and D^1 in the original equation. This cycle is continued until K and R are within one per cent of the preceding K and R. The index of refraction

$$N = \frac{1 + \sqrt{R}}{1 - \sqrt{R}}$$

and dielectric constant $\epsilon = N^2$ are calculated. (George D. Clark)

1121-4Ø036 * Bureau of Economic and Business Research. Variation of Response by Format. An exploration of the effects of a change of questionnaire format on the response elicited is to be studied. (Wynne)

1122-4Ø037 * Soil Conservation Service. Watershed Hydrological Analysis. Two existing programs are to be revised. The first program is a water-surface profile program which will be revised to run several water-slopes at the same time instead of one at a time.

The second program is a hydrological analysis program which will be revised so it can also be used as a structure design program which considers various alternatives and optimizes the final solution. (Arden O. Weiss)

1123-4Ø038 Home Economics. Correlates of Behavioral Understanding. An attempt is being made to systematically construct a configuration of variables which will allow the prediction of an individual's level of behavioral understanding regarding pre-school children. The Film Test for Understanding Behavior (Form II) will provide the criterion scores while the pertinent prediction variables are expected to be found within a constellation of personality, parent-child interaction, parental attitude and marital integration measurements.

Computer use will be restricted to multiple regression analyses during the initial stages of the project, but will shift to some modification of the Wherrey-Doolittle test selection method during the latter stages. (Philip Oneill)

1124-4Ø039 Mechanical Engineering. Non-Equilibrium Flow. The expansion of a gas, initially at an elevated temperature, will, under conditions of low density, result in deviations from equilibrium. The relaxation of the resulting deviations toward equilibrium will be studied for various relaxation rate formulations. Numerical integration of the resulting family of differential equations will be performed utilizing the Runge-Kutta Routine. (W. E. Bair)

1125-4Ø040 T Agricultural Economics. Correlation Analysis of Landlords' Improvement Investment. The problem is a land tenure study to determine the relationship between the annual investment made by landlords for buildings and fences and several independent variables measuring the size of business and the landlords' income. The study deals with three types of tenure: owner operator units and rented tracts which are classified by lease type, livestock share leases, and crop-share cash leases.

The regression equation will be one in which there is a single dependent variable (landlords' improvement investment) and ten independent variables for the owner operator units. Similar regressions will be run for the livestock share and crop share cash farms.

With the use of the IBM 7094 computer, these regressions can be run in a step-wise manner in which those independent variables best "explaining" the dependent variable for each farm tenure type may be obtained. (John H. Berry)

1126-40041 T Civil Engineering. Anchorage Zone Stresses. The research problem is to evaluate the concrete stresses, stirrup force, crack width and crack length in a reinforced end block of a prestressed concrete beam. A beam-on-elastic-foundation analysis has been used to generate the equations. The computer will be used to solve a cubic equation which relates the crack length to the tensile strength of the concrete, modulus of elasticity of concrete, and crack width. The theoretical analysis is to be compared to test results. (W. A. Welsh)

1127-40042 T Geography. Regional Voting Behavior. Patterns. The problem concerns three regional case studies of voting behavior in English and Welsh Parliamentary constituencies for the elections of 1950 and 1951. Certain voting characteristics such as the percentage of the electorate voting Liberal and the percentage of the electorate voting Labour are included in correlational analyses, together with socio-economic variables such as sex ratio and the percentage of the labour force employed in mining. The resultant intercorrelation matrices are then analysed for common factors, resulting in factor loadings on the variables and on the constituencies.

Pearsonian correlations for each of the three sets of data will be calculated.

Centroid factor analysis (plus varimax rotation) on each of the three intercorrelation matrices will then be done yielding. factor loadings on variables and factor loadings on the geographic units to which the original raw data refer. (Kevin Cox)

1128-4Ø043 T Aeronautical and Astronautical Engineering. Studies of Net Heat in Nozzles. This problem is concerned with the stability of non-steady nozzle flows with heat addition. The flow is assumed to be one-dimensional and the heat addition is varied to examine the stability of the system. The computer is used to construct the flow field by the method of characteristics. (Walt Weaver)

1129-4Ø044 T Education. Minnesota Multiphasic Personality Inventory Profiles of Teacher Education Curriculum Groups. Minnesota Multiphasic Personality Inventory profile norms (based on raw scores) will be developed for men and women graduates of different curriculum groups in teacher education. These norms will be compared for differences between the curriculum groups on 3 validity scales and the 10 clinical scales of the Minnesota Multiphasic Personality Inventory. Where statistically significant differences are found, further analysis will be made to identify the deviant group(s).

Sixteen columns will be punched on approximately 800 cards. The cards will be separated into approximately 30 groups. For each group, the mean, standard deviation, median, and standard scores will be derived for each of the 13 columns. Analysis of variance will be performed for between-group differences on each of the 13 columns. Where these differences are statistically significant analysis of variance for multiple comparisons will be performed. (Elayne Miller)

1130-4Ø045 Electrical Engineering. Analog Simulation. The program will assemble, from a collection of coded definitions, a routine that will simulate an analog computer program wired according to the definitions. Integration is performed by rectangular approximation of the area under the curve, with 10 iterations per analog second, or 1000 iterations per problem. The program will be written in FORTRAN with no subroutines other than SINE and COSINE, so that, if needed, the program can be easily modified to run on any computer having a FORTRAN compiler. The definitions are coded with an alphameric character in the first column, followed by fields defining control setting and node number. The character defines the operation of the analog block. e.g., "I" for integration, "+" for summation, "R" for relay, "C" for initial conditions, etc. Output is a plot of any node voltage versus any other node voltage for a 100 analog second run. The abscissa is labelled from 0 through 100 seconds, and the value of the ordinate is printed in the margin for each second. The only scaling required is time scaling; other scaling is accomplished internally by the program when needed. The unscaled value of the ordinate is printed. (Larry Rosen)

1131-4ø046 T Theoretical and Applied Mechanics. Couette Flow. The computer will be used to facilitate the reduction of experimental data taken in a study of plane Couette flow. Turbulent flow quantities will be solved for by inserting test data into the hot wire anemometry equations. Also, the computer will be used to find various viscous flow quantities by solving the viscous flow equations. (H. F. Johnson)

1132-4ø047 * Physics. Reactor Optimization. The object of this study is to investigate various optimization schemes of general interest for systems analysis. The calculations will involve analysis of nuclear data on the one hand, and the evaluation of their role in different optimization schemes for reactors. As a by-product, it is hoped to obtain information on the usefulness of various mathematical methods (variational approach, Pontryagin method, dynamical programming) and on the comparative speed of digital computations as related to the mathematical models involves. (F. T. Adler)

1133-4ø049 Finance. A Theory of Business Risk. An empirical test will be made of the proposition that for any homogeneous class of business firms there is a rate which equates the probable mean net profit on the total capital investment of any member of the class with the risk (probability) that the firm may prove unable to produce that large a mean net profit. The test is to consist of a statistical analysis of capital productivity, during 1957-63, of about one hundred firms in each of four classes which are generally considered to possess intraclass homogeneity as to business risk but marked interclass differences. The firms to be studied, all domestic corporations, include all (102) of the mining companies, all (108) of the food processors, half (104) of the machinery manufacturers, and three fourths (104) of the retail stores whose financial statements for the seven years 1957-63 were published in Moody's Industrial Manuals. The latter two samples were selected by ranking all the firms in each class by alphabetical order of name and then dropping every second machinery manufacturer and every fourth retail store.

For each firm net profit rate for each year, earnings for the year (after taxes but before interest) divided by total tangible assets at the end of the year, the quotient minus the index yield for that year on long term Federal bonds, unweighted mean net profit rate for the seven year period, and standard deviation of annual net profit rates from period mean net profit rate will be computed.

For each class of firm unweighted mean of firm period mean net profit rates, interfirm variance index (standard deviation of individual firm period mean net profit rates from class mean net profit rate), interyear variance index (unweighted mean of individual firm standard deviations of annual net profit rates from period mean net profit rate), predictive value index (ratio of interfirm variance index to interyear variance index), and risk schedule (a table indicating, for each half percent from 0% to 100%, the proportion of the total number of firms with period mean net profit rates less than that rate) will be computed. (R. W. Mayer)

1134-4Ø050 * Electrical Engineering. Network Analysis. The main objective of the program is to develop, automatically, maintenance procedures for conventional linear systems. The core is a general purpose network analysis program capable of computing, rapidly, the symbolic transfer function of a network which may contain active elements and transformers. The Maxwell-Mayeda topological formulas are used for the transfer functions. Generation of trees will be accomplished through the new procedure of Mayeda and Seshu, which avoids duplication. Thus large networks (with 100 to 200 components) can be handled. Transfer function generation is done in SCATRE and I/O in FØRTRAN. (S. Seshu)

1135-4Ø053 Digital Computer Laboratory. Calculation of e. According to conjectures of Von Newmann and others, the distributions of digits and of terms in partial fraction expansions of transcendental numbers should conform to certain well-known mathematical expressions. It is desired to test some of these conjectures by calculating one million digits of e (the base of natural logarithms), for which a particularly simple recursion scheme exists. (John Ehrman)

1136-4Ø054 T Animal Science. Study of Carbohydrate Content. A study of the influence of season and nitrogen fertility on the soluble carbohydrate content of forages will be carried out. The data will be subjected to a Multiple Regression Analysis. (Huggard)

1137-4Ø058 T Dairy Science. Relationships Between Body Measurements and Production in Dairy Cattle. The problem is to find the relationships between seven body measurements and seven measurements of production in dairy cattle.

The computer will be used to summarize production data, make corrections for herds, calculate means, variances, covariances, regressions, correlations, and analyses of variance. (W. V. Thayne)

1138-4Ø059 T Dairy Science. Heritability Estimates of Rate of Milk Removal in Dairy Cattle. The problem under study requires calculation of means, sums of squares, and variance components.

Analysis of variance in estimating various effects on milking rates in dairy cattle will be used. The analysis of variance will be of the nested or hierarchial type with S stages and unequal numbers ($S \leq 5$).
(H. G. Markos)

1139-4Ø060 Agricultural Economics. Educational Status of Rural Youth. IBM cards were punched by the Division of Employment Security, Department of Labor and Industrial Relations, State of Missouri, on migrants to St. Louis seeking jobs. These cards were duplicated for those living in the rural areas outside the metropolitan area of the city. It is the purpose of this study to find out who these youths were, how successful they were in getting jobs, and what differences showed up based on education, sex, types of jobs being sought, and scores on capability tests.

Frequency distributions on various items in the questionnaire are needed. A computation of statistically significant differences in various variables will be carried out. (Lindstrom)

1140-4Ø061 T Aeronautical and Astronautical Engineering. Curved Panel Vibration. This program is for the solution for natural frequencies and mode shapes of curved panel systems by the method of transfer matrices.
(Walter J. Dwyer)

1141-4ø062 * Chemistry and Chemical Engineering. Isotope Effects from Absolute Rate Theory. The theory of absolute rates states that the effect of isotopic substitution on a chemical process can be calculated from a knowledge of the structure of the initial and the transition states. In practice this means the eigenvalue problem $(GF - \Lambda) L = 0$ must be solved for the eigenvalues, $\Lambda = (\lambda_1, \lambda_2, -, \lambda_n)$, and eigenfunctions, L, where the matrices F and G describe the structure of the molecules. These eigenvalues are then substituted into the formula for the effect of isotopic substitution on the rate of a chemical reaction. (W. E. Buddenbaum)

1142-4ø063 * Physics. Peripheral Collisions. One meson exchange models have been used to describe peripheral reactions involving the production of unstable resonances in high energy collisions. For a proper description of the reaction process the absorptive effects due to the many other open channels must be included. A high energy version of the distorted wave Born approximation has been developed which allows calculation of the absorptive effects. During the past year computer programs to calculate production angular distributions and decay correlations for a variety of reactions have been developed. These programs and modifications of them will be used to calculate theoretical curves for comparison with high energy data. The computer is used to fold the absorptive effects into the Born amplitudes once the absorption has been parameterized in a simple manner, and to carry out various kinematical transformations in order to exhibit the results in a form immediately useful to the experimentalists. (J. D. Jackson)

1143-4ø064 T* Education. Influence of Congruity on Cognitive Processes. The computer facilities will be used to study the manipulation of reasoning errors by systematic variation of the linguistic context of syllogistic conclusions. These manipulations are derived from an application and extension of the principle of congruities, recently developed. In addition, the influence of training on reasoning errors, and reasoning errors across syllogistic figures, will be investigated. Further, the correlation of various verbal and mathematical abilities with reasoning behaviors will be studied.

The research described will require simple and complex analysis of variance and covariance, as well as simple and multiple aggression analysis. (L. T. Frase)

1144-4Ø065 Mechanical Engineering. Minor Heat Transfer Problems. The computer is to be used for calculating the results of varied minor problems encountered in heat transfer. (L. D. Savage)

1145-4Ø067 T Physics. Mobility Calculation. The effective mobility ratio, $\frac{\mu_{eff}}{\mu_b}$, for holes in semiconductor surfaces is to be calculated from

$$\frac{\mu_{eff}}{\mu_b} = 1 - \frac{\int_{u_F}^{u_S} e^{\nu}\,(1 - e^{-2K_o})\,d\nu}{\int_{u_F}^{u_S} e^{\nu}\,2K_o\,d\nu}$$

where

$$K_o = \int_r^{u_S} \frac{du}{\frac{\tau F(u,u_F)}{L_D}\left[\frac{2kT}{m}(u - r)\right]^{1/2}}$$

$$J \equiv \frac{m\,\mu_b}{q} = \left(\frac{m}{kT}\right)\left(\frac{kT}{q}\right)\mu_b$$

$$F(u,u_F) \equiv \left[e^{u_F}(e^{-u} - 1 + u) + e^{-u_F}(e^{u} - 1 - u)\right]^{1/2}$$

$$\mu_b = 480 \text{ cm}^2/\text{volt-sec}$$

$$kT/q = .0257$$

$$L_D = 2.61 \times 10^{-3} \text{ cm}$$

$$\frac{kT}{m} = .453 \times 10^{14}$$

$$u_F = 10.15$$

$\frac{\mu_{eff}}{\mu_b}$ is to plotted versus V_G', where $V_G' \equiv \frac{kT}{q}\left[u_s + 8\,F(u_s, u_F)\right]$ for $\gamma = 2.99 \times 10^{-2}$, 2.30×10^{-2}, and 7.12×10^{-2}. (R. F. Pierret)

1146-4Ø068 Mining, Metallurgy and Petroleum Engineering. Mine Roof on Elastic Pillars. This is an extension of a previous problem in which difference equations were used to calculate deflections, moments, and shears in an elastic mine roof slab supported by elastic pillars and other elastic supports. The previous problem employed only core memory so was limited to 121 equations. In order to solve for additional pillar geometries, it is necessary to use up to 400 equations. The present program has a subroutine that uses disk memory to solve these 400 equations. (F. D. Wright)

1147-4Ø069 Psychology. Two Choice Learning Transitions. The data to be analyzed by this program consist of individual protocols from two-choice learning situations. Each protocol consists of 101 trials for which the four combinations of choice (correct or incorrect) and reinforcement (reward or no reward) are listed in a 1, 2, 3, 4 code.

For each protocol, nine 4x2 transition matrices are prepared. The cell entries are frequency counts indicating the number of times correct and incorrect responses occurred on trials following each of the four choice-reinforcement combinations. Only one trial transitions are considered.

The program output consists of three sets of three such matrices for each protocol. The first set concerns transitions on trials 1 through 50, the second on trials 51 through 100, and the third on trials 1 through 100. Within each set the counts are accumulated for transitions from the first to second trial of successive blocks of ten trials, for transitions from the last trial of each block of ten to the first trial of the next block, and for the nine one-step transitions within each block of ten trials. (R. W. Frankmann)

1148-4Ø070 * Agronomy. Illinois Seed Survey. This problem deals with the results of a survey of retail grass and legume seed sales in Illinois during the period July 1, 1963 to June 30, 1964. Totals and percentages are to be calculated for pounds of seed of several species and varieties within species sold in Illinois during that 12 month period. A FORTRAN program has been written to perform the necessary computations. (Pardee)

1149-4Ø071 Microbiology. Limitority of Population of CEUTHOPHILUS. Correlations in morphological characteristics of local populations of the camel cricket Ceuthophilus guttulosus will be studied. SSUPAC will be used. (Eades)

1150-4Ø073 T Agricultural Economics. The Role of Cultural Influences in Economic Development. This research is designed to study the inter-relations of certain cultural factors and the relationship of these factors to economic development. An attempt will be made to assess the changing nature and function of rural communities in Illinois.

Computations will be made of co-relations and factor scores. These will be used to classify the state into homogeneous cultural areas. Analyses of variance will be carried out to measure homogeneity. (W. W. Riffe)

1151-4Ø074 Psychology. Sixteen Personality Factors versus Minnesota Multiphasic Personality Inventory. Factor matching techniques will be used to compare scores obtained on 37 scales of the Minnesota Multiphasic Personality Inventory and on Cattell's 16 Personality Factor Questionnaire from the scores of 300 Air Force men. The Minnesota Multiphasic Personality Inventory scales will be factor analyzed using machine (oblimax) rotation with iterative procedures parallel to an already completed factor analysis of Cattell's 16 Personality Factor for the same subjects. As opposed to standard Minesota Multiphasic Personality Inventory scales, these scales are nonoverlapping, i.e. each item occurs in one scale only. Relevance of each item to its scale was determined by previous experiment. The factors resulting from analysis of the Minnesota Multiphasic Personality Inventory data will then be matched to those obtained from the 16 Personality Factor analysis. Item analysis on each of 256 variables for the 300 subjects is planned as further comparison of the tests as well as verification of the experimentally determined scales. (L. Specht)

1152-4Ø075 T Agricultural Economics. Egg Marketing Survey 1964. The research problem is concerned with the analysis of original data from large poultry producers in Illinois. The mail questionnaires have been received from 800 producers. Although this is a 48% response from the known total population, on some replies there is missing data. The computer can be used in this analysis by facilitating the estimation of inductive statistics.

Frequency counts of variables are to be made to indicate trends that have occurred in the last three and expected in the next three years. They will be in respect to marketing practices, and size of the Illinois flock. The determination of means and standard deviations of variables such as flock size, husbandry and marketing practices will be made for use in the descriptive and synthetic phases of the project. A correlation analysis will be carried out to identify factors that are important to commercial egg producers, and help to identify factors that explain trends such as the sharp decrease in the number of producers in Illinois in recent years. (S. D. Biggs)

1153-4Ø076 Chemistry and Chemical Engineering. Convective Instability I. The stability of an initially quiescent, horizontal fluid layer which is subjected simultaneously to the transfer of heat and mass is investigated. Buoyancy, surface tension and viscous forces are presumed to be the predominant forces in the system. In general the mathematical characterization of the physical system leads to a complex-valued, transcendental secular equation for the determination of the stability parameter of the system. The stability of the system is determined by using a modified Newton's method to solve the secular equation. (R. L. Sani)

1154-4N001 Mining, Metallurgy and Petroleum Engineering. Slip Angle Determination. The problem requires calculation of the slip angle of fault plane solutions of earthquakes. The slip angle is calculated from relationships involving trigonometric functions. A statistical analysis of the results from 1500 earthquakes is intended. (Hans Pulpan)

1155-4N002 Education. Stimulus Sequence and Concept Learning. The problem is the determination of the effects of various sequences of stimuli on concept learning. The immediate issue is the dissection of the sequence variables that affect concept learning. The longer-term goal is the optimization of sequences with respect to learning efficiency and transfer of training. The computer is needed for the statistical analysis of experimental data. Analysis of variance, analysis of covariance, and occasionally correlational techniques are to be employed. (R. C. Anderson)

1156-4N003 Psychology. Structure of Therapist Needs. The problem will use the SSUPAC Matrix package to compute eigenroots and eigenvectors prior to the computation of the principal component analysis of a 37 x 20 matrix, and will use SSUPAC to perform a Q Factor Analysis on the same data.

The data consist of scores on personality measures for 37 psychotherapists. The current problem on these ipsative scores is to find appropriate factors on components across individuals to assess effects of training, experience, and sex of the therapist. (David Mills)

1157-4N004 Mining, Metallurgy, and Petroleum Engineering. Moving Interfall Problem. The computer time will be used for the numerical solution of the Navier Stokes Equations for a two dimensional case. No use will be made of subroutines other than the standard library subroutines. (W. D. Rose)

1158-4N005 T Psychology. Tasks-Process-Products. The task-process-product project is an attempt to systematically relate aspects of small group input (tasks) to the group interaction (process) and output (products). The 7094 will be used for most aspects of the data analysis, and will be especially useful in computing large scale factor analyses and analyses of variance. (Richard Hackman)

1159-4N007 * Nuclear Engineering. Gamma Penetration through Slabs. Monte Carlo calculations will be performed to determine the transmission of 1.0 Mev gamma rays through ribbed slabs of concrete. Emphasis will be put on the "ribbed" part of the problem since good results have been obtained from similar calculations for plane slabs. Theoretical calculations will also be made for the single-scattered contribution in search of a semiempirical formula which will yield values for the differential dose from transmitted gamma rays through plane slabs of concrete. The radiation is assumed to be incident on various slab thicknesses and at various angles. Differential dose distributions as a function of azimuthal and polar angles for ribbed slabs, together with the semiempirical formula for plane slabs will be reported. (A. B. Chiton)

1160-4N009 Digital Computer Laboratory. Poly Atom. Modifications are to be made to a program in a system called POLYATOM. The POLYATOM system is used to carry out molecular orbital calculations with a gaussian basis set. The modifications to be made consist entirely of correcting 11 Fortran algebraic statements which calculate certain basis integrals. Due to the extreme complexity of the equations, it is necessary to produce the formulae, reduce, factor, and write the card images automatically. The programs for doing this already exist, so the entire problem time will be spent in running rather than debugging and testing. (Alton Otis)

1161-4N010 *T Chemistry and Chemical Engineering. Eddy Diffusivity. The present problem is to find a correct expression for eddy diffusivity. The equation involved in this study is the diffusion equation

$$U^+ \frac{\partial C^+}{\partial X} + = \frac{\partial}{\partial y} + \left[(n + e^+ f(y^+)) \frac{\partial c^+}{\partial y} + \right]$$

with boundary conditions:

$$c^+(x^+, u^+ \to \infty) = 1$$

$$c^+(x^+ < 0, y^+) = 1$$

$$c^+(x^+ = 0, y^+) = 0$$

and where u^+ = velocity; $u^+ = y^+$ for $y < 5$ (region of interest in this study)

c^+ = concentration

N = Smith number

E^+ = Eddy diffusivity

Using different equations for eddy diffusivity, the diffusion equation is to be solved by numerical methods for various concentration profiles.
(Jaime Santos Son)

1162-4N011 * Advertising. The Effect of Advertising on Liquor Sales. The problem is to determine the affect of advertising and other variables upon the sales of a sample of whiskey brands. Included among the variables are lagged prior sales. The study should yield coefficients that will make possible the comparison of brands of different price levels, and different social trends.

The standard step-wise regression routine will be the basic analytic technique. (Julian L. Simon)

1163-4N012 Physics. Grading Program. This is a program that will hopefully relieve the instructor of the routine arithmetic and bookkeeping chores now necessary prior to assigning grades to students. The program will be general enough that it will be of use throughout the University. Initially it will be tested on an already graded physics 106 class. Special attention will be paid to providing flexibility as well as simplicity to the user. (W. Peter Trower)

1164-4N014 T Aeronautical and Astronautical Engineering. Matrix Algebra Computer Language. The purpose of this research is to implement and document a Matrix Algebra Computer Language as a tool to be used to obtain numerical answers to problems that are presented in matrix algebra notation.

The Matrix Algebra Computer Language will be a computer programming system (compiler) to process extensive matrix operations from simple, symbolic input. The programming system will perform all the matrix operations called for, and will handle all the storage and housekeeping requirements of the computer. The user of the language would not need to program or debug any computer operations.

There are over 15 matrix operations planned for this first version of the Matrix Algebra Computer Language, such that most problems in the fields of aeroelasticity, dynamics, strength analysis, vibrations, stability, and statistics that can be formulated in matrix algebra notation can be solved. Input matrices may be from tapes, disk tracks, and cards produced by other programs as well as from keypunch cards. Output matrices may be printed, punched on cards, and written on tape or disk. (Mel Haas)

1165-4N015 Office of Instructional Resources. Statistical Analysis of Test Data. The computer will be used to score and analyze many different types of objective tests. The analysis to be performed will consist of bi-serial correlations, factor analysis, factor rotation, and test reliability. There will undoubtedly be other statistical procedures applied to the data which cannot be foreseen at this time.

The major objective of this study is to devise generalized procedures for analyzing objective tests, and thus increase the usefulness of objective tests. (Gene W. Goodman)

1166-4N016 Student Counseling Service. Daydreaming Analysis. A questionnaire concerning "daydream" frequency was administered along with one containing four Minnesota Multiphasic Personality Inventory subscales. The daydream questionnaire was broken down into 25 subscales based on the content of the dreams reported. Grades and ability scores were later obtained for all subjects. The analysis of the data will include correlations of all subscales, grades, and ability measures. In addition, selected t-tests will be performed. (James Nugent)

1167-4N017 T Electrical Engineering. Anisotropic Guides. The waves that can exist in plasma filled waveguides build a set of modes which are the eigenfunctions of the wave equation with the eigenvalues at the zeros of a very complicated higher order transcendental equation. The first task is to find the set of these eigenvalues under various conditions. The expressions for the components of the fields and the radiation impedance of an antenna in the waveguide will then be computed. Integrations of transcendental functions will be carried out for various cases. In the case of warm plasma all the above quantities will be evaluated. (Akkaya)

1168-4N020 Sociology. Schizophrenic Language. Comparable samples of "schizophrenic" and "normal" language were analyzed on a large number of structural linguistic variables to obtain distinctive descriptive profiles of each type of language. The computer will be used to derive the complex average scores that comprised the final profiles and to assess the statistical significance of the differences between profiles, by means of several hundred t-tests and several thousand analyses of variance (two criteria of classification, with unequal groups). (George J. McCall)

1169-4N021 * Astronomy. Time Conversion. The purpose of this program is to convert from central standard time to local sidereal time at the University of Illinois radio telescope in Danville. The two times differ by a given increment per hour, so the sidereal time is determined by adding the proper increment to the standard time. (John Dickel)

1170-4N022 Agricultural Economics. Hog-Beef Supply Response. Linear programming will be used to develop optimal farm production plans for representative farms in three areas in Illinois. Twenty seven price combinations of corn, hog, and beef prices will be used. The results will be aggregated into state totals. The mathematical form of the problem is the standard linear programming one of maximizing an objective function subject to linear inequalities. (E. R. Swanson)

1171-4N023 Agricultural Economics. Forecasting by Econometric Systems. The program estimates the coefficients of a system of linear simultaneous stochastic equations by three methods: 1. single equation least-squares; 2. two-stage least-squares; and 3. limited information (maximum likelihood). The program is a nine core-load ping-pong job and requires logical tape units 2,3,4,8 and 10 in addition to the system master tape and I/O tapes. The problem can be loaded with other problems, but the remounting of system tape 2 is essential. (V. I. West)

1172-4N024 Accountancy. Depreciation and Investments. The problem involves the analysis of financial data of 3500 Swedish corporations. It is the purpose of the investigation to reveal the impact of Swedish tax depreciation and inventory valuation policies on investments and corporate incomes. The results will then be used to evaluate current American taxation and valuation policies and practices. (Nils Vasthagen)

1173-4N025 Psychology. Short Term Memory. The experimental design is a replicated factorial design. An analysis will be made of the effects of a noise-no noise factor upon short term memory for both male and female subjects on three tasks. Bivariate correlation, t-test, analysis of variance and frequency distributions will be utilized to infer the effects. (Howard Thorsheim)

1174-4N026 *T Civil Engineering. Effects of Advisory Speed Limits. This problem deals with the effects of advisory speed limits on horizontal curves of two-lane rural highways. Signs of varying numerical values and legends were tested on curves of various degree of curvature. Samples were collected at twelve locations: speed of vehicle, sex of drivers, number of passengers, make of vehicle, and license plate of vehicles were recorded.

An analysis of variance technique will be performed on such variables, to determine whether this is an effect on the driver's compliance with the advisory speed limits. (Chih-Cheng Ku)

1175-4N027 * Digital Computer Laboratory. WEB. This program will print out logic tracing and wiring tables to assist in the packaging of the Illiac III computer. (Lieman)

1176-4N028 Medicine. Longitudinal Studies. The purpose of requesting usage of the Urbana-Champaign computer facilities is to provide statistical biological data in evaluating and correlating data of the Oral Health of Freshman Dental Students. The aim of this research program is to achieve a more objective clarification of the epidemiological characteristics of periodontal disease through a development of better indices for the assessment of these diseases. The computer will be used to tabulate and correlate the collected data. It is not feasible to do this tabulation and correlation by hand. No involved mathematical methods will be used. (Ronald Pirok)

1177-4N029 T Civil Engineering. Buckling of Shallow Shells. The research problem is to determine analytically the buckling load of shallow shells. A variety of shells under various loadings and boundary conditions will be analysed. By applying the approximating "Galertin" method the problem will be changed to one of solving several simultaneous non-linear equations with constant coefficients. The computer will be used to set up and solve these equations. (Robert Leicester)

1178-4N030 * Physical Education for Women. Study of Women's Physical Education. The purpose of the study is three-fold: 1) to discover the nature of student problems in registration for Physical Education for Women Basic Instruction Program courses; 2) to determine the Physical Education for Women Basic Instruction Program courses which freshman and sophomore women prefer to take; 3) To discover the days and hours on which freshmen and sophomore women are most often free for Physical Education for Women Basic Instruction Program courses. (O. G. Young)

1179-4N031 T Psychology. Attitudinal Rigidity. Measures of cognitive rigidity will be correlated with predictions of attitudes toward various concepts to determine whether rigidity is a limiting factor in these theories. In order to define a scale of ego involvement important in the above experiment, a factor analysis (varimax, orthogonal rotation) will be performed. (Howard Marcum)

1180-4N032 * Civil Engineering. Shallow Shell Elastically Supported. The program solves numerical equations describing shallow shells elastically supported. Flexural and torsional stiffnesses of the curved beam at the boundaries are taken into account. Finite difference schemes are used to establish as many simultaneous equations as there are points in the grid covering the shell. After solving the equations for the displacements the program finds the static quantities at each point. (A. Padilla)

1181-4N033 Psychology. K-C Scale Intercomparisons. The study concerns the prediction of attitude toward an attitude object on the basis of attitudes toward attitude objects associated with it. The affect (A) toward the attitude objects (AO_i) associated with the attitude object, and the belief (B) that they are associated are assessed. The attitude toward the attitude object is measured separately. Two matrices of A, two of B, and the C (criterion) matrix, all subject by concept, result. The scores will be scaled by various techniques. Component analyses will be done on the A matrices to assesstheir effective rank. Various combinations of A and B scores will be made to find the best prediction of C. A comparison of two types of scales which differ in their method of obtaining A and B scores will be made. (Arthur R. Carlson)

1182-4N034 * Medicine. Frequency Analysis of EEG. The problem will explore the relationship between electroencephalographic recordings from the occipital scalp, overlying visual cortex, and specific changes in the visual field. In brief the following is an outline of the work.

The occipital EEG is recorded from bilateral monopolar placements on a subject's scalp. Simultaneously the subject matches the brightness of two adjacent semi-circular fields of light, one steady and the other flickering, presented in Maxwellian view. These matches are made using the method of limits, a standard psychophysical procedure.

The stimulus parameters varied are rate of flicker, intensity of flickering field, and size of field. The dependent variables are the brightness match curves plotting steady field intensity as a function of flicker rate at a given intensity and size of flickering field and the frequency spectra of the EEGs.

The purpose of the work is to determine if there are concomitant changes in the EEG and subjective brightness levels as the parameters of the flickering field are varied. The relevant literature suggests the existence of such relationships.

Most of this work utilizes standard procedure although it is time consuming. It has taken two years to construct the necessary optical equipment, work out procedure and gather the data. Originally the analysis of the EEG's was to have been carried out with Muirhead electronic frequency analysers. This has proved to be an impractical if not impossible task.

Recently a program has been developed at the Brain Research Institute of the University of California Medical School to perform analyses of this type. The program needs and was developed for a 7094. (Herbert Kohn)

1183-4N035 Civil Engineering. Rain Distribution. The research problem has to do with the rainfall distribution according to space. It has been found that rainfall distribution for local thunderstorms can be described approximately by the equation $y = a\sqrt{x}$ where: $y = \frac{H_o}{H} - 1$

H_o - max. rainfall in inches in the core of the storm
H - average rainfall in inches over area x.
a - coefficient
x - area in square miles.

Further investigations for extended storms over bigger areas up to 100,000 square miles showed that a general formula of the nature $y = a_x b$ might be applied (b begin another coefficient).

Data for some decays of storms is available. Each storm lasts for m days (m = 1, 2, 3, 4, 5). For each day $X_1 \ldots X_n$ are given, as well as the corresponding $y_1 \ldots y_n$ (n = 4, 5, 6, 7, 8, 9, 10).

For each set of x's and corresponding y's, a and b have to be found by the computer so that they fit best that particular set, according to the method of least squares. (N. Marcus)

1184-4N037 Graduate School of Business Administration. Portfolio Selection Process. The Portfolio Selection Process involves minimizing a matrix of variances and covariances of yields, given desired yields ranging from 4 to 16 per cent. Let G = portfolio of common stocks, V = variance, δ_i = preparation of portfolio in the security, σ_{ij} = matrix of variance and covariances, μ_i = mean yield, and $E(X_i)$ = expected or mean yield. Then σ_{ij} is determined from Min $V(G) = \epsilon_i \epsilon_j \delta_i \sigma_{ij} \delta_j$, subject to the constraints $\epsilon_i \delta_i = 1$, yields varying from 4 to 16 per cent. $Z_i \leq \delta_i \leq .3$, for $Z_i = .05$, $\delta_i \geq 0$. (Richard Stark)

1185-4N038 * Coordinated Science Laboratory. DIOG Time-Sharing System. This work involves the initial checkout of the DIOG System for experimental time-sharing of the 7094 by the CSX-1 computer of the Coordinated Science Laboratory.

A modified 7094 monitor system will permit the CSX-1 to interrupt the 7094 in order that the entire set of communication logic may be checked out. (Richard M. Brown)

1186-4N039 * Physics. Airy Function Problem. The research problem concerns the theory of the Franz Keldysh Effect, in which various combinations of Airy Functions occur which must be evaluated numerically. (Claude Penchina)

1187-4N040 Ceramic Engineering. Modulus of Elasticity of Glass. SSUPAC programs will be used to determine the relationship between components of a glass and its modulus of elasticity. (Tooley)

1188-4N041 * Office of Instructional Resources. Congress Circle Study. The improvement of instruction in a university is to be approached by the interaction of instructional specialists, faculty committees to improve instruction, and the general faculty. The computer is to be used for statistical analysis of faculty questionnaires. In addition, sociometric analysis of faculty interactions by matrix manipulations will be used to evaluate the impact of instructional improvement committees and the degree to which instructional specialists are used. Special programs to analyze group structure will be written. (Hennes)

1189-4N042 * Psychology. Maxplane Development. The research problem is to develop a program that will rotate factors to a unique resolution based on maximal hyperplane counts. (Wriffenbach)

1190-4D001 T Electrical Engineering. Propagation Through Plasmas. This research problem involves the calculation of reflection and transmission coefficients of an electromagnetic wave incident upon a plasma with an electron density gradient in the direction of propagation. Since the solutions are expressed in terms of functions for which adequate tables do not exist, it will be necessary to generate the functions with the computer. These operations will be repeated for a large number of input parameters such as plasma thickness and maximum density. (Donald Young)

1191-4D003 * Animal Science. Swine Blood Groups. Blood groups of pigs in eleven blood-group systems will be analyzed to examine the association between blood groups and other traits. The method of least squares will be used. (Ben Rasmusen)

1192-4D004 * Veterinary Pathology and Hygiene. Respiratory Flora of Swine. The problem involves investigation of the influence of the respiratory flora on the health of growing swine.

The computer will be used in statistical analysis of the data. Chi squared tests of association and analyses of variance will be used. (G. T. Woods)

1193-4D005 * Physics. Evaluation of Thermal Conductivity Integral. In the Callaway analysis of low temperature lattice thermal conductivity a complicated integral is employed. The present project is to fit this integral to data obtained on alkali halide crystals doped with various impurities in the temperature range 1.2°K to 250°K, for a variety of experimentally determined parameters. (M. V. Klein)

1194-4D006 T Theoretical and Applied Mechanics. Elastic-Inelastic Analysis of Circular Torsion-Tension Member. The "Torsion-Tension Circular Member" will be loaded beyond the elastic limit (proportional limit). The member will be loaded along various strain paths characterized by increments of axial strain and increments of shearing strain. Two theories, the incremental strain theory and the total strain theory, will be used to predict the final load and the angle of twist.

The Prandtl-Reuss incremental strain equations for a volume element of a circular torsion-tension member (in which the cylindrical coordinates are used and in which the Z-axis is parallel to the longitudinal axis of the member) reduce, in the case of elastic volume element, to two algebraic linear equations with two unknowns. The two unknowns are the increment of normal stress and the increment of shearing stress. In the case of the inelastic volume element, the incremental strain equations reduce to two algebraic linear equations with three unknowns. A third equation obtained from the loading function will give the necessary number of equations to solve for the three unknowns.

The IBM 7094 will be used to solve the above mentioned equations for a number n of volume elements into which the member is divided. Given increments of strains, the increments of stresses for each volume element will be obtained as described above. Having obtained the normal stress distribution and the shearing stress distribution on the member's cross-section, the axial load and the tongue will be found by numerical integration. The above procedure will be repeated for various combinations of strain increments. (M. R. Shammamy)

1195-4D007 T Education. School Organizational Differences. This is an attempt to compare differences in the operational effectiveness of certain principles of school administration in schools with teachers organized for professional welfare purposes in different patterns. T-tests of significance of difference in means between schools organized as an AFT union, or as a classroom teachers association, or with no formal organization or with no formal organization and a merit pay plan in effect will be made. These four conditions will constitute variables A, B, C and D. All cross comparisons will be made on clusters of questionnaire responses as well as comparisons on individual items. Frequency counts will be needed. (George R. Cox)

1196-4D008 * Provost's Office. Study of Illinois Water Supply. An estimate of future water needs for the state of Illinois is made by projecting the population of various areas of the state from past population data. Statistical Service Unit programs are to be utilized to obtain various least squares fits of population to time. (L. H. Lanier)

1197-4D009 T* Chemistry and Chemical Engineering. Surface Fouling Data Correlation. The program will be used to reduce data and determine correlation constants involved in a master's thesis on fouling on heat transfer surfaces. (J. W. Palen)

1198-4D011 * Children's Research Center. Multi dimensional analysis of Retarded and Disturbed Children. The essential nature of the research is the discovery by statistical methods, of dimensions underlying the behavior and personality of disturbed and retarded children. The primary statistical method is factor analysis, a technique impossible to employ with large numbers of variables without the computer. (Herbert C. Quay)

1199-4D012 *T Chemistry and Chemical Engineering. Boiling on Fin. This problem is a continuation of work done under specification number 3Ø018. The study will be extended to determine the optimum shape fin when boiling is taking place on the fin.

Standard library subroutines will be used to solve the applicable differential equation. (Kenneth Haley)

1200-4D013 T Agricultural Economics. Lease Choice With Game Models. Lease contracts for farm tenants and landlords are specified as actions in game theoretic models. Payoffs are generated in time series for each type of lease contract. Choices are implied by output of solutions wherein game theoretic criteria are used: maximum of minimum payoffs and minimum of maximum regrets, to specify two of several possible criteria. The problems are converted into linear programming models, solvable with simplex methods. (Ron Tongate)

1201-4D014 * Library Science. Index of Textbook Prices. Approximately 5000 cards must be sorted to obtain price averages for the following categories: 1. Level of textbooks: a) elementary, b) junior high, c) senior high, d) combined junior and senior high, e) college; 2. Form of material: textbook, teacher's manual, workbook, etc; 3. 10 subject areas. (H. Goldstein)

1202-4D015 Psychology. Fluid and Crystallized Intelligence. This study will examine crystallized and fluid intelligence as possible second-order factors in intelligence as related to performance on various intelligence and personality scales.

The mathematical method will involve intercorrelations on 40 variables (113 subjects), iteration, factor analysis, principal axis rotation, rotoplot and some item analysis. (Willis)

1203-4D016 Advertising. Advertising Budgets Investigation. In general, the problem is to investigate the factors that influence the determination of advertising budgets by firms, and how it is distributed among possible media. One of the important attacks on the problem is a regression analysis of yearly advertising budgets. The analysis is of the form: Budget in year t = f(budget in year t - 1, sales in year t, sales in year t - 1, etc.) Standard library routines will be sufficient. (Julian L. Simon)

1204-4D019 * State Water Survey. Sample Size Requirements for Raindrop Size Spectra. Data has been obtained on the size of raindrops in samples from 1/7 cubic meter to eight cubic meters of space. This data will be analyzed to determine the sample size requirements for radar-rainfall studies. Each sample will require tabulation into frequency distribution form. These distributions will then be used for a statistical analysis of the improvement of the reliability of the sample with increasing sample size. (A. Sims)

1205-4D020 * Chemistry and Chemical Engineering. Polymer Absorption. The kinetics of adsorption of polymers on surfaces is being studied. Beginning with a lattice description of the polymer motion, the problem is transformed into a diffusion process in a finite or semi-infinite medium with a partially adsorbing, partially reflecting barrier. By the use of standard numerical techniques for the solution of parabolic partial differential equations, the number of polymer segments on the surface and at various distances from it in the bulk phase are computed as a function of time. Among the parameters to be studied are chain length, the free energy of interaction of the segments with the surface, and force fields such as would arise between a polyelectrolyte and a charged surface. (Victor Bloomfield)

1206-4D021 * Mechanical Engineering. Transient Response of an Evaporator. The problem to be investigated is the transient response of an evaporator. The computer will be used for the reduction of experimental data as well as for theoretical analysis. Only basic mathematical operations and standard library routines will be used. The primary aim of the investigation is to determine the important parameters and governing mechanisms involved in the transient response of an evaporator. (G. L. Wedekind)

1207-4D022 * State Water Survey. Electrical Variables in the Atmosphere. During the summer of 1963, a C-45 airplane was instrumented to measure the following atmospheric variables; temperature, humidity, vertical potential gradient, horizontial potential gradient, positive and negative polar conductivities, and net space charge. In addition the aircraft variables of pitch, roll, altitude and air speed were measured. These measurements were recorded on a twenty channel strip recorder. This record has been read with the aid of a Benson-Lehner "Oscar" so that the measurements are now on IBM Cards. It is desired that the 7094 process these readings correcting the atmospheric measurements for aircraft speed, altitude and attitude. Two outputs are desired: a table of the corrected atmospheric values, and an altitude-height plot of some of the variables. Approximately 50 soundings to 10,000 feet were made and are available for analysis. (W. E. Bradley)

1208-4D023 T Physical Education for Men. Eosinopenia and other stress indices. The problem of this study is twofold: (a) to determine if eosinopenia and other stress parameters are significantly different with respect to four levels of treadmill running, i.e., 2, 4, 6 minute and all-out run., (b) to determine what per cent of the net variance is accounted for by the stress parameters in question with regard to the criterion of the all-out treadmill run, 7 mph; 8.6 % grade. The analysis of variance procedure is used with (a) to test the hypothesis of significance among the four levels of treadmill running. Multiple regression is employed to formulate the highest multiple R obtainable using these variables, and to construct a prediction equation with the all-out treadmill run as the dependent variable. (Herb Weber)

1209-4D024 * Physics. Breit-Wigner Fit. Raw data of Mössbauer experiments (number of counts versus velocity) are normalized, plotted, and fitted to a number of Breit-Wigner curves or modifications thereof by least square method. (Debrunner)

1210-4D026 *T Agricultural Economics. Economy Consideration of Fixed Assets on Corn Belt Farms. This problem is concerned with estimating the market value of a fixed specialized asset over time, once it has been put in place on a Corn Belt farm. In making this estimate it will be necessary to determine the effect such factors as technology, weather, rate of farm consolidation and farm population decline, and obsolecence of both service buildings and machines have on the demand for fixed assets. The computer will be used to calculate regression coefficients, technology matrices, and indexes which will be used in the final demand quations. (Gordon Rodewald)

1211-4D027 * Chemistry and Chemical Engineering. Unitary Interchange of Matrices. Nuclear Magnetic Double Resonance gives two matrices of immediate concern; one is obtained from resonant frequencies and coupling constants and the other from the allowed transitions and the uncertainty principle. Both matrices are symmetric and the one may be obtained from the others by a unique interchange of corresponding rows and columns. The primary purpose is to calculate an orthogonality transform that will accomplish this interchange. The goal is to be able to obtain useful information, e.g., chemical shifts from the information mentioned above by means of the two matrices and their interchange. (Eugene Friedman)

1212-4D028 * Nuclear Engineering. Neutron Penetration of Structures. The neutron penetration computation will involve 3 problem types: (1) Structures are idealized as semi-infinite media of concrete, or other structural material. Calculations will involve standardized methods, such as multigroup diffusion theory. Perturbations caused by voids (rooms) will be analyzed, by various techniques - possibly Monte Carlo. (2) Apertures or ducts in structure walls will be analyzed, by recently developed methods, such as that of Spencer or Song. This involves albedo calculations of neutron scattering off the walls. (3) Source energy and angular distributions will be studied by calculating penetration of neutrons through many mean-free-paths of air. A moments-code, to be developed under another contract, will be used. (A.B. Chilton)

1213-4D029 T* Physics. Feynman Integrals. The main problem will be the evaluation of Feynman integrals with a large number of variables over a multi-dimensional space, for a number of well-behaved functions. These integrals result from evaluating S-matrix elements in Quantum Field Theory. (J.M. Mangan)

1214-4D030 T* Geology. Pleistocene Geology of St. Louis, Missouri. The research problem deals with the surficial or Pleistocene Geology of the city of St. Louis and St. Louis County, Missouri. The surficial deposits of this area are being mapped in regards to their areal extent and stratigraphic sequence and the mineralogy and size distribution of these deposits are being determined in the laboratory. In addition the geological history of the area, with regards to the surficial deposits, is being determined.

The size distribution is determined by sieve analyses combined with hydrometer analyses. A computer program is available which computes the particle size and percent remaining in solution from the hydrometer analyses. These computations are based on Stokes' Law. (Alan Goodfield)

1215-4D032 Agricultural Economics. Area Resource Adjustments. The purpose of this research is to determine the resource allocation and enterprise combination on a regional basis which will maximize area income subject to constraints of existing soil capabilities, capital limitations, and farm organizations. The computer will be used to solve a linear programming model by the simplex method. (Lowell Hill)

1216-4D034 T Botany. Correlation of environmental factors with tree growth. Multiple regression analyses for possible correlation of environmental factors (daily mean, daily mean maximum, and daily mean minimum temperature, the same for the previous 1st and 2nd days, daily mean, daily maximum, and daily minimum relative humidity, daily wind velocity, weekly precipitation, and weekly soil moisture) with daily and weekly increments of the diameter growth and leaf water and wood water content. The study was conducted on two tree species in each of two forests in Central Illinois. (I. Soerianegara)

1217-4D037 *T Civil Engineering. Optimum Design of Frameworks. The problem is getting the optimum design of frameworks. Given the objective function (the cost of material and connections) and the constraints (the strength, stability, and behavior requirements), the computer is to output the optimal solution. The objective function and the constraints are generally non-linear.

The method of steepest descent is used for getting the solution. When the current point is a free point (all constraints satisfied by a margin) the direction of steepest descent is given by the negative of the unit gradient of the objective function. When some constraints are equality satisfied, these constraints are active constraints and the direction of steepest descent is obtained by sweeping from the direction of steepest descent at a free point the components along the active constraints.

The length of the step (in the admissible direction of steepest descent) is found by the method of binary chopping. Knowing in which direction to move and how far to go, a step is taken to the next point at which the value of the objective function is less. Iteration continues until the optimal solution is reached.

If moving in the direction obtained violated some of the previously active constraints, the program asks for a movement back to the solution space.

In each iteration, the iteration number, the solution vector, the value of the constraints, and the value of the objective function are output. When the optimum solution is obtained it is output in a new pass. (R.A. Ridha)

1218-4D038 * Civil Engineering. Structural Response to Harmonic Water Wave Pressures. Little is known about the dynamic effects of trains of ocean waves on pile supported structures in regions of finite water depth, although a considerable amount of work has been done on single maximum wave forces. The result of this project will be a program (or procedure) that will first determine numerically the harmonic fluid forces and moments on a slender vertical obstacle due to a train of surface gravity waves and then will determine the time varying response of the structure to this particular loading condition. Particular attention will be paid to the forces caused by a train of surface waves moving over a sloping beach.

The fluid forces at different phases of the wave cycle are determined by breaking the force up into two components: the inertia component and the viscous drag component. Velocities and accelerations of the fluid particles that are required in order to determine the force on the obstacle are determined from approximate solutions of the ideal fluid-flow differential equations and the appropriate boundary conditions. Once the forces and their corresponding moment arms have been determined, a harmonic analysis procedure is used to determine a continuous time dependent loading pattern. This loading pattern in turn is used to determine the dynamic response of the vertical obstacle.

Due to the fact that lengthy equations involving transcendental functions define the approximate solution of the progressive water wave differential equations, a digital computer is practically a prerequisite for making the numerical calculations that are involved in carrying out operations such as three point integration, determination of root-mean-square velocities, determination of implicitly defined parameters, and determination of the constants of a harmonic series. (Dick Wiseman)

1219-4D039 * Mining, Metallurgy and Petroleum Engineering. Laser Fracture. The transient-decay of a cylindrical pressure tube is being studied. This is to simulate the effect of the transmission of a Laser beam through a crystal. The numerical problem is to integrate by quadrature the expression

$$P(L,K) = - \int_0^\infty e^{-Kx} \, x \, I_0(Lx) \, I_2(x) \, d\, x$$

for a range of the parameters L and K. (R. Bullough)

4.3 Instructional Problem Specifications

During the fourth quarter of 1964, 27 instructional problem specifications were submitted to the IBM 7094 for calculation. The following brief descriptions of these problems have been prepared for inclusion in this report by those submitting them.

I135-49046 Nuclear Engineering 456. Class Problems. These problems deal with reactor physics calculations. They may be of two types: small Fortran codes written by the students, or codes available through the Argonne Code Library which will be used by the students. A typical example of this is AIM-6, a multi-group diffusion theory code with perturbation theory options. (G. H. Miley)

I136-4Ø003 Mechanical Engineering 214. Turbine Energy Balance. The problem is to operate several steam turbines under practical operating conditions. Data observed is processed by the 1401-7094 digital computer system and tabulated for such operating variables as the steam rate, several component efficiencies and the overall efficiency. The primary objective is to illustrate to the undergraduate that the digital computer can be a powerful engineering tool. (E. F. Hebrank)

I137-4Ø009 Civil Engineering 391. Class Problems - Section E1. Three programming assignments on the 7094 will be given during the semester. In addition, approximately half of the students will work on individual programs for their term projects. (S. J. Fenves)

I138-4Ø010 Civil Engineering 391. Class Problems - Section E2. Three programming assignments on the 7094 will be given. Some students will then write individual programs for their term projects. (J. W. Melin)

I139-4Ø011 Civil Engineering 497. Problem Number 1. Geodetic Adjustments. This problem involves the adjustment of geodetic triangulation, trilateration, traverse and level networks by the method of least squares. A number of photogrammetric adjustment problems are also included.

The formation and solution of the individual problems are accomplished in large part by a special matrix arithmetic program that is available to the students.

In addition to the statistical estimation of the unknowns involved in each problem, the variance of unit weight is estimated, and the precisions of the unknowns and functions of the unknowns are investigated. (G. Gracie)

I140-4Ø013 Aeronautical and Astronautical Engineering 261. Aerodynamics Laboratory. The 7094 will be used to carry out some of the data reduction proces required. In most cases, the computation involves numerical integration of experimentally measured quantities. (Eugene Chang)

I141-4Ø023 Mechanical Engineering 259. Capillary Tube. Calculating the pressure drop when refrigerant flows through a capillary tube is a step-wise process. The students will work in pairs in running programs through for various entering and leaving conditions of the tube. (W. F. Stoecker)

I142-4Ø024 Mechanical Engineering 421. Air Conditioning System Design. The performance of components of a refrigeration system will be expressed mathematicall in terms of series equations, and the performance of the entire system will be predicted by combining these performance characteristics by successive approximatio (W. F. Stoecker)

I143-4Ø025 Electrical Engineering 383. Problem Number 1. Analysis of Linear Networks. Given a network consisting of R's, L's, C's, and voltage-controlled current sources arranged in arbitrary configuration, it is desired to find the poles and zeros, frequency and transient response associated with some network function $T(s)$.

Topological methods are used to find $T(s)$ and numerical integration used to find the transient response. The program itself has already been prepared and will be stored on the disc file. (D. A. Calahan)

I144-4Ø026 Electrical Engineering 324. Problem Number 1. Optimization of Frequency and Response. Given a rational function $T(s)$ in terms of the Laplace transform variable, it is desired to perturb the coefficients of $T(s)$ so as to better approximate a given amplitude response $|T(jw_k)|$, $k = 1,..n$.

The method of steepest descent is used for iteration. The program itself has already been prepared and will be stored on the disc file. (D.A.Calahan

I145-4Ø029 Civil Engineering 318. Problem Number 1. CE 318 Class Problem. This course teaches the practical aspects of construction cost estimating and control. To teach this material properly, the students must be able to use modern techniques. The students will process data on fully operational programs. Most of the processing will be done using a program which performs the basic computations of quantity take-off; it also calculates volume, surface area, and perimeter; it sums lengths and numbers of items. From a description of the item to be taken off, required calculations are carried out and the results stored. (W. Lyle Meyer)

I146-4Ø030 Aeronautical and Astronautical Engineering 241. Problem Number 1. Flight Vehicle Design. The design problem involves the optimization of a single stage, liquid propellant rocket vehicle. The computer will be used to aid in the optimization studies of the flight trajectory, the vehicle structure, and engine performance parameters.

Various sub-programs will be formulated, such as pump performance, turbine performance, heat transfer and stress analysis. The sub-programs will aid in optimizing individual components, and will then be used together, as much as possible, for propulsion system and vehicle optimization. (V. P. Roan)

I147-4Ø032 General Engineering 288. Problem No. 2. Batch-Flow Sequencing. An algorithm for Batch Flow Job Shop scheduling will be developed as a special project. In addition the students will work several linear programming problems using the existing programs. (Descheck)

I148-4Ø033 Electrical Engineering 386. Automatic Control Systems. The class problems will generally involve the following types of problems: transient responses of high-order systems (given a deterministic input, find the output response of a linear system); root locus plots (given a high-order polynomial with one or more variable coefficients, plot the roots of the polynomial as a function of the variable coefficient); frequency response plots; and nonlinear system analysis (with on-off control). Only standard library routines will be used. (B. C. Kuo)

I149-4Ø034 Electrical Engineering 454. Discrete-data Control Systems. These class problems deal with control systems that have discrete data. Most of the problems involve Z-transforms and the solution of matrix equations. Some root locus problems will also be run.

Only standard library routines are necessary. (B. C. Kuo)

I150-4Ø048 Theoretical and Applied Mechanics 293. Research, Development and Design. The problems will be concerned with generation of waves about the flow of a surface vessel of various simple and complex shapes.

Vibrations of multidegree of freedom systems will also be treated. (Will J. Worley)

I151-4Ø056 Ceramic Engineering 422. X-Ray Diffraction Analysis. Calculations of unit cell dimensions and extrapolated back reflection data from diffractometer film patterns taken from specimens at elevated temperature will be carried out. Changes in cell dimensions as a function of temperature and solid solution composition are to be determined. (A. W. Allen)

I152-4Ø057 Mathematics 387. Mathematics 387 Class Problems. A series of problems in numerical analysis will be assigned which the students may run on the computer. (C. W. Gear)

I153-4N008 Mechanical Engineering 221. Kinematic Studies. The problems to be studied will deal with the kinematics of mechanical systems. The solutions will involve algebra and differential equations of motion. Repeated calculations will be made to analyze entire cycles of operation. (C. Larson)

I154-4N013 Electrical Engineering 389. Problem No. 1. Receiver Tracking Problem. This problem is part of a larger problem of designing a radio receiver. It consists of calculating the points for a tracking curve in which certain specified values are given. By means of simple algebraic manipulations, the actual intermediate frequency is determined. The problem is to be put on the computer since the same operation is repeated many times to cover the entire band of frequencies, and accuracy to at least 5 significant figures is required. (P. F. Schwarzlose)

I155-4N036 Industrial Engineering 237. Problem No. 1. Space Requirement. Large manufacturing organizations are frequently faced with skilled manpower demands which cannot be met by the Personnel Department and must set up factory training programs to obtain these specialized workers. The required space must be determined based on the type and extent of training to be given and space needed for this use.

This problem is concerned with the determination of the number of classrooms needed and the areas required for the classrooms and associated workshops per month over an extended period into the future by the Space Allocations Department. A schedule of the number and kind of workers to be trained each month is the only information supplied to the Space Allocations Department.

Standard data has been developed from studies of the situation to include such information as the number of trainees per classroom, the departmental square feet per trainee for classroom and for workshop and other special allowances. Special formulas have been constructed based on the various relationships to obtain the number of classrooms and the areas required.

Other data is provided for printout so that the results of the new computations can be readily compared with projections of space already allocated and available space. (Anderson)

I156-4D002 Industrial Engineering 350. Problem No. 2. Computing Cutting Speeds. The program will calculate cutting speeds of high power turret drills given tool material, material type, material life, thickness of material, and other parameters. (L. E. Doyle)

I157-4D017 General Engineering 393. Production Sequencing and Process Planning. Selection of technological production sequence and the scheduling thereof by computer system. The selection process will be generative rather than by recall. The mathematical basis comes from the work of Giffler and Thompson as reported in U. of O. R. 1959 and Miller and Hohn on Networks found in IRE Journals 1957. This problem is an extension of topics taken up in GE 288. (D. E. Scheck)

I158-4D018 * Marketing 321. Illini Union Communication Use-Study. We wish to use the distribution analysis and the cross tabulation SSUPAC programs for analyses of questionnaire data. This research problem is a questionnaire study of students' attitudes towards and use of the Illini Union. (Deboer)

I159-4D035 Economics 470. Graduate Student Education-Solutions for Economic Models. Each of 30 students in Economics 470 is responsible for the construction of an econometric model and for the estimates of the parameters of the model. It is to obtain these estimates that the requested machine time is needed. (Aigner)

I160-4D040 Industrial Administration 205. Linear Program. Linear programming is a convenient way to formulate production planning problems. By using the disk linear program, the student is freed of long computational time and can use more of his time on problem formulation and answer interpretation. (R. M. Burton)

I161-4D041 Nuclear Engineering 495. Dose Attenuation. The object is to determine the total dose rate (neutron plus secondary gamma) received in an underground detector due to irradiation of the ground surface with broad parallel neutron beams of single energy, E_o. It is assumed that initial collisions of the original beam will give rise to plane, isotropic neutron sources of energy E. at various points below the ground surface.

A multigroup diffusion approximation is used. The computer will be used to average the various cross sections required. These values being known, the computer can be used to generate the coefficients required for the solution of the fluxes in all assumed energy groups. Numerical integration is used to add up the contribution of all plane isotropic sources to get the fluxes at any point due to the original beam.

These fluxes give rise to secondary gammas (through inelastic scattering and neutron capture). Numerical integration of fluxes at all points will then yield the gamma dose at any desired point.

The dose rate at a point due to neutron fluxes can be found by use of the appropriate flux-to-dose conversion.

The total dose rate at a point is then the sum of the gamma dose contribution and neutron dose contribution at that point. (A.B. Chilton)

Table I - IBM 1401-I

Summary of Use

October, 1964

Scheduled Engineering		5:50
Unscheduled Engineering		17:44
Maintenance		8:03
7094 Preparation		419:21
Listing		18:36
Monthly Report Listing		2:44
Code Checking		18:24
Tape Dump		2:44
Reproduction		21:01
1604 Preparation		:20
Scanning Measuring Projector		6:48
Tape Testing		1:35
Idle		84:18
	Total	607:28

Table II - IBM 1401-I

Summary of Machine Errors

October, 1964

1402 Card Reader-Punch		12
1403 Printer		1
729 V Tape Drives		3
	Total	16

Table I - IBM 1401-II

Summary of Use

October, 1964

Scheduled Engineering		13:35
Unscheduled Engineering		32:49
Maintenance		10:11
7094 Preparation		324:55
Listing		17:37
Monthly Report Listing		5:43
Code Checking		18:54
Tape Dump		1:48
Reproduction		20:32
1604 Preparation		:05
Scanning Measuring Projector		11:47
Tape Testing		12:50
Idle		121:02
	Total	591:48

Table II - IBM 1401-II

Summary of Machine Errors

October, 1964

1401 Main Frame		6
1402 Card Reader-Punch		7
729 V Tape Drives		2
	Total	15

Table I - IBM 7094

Summary of Use

October, 1964

Scheduled Engineering			48:21
Unscheduled Engineering			7:28
Maintenance			9:37
Air Conditioning			:20
Miscellaneous (Operator training, tape rewind, both system and user, rerun of failing problems, tape skipping, destruction of clock reading.)			141:29
Total Use (See also Table III)			
Training and Education			26:59
System Updating			3:22
System Improvement and Modification			38:26
System Improvement and Modification (Relinquish)			2:49
Customer Use			
In System		418:22	
Relinquish			
AGEC	9:32		
ME	:20		
PHYCS	35:01		
		44:53	
Special Short Shots		2:54	
Total Customer Use			466:09
Total Use			537:45
Total Time On			745:00

Table II - IBM 7094

Summary of Machine Errors

October, 1964

7094	2
7302 Core Storage Unit	1
7607 Data Channel	2
7606 Multiplexor	1
729 VI Tape Drives	7
711 Card Reader	3
716 Printer	1
Total	17

Dept[1]	Number of Runs			Number of Specs			7094 Usage in Hours-Minutes		
	TandE[2]	Res	Total	TandE[2]	Res	Total	TandE[2]	Res	Total
AAE	80	92	172	3	5	8	1 27.0	3 2.5	4 29.5
ADMRE	0	65	65	0	1	1	0.0	2 52.5	2 52.5
AGE	0	49	49	0	3	3	0.0	23.8	23.8
AGEC	0	247	247	0	20	20	0.0	13 49.6	13 49.6
AGRON	668	166	834	1	15	16	7 0.2	2 46.1	9 46.4
ANGEN	0	57	57	0	2	2	0.0	42.1	42.1
ANS	0	40	40	0	2	2	0.0	29.8	29.8
ANTH	0	31	31	0	1	1	0.0	25.2	25.2
ASTR	0	32	32	0	2	2	0.0	12.2	12.2
BECBS	0	18	18	0	3	3	0.0	54.4	54.4
BOT	0	3	3	0	1	1	0.0	0.5	0.5
CE	184	755	939	6	30	36	1 58.3	76 48.1	78 46.4
CERE	3	0	3	1	0	1	1.0	0.0	1.0
CHE	59	1102	1161	1	48	49	17.0	40 28.3	40 45.4
COMM	0	49	49	0	1	1	0.0	2 7.2	2 7.2
CSL	0	4	4	0	1	1	0.0	0.8	0.8
DCL	264	217	481	3	13	16	4 13.8	41 33.2	45 47.0
DS	0	117	117	0	4	4	0.0	1 1.7	1 1.7
ECON	0	72	72	0	3	3	0.0	1 11.9	1 11.9
ED	0	122	122	0	4	4	0.0	6 10.2	6 10.2
EE	99	342	441	4	20	24	41.5	7 5.3	7 46.9
FIN	0	24	24	0	1	1	0.0	20.2	20.2
FOR	0	9	9	0	1	1	0.0	1 19.7	1 19.7
GENE	1	0	1	1	0	1	23.0	0.0	23.0
GEOG	0	27	27	0	1	1	0.0	25.8	25.8
GEOL	0	1	1	0	1	1	0.0	0.1	0.1
GSBA	55	62	117	2	1	3	36.8	45.4	1 22.3
HORT	0	5	5	0	1	1	0.0	4.4	4.4
ICR	0	88	88	0	3	3	0.0	1 8.6	1 8.6
IE	118	6	124	2	1	3	50.9	1.4	52.4
IED	0	36	36	0	2	2	0.0	21.5	21.5
INADM	0	13	13	0	2	2	0.0	11.4	11.4
IREC	0	11	11	0	3	3	0.0	5.9	5.9
MATH	2616	0	2616	1	0	1	6 0.4	0.0	6 0.4
ME	118	734	852	6	24	30	53.7	104 23.1	105 16.9
MKTG	0	17	17	0	1	1	0.0	1 4.3	1 4.3
MMPE	0	50	50	0	4	4	0.0	34.8	34.8
MUSIC	0	1	1	0	1	1	0.0	0.3	0.3
NHS	0	15	15	0	2	2	0.0	1 9.6	1 9.6
NUCE	101	141	242	3	8	11	1 50.3	3 24.2	5 14.6

7094 TABLE III OCTOBER 1964 - CONT

Dept[1]	Number of Runs			Number of Specs			7094 Usage in Hours-Minutes		
	TandE[2]	Res	Total	TandE[2]	Res	Total	TandE[2]	Res	Total
PEM	0	11	11	0	1	1	0.0	14.6	14.6
PHYCS	16	1677	1693	2	34	36	4.4	101 13.9	101 18.3
PHYSL	0	1	1	0	1	1	0.0	0.1	0.1
PSYCH	0	389	389	0	28	28	0.0	13 2.3	13 2.3
SCONS	0	25	25	0	2	2	0.0	15.1	15.1
SCS	0	55	55	0	1	1	0.0	35.8	35.8
SGS	0	2	2	0	1	1	0.0	0.3	0.3
SHCBR	0	21	21	0	1	1	0.0	27.9	27.9
SOC	0	14	14	0	2	2	0.0	45.8	45.8
SPCH	0	19	19	0	3	3	0.0	6.5	6.5
SSU	0	480	480	0	2	2	0.0	16 58.5	16 58.5
SWS	0	130	130	0	12	12	0.0	6 36.0	6 36.0
TAM	11	169	180	1	8	9	40.3	3 30.3	4 10.6
VMS	0	2	2	0	1	1	0.0	2.6	2.6
XSSS[3]	0	379	379	0	1	1	0.0	2 54.3	2 54.3
ZOOL	0	18	18	0	3	3	0.0	24.7	24.7
Subtotal	4393	8297	12690	37	338	375	26 59.5	466 09.3	493 08.8
DCLSY[4]	0	1322	1322	0	17	17	0.0	41 15.1	41 15.1
XDCL[5]	0	42	42	0	1	1	0.0	3 21.6	3 21.6
Total	4393	9661	14054	37	356	393	26 59.5	510 46.0	537 45.5

[1] See list of departmental codes following

[2] Training and Education

[3] Special Short Shots

[4] System Improvement and Modification

[5] System Updating

TABLE I - IBM 1401-I

Summary of Use

November, 1964

Scheduled Engineering	5:05
Unscheduled Engineering	2:20
Machine Maintenance	9:44
Air Conditioning	2:35
7094 Preparation	408:17
Listing	14:33
Monthly Report Listing	:54
Code Checking	11:45
Tape Duplication	:31
Tape Dumping	1:46
Reproductions	30:18
1604 Preparation	:20
Scanning Measuring Projector	18:18
Tape Testing	4:03
Tape Labeling	:34
Idle	43:51
Total	554:54

TABLE II - IBM 1401-II

Summary of Machine Errors

November, 1964

1401 Main Frame	1
1402 Card Reader Punch	1
729 V Tape Drive	2
1401 Air Conditioning Unit	1
Total	5

TABLE I - 1401 II

Summary of Use

November, 1964

Scheduled Engineering	4:30
Unscheduled Engineering	10:51
Machine Maintenance	7:29
7094 Preparation	340:25
Listing	15:07
Monthly Report Listing	4:05
Code Checking	6:55
Tape Duplication	1:40
Tape Dumping	2:39
Reproduction	28:52
1604 Preparation	:10
Scanning Measuring Projector	17:05
Tape Testing	6:12
Idle	71:11
Total	517:11

TABLE II - IBM 1401-II

Summary of Machine Errors

November, 1964

1402 Card Reader Punch	7
1403 Printer	4
729 V Tape Drives	4
Total	15

TABLE I - IBM 7094

Summary of Use

November, 1964

Scheduled Engineering				43:52
Unscheduled Engineering				17:06
Maintenance				9:57
Air Conditioning				1:25
Miscellaneous (Operator training, Tape rewind, Tape mounting, both systems and user, rerun of failing problems, Tape skipping, destruction of clock reading)				84:16
Idle				:22
Total Use				
Training and Education			45:44	
System Updating			4:36	
System Improvement and Modification			50:35	
System Improvement and Modification (Relinquish)			13:00	
Customer Use				
In System		262:27		
Relinquish				
AGEC	2:27			
CSL	1:48			
ME	:06			
PHYCS	57:54			
SSU	:04			
(Relinquish)		62:19		
Special Short Shots		1:54		
(Customer Use)			326:40	
Total Use				440:35
Total Time On				597:33

TABLE II - IBM 7094

Summary of Machine Errors

November, 1964

716 On Line Printer	1
721 Card Punch	1
729 VI Tape Drives	11
1301 Disk Storage Unit	3
7606 Multiplexor	1
Total	17

Dept[1]	Number of Runs			Number of Specs			7094 Usage in Hours-Minutes		
	TandE[2]	Res	Total	TandE[2]	Res	Total	TandE[2]	Res	Total
AAE	85	120	205	3	8	11	1 18.6	2 31.9	3 50.6
ACCY	0	1	1	0	1	1	0.0	0.0	0.0
ADV	0	7	7	0	1	1	0.0	44.2	44.2
AGE	0	16	16	0	1	1	0.0	5.3	5.3
AGEC	0	169	169	0	18	18	0.0	6 40.7	6 40.7
AGED	0	2	2	0	1	1	0.0	17.0	17.0
AGRON	584	150	734	1	12	13	10 58.3	2 44.8	13 43.1
ANGEN	0	7	7	0	2	2	0.0	9.8	9.8
ANS	0	76	76	0	2	2	0.0	1 17.9	1 17.9
ANTH	0	19	19	0	1	1	0.0	9.3	9.3
ASTR	0	15	15	0	2	2	0.0	3.7	3.7
BECBS	0	24	24	0	4	4	0.0	19.6	19.6
CE	449	885	1334	6	30	36	2 50.6	58 32.9	61 23.6
CERE	21	0	21	1	0	1	10.6	0.0	10.6
CHE	197	855	1052	1	42	43	1 0.2	34 58.7	35 58.9
COMM	0	55	55	0	1	1	0.0	2 12.7	2 12.7
CSL	0	18	18	0	1	1	0.0	3 42.1	3 42.1
DCL	187	210	397	3	12	15	2 0.7	12 7.7	14 8.4
DS	0	43	43	0	3	3	0.0	32.4	32.4
ECON	0	36	36	0	4	4	0.0	33.8	33.8
ED	0	117	117	0	5	5	0.0	2 10.0	2 10.0
EDTES	0	6	6	0	1	1	0.0	3.2	3.2
EE	723	355	1078	7	17	24	4 50.5	6 18.5	11 9.0
FIN	0	36	36	0	2	2	0.0	32.1	32.1
FOR	0	8	8	0	1	1	0.0	5.3	5.3
GENE	5	0	5	1	0	1	20.5	0.0	20.5
GEOG	0	20	20	0	1	1	0.0	23.6	23.6
GEOL	0	4	4	0	1	1	0.0	0.5	0.5
GSBA	131	118	249	2	1	3	1 17.9	1 10.5	2 28.5
ICR	0	53	53	0	2	2	0.0	1 24.5	1 24.5
IE	21	2	23	2	1	3	9.8	0.9	10.8
IED	0	12	12	0	1	1	0.0	12.4	12.4
IGPA	0	5	5	0	1	1	0.0	4.3	4.3
INADM	0	10	10	0	2	2	0.0	8.2	8.2
IREC	0	1	1	0	1	1	0.0	0.5	0.5
LIBS	0	1	1	0	1	1	0.0	4.5	4.5
MATH	3583	0	3583	3	0	3	16 30.7	0.0	16 30.7
MCBIO	0	9	9	0	1	1	0.0	25.8	25.8
ME	319	649	968	7	26	33	2 33.3	17 13.4	19 46.8

7094 TABLE III November 1964 - CONT

Dept[1]	Number of Runs			Number of Specs			7094 Usage in Hours-Minutes		
	TandE[2]	Res	Total	TandE[2]	Res	Total	TandE[2]	Res	Total
MKTG	0	2	2	0	1	1	0.0	2.5	2.5
MMPE	0	65	65	0	6	6	0.0	46.6	46.6
MUSIC	0	15	15	0	1	1	0.0	7.7	7.7
NHS	0	8	8	0	1	1	0.0	38.9	38.9
NUCE	71	97	168	3	7	10	55.9	1 43.3	2 39.2
OIR	0	59	59	0	2	2	0.0	1 10.1	1 10.1
PEM	0	10	10	0	1	1	0.0	5.2	5.2
PHYCS	51	1845	1896	2	35	37	38.0	123 37.3	124 15.3
PHYSL	0	2	2	0	1	1	0.0	0.2	0.2
PSYCH	0	598	598	0	25	25	0.0	12 49.7	12 49.7
SCONS	0	9	9	0	2	2	0.0	7.3	7.3
SCS	0	4	4	0	2	2	0.0	4.8	4.8
SGS	0	12	12	0	1	1	0.0	4.6	4.6
SHCBR	0	14	14	0	1	1	0.0	10.0	10.0
SOC	0	13	13	0	2	2	0.0	13.5	13.5
SPCH	0	3	3	0	1	1	0.0	20.9	20.9
SSU	0	543	543	0	2	2	0.0	14 27.2	14 27.2
SWS	0	107	107	0	12	12	0.0	2 32.2	2 32.2
TAM	13	182	195	1	8	9	7.4	7 15.0	7 22.5
VMS	0	20	20	0	1	1	0.0	18.2	18.2
XSSS[3]	0	263	263	0	1	1	0.0	1 53.9	1 53.9
ZOOL	0	4	4	0	1	1	0.0	4.9	4.9
Subtotal	6440	7989	14429	43	325	368	45 43.7	326 40.4	372 24.2
DCLSY[4]	0	1081	1081	0	17	17	0.0	63 35.1	63 35.1
XDCL[5]	0	62	62	0	1	1	0.0	4 35.7	4 35.7
Total	6440	9132	15572	43	343	386	45 43.7	394 51.2	440 35.0

[1] See list of departmental codes following

[2] Training and Education

[3] Special Short Shots

[4] System Improvement and Modifications

[5]

Table I - IBM 1401 I

Summary of Use

December, 1964

Scheduled Engineering	1:05
Unscheduled Engineering	3:13
Maintenance	8:28
7094 Preparation	462:33
Listing	13:25
Monthly Report	4:59
Code Checking	5:30
Tape Duplication	18:00
Tape Dumping	5:30
Reproduction	29:05
Scanning Measuring Projector	16:05
Tape Testing	3:09
Tape Labeling	:50
Illiac II Preparation	3:37
Idle	43:54
Total	619:23

Table II - IBM 1401 I

Summary of Machine Errors

December, 1964

1402 Card reader Punch	6
1403 Printer	4
Total	10

Table I - IBM 1401 II

Summary of Use

December, 1964

Scheduled Engineering	3:00
Unscheduled Engineering	8:31
Maintenance	8:41
7094 Preparation	455:47
Listing	24:53
Monthly Report	3:15
Code Checking	10:19
Tape Duplication	1:45
Tape Dumping	:45
Reproduction	28:25
Scanning Measuring Projector	14:59
Tape Testing	4:42
Tape Labeling	:50
Idle	56:45
Total	622:37

Table II - IBM 1401 II

Summary of Machine Errors

December, 1964

1402 Card Reader-Punch	4
1403 Printer	1
1406 Core Storage Unit	1
Total	6

Table I - IBM 7094

Summary of Use

December, 1964

Scheduled Engineering				28:29
Unscheduled Engineering				40:08
Maintenance				7:29
Idle				1:28
Miscellaneous (Operator training, tape rewind, Tape mounting, both System and user, Rerun of failing problems, tape skipping, Destruction of clock reading)				102:31
Total Use				
	Training and Education			62:17
	System Updating			5:41
	System Modification and Improvement			43:36
	System Modification and Improvement (Relinquish)			13:30
	Customer Use			
		In System	283:02	
		Relinquish		
		AGEC	21:23	
		CSL	:29	
		ED	1:11	
		PHYCS	87:14	
			110:17	
		Special Short Shots	1:21	
				394:40
		Total Use		519:44
				699:49

Table II - IBM 7094

Summary of Machine Errors

December, 1964

716 On-Line Printer	3
721 Card Punch	3
729 VI Tape Drives	11
1301 Disk Storage Unit	1
7110 Central Processing Unit	3
7302 Core Storage Unit	1
7094	1
Total	23

7094 Table III December 1964

Dept[1]	Number of Runs			Number of Specs			7094 Usage in Hours-Minutes		
	TandE[2]	Res	Total	TandE[2]	Res	Total	TandE[2]	Res	Total
AAE	91	116	207	3	6	9	1 47.5	2 48.1	4 35.6
ACCY	0	1	1	0	1	1	0.0	0.3	0.3
ADV	0	9	9	0	2	2	0.0	28.1	28.1
AGE	0	26	26	0	2	2	0.0	22.5	22.5
AGEC	0	281	281	0	23	23	0.0	28 30.0	28 30.0
AGED	0	5	5	0	1	1	0.0	54.7	54.7
AGRON	757	225	982	1	13	14	15 6.5	5 15.8	20 22.4
ANGEN	0	2	2	0	2	2	0.0	1.2	1.2
ANS	0	46	46	0	3	3	0.0	42.2	42.2
ANTH	0	86	86	0	1	1	0.0	1 19.4	1 19.4
ASTR	0	4	4	0	1	1	0.0	1.4	1.4
BECBS	0	50	50	0	6	6	0.0	1 7.1	1 7.1
BOT	0	24	24	0	1	1	0.0	15.3	15.3
CE	747	1017	1764	6	34	40	6 54.6	40 15.5	47 10.1
CERE	18	0	18	1	0	1	11.3	0.0	11.3
CHE	124	1012	1136	1	48	49	42.6	68 0.2	68 42.8
COMM	0	34	34	0	1	1	0.0	1 40.1	1 40.1
CRC	0	8	8	0	1	1	0.0	3.2	3.2
CSL	0	12	12	0	1	1	0.0	48.1	48.1
DCL	127	253	380	2	9	11	1 36.9	10 29.8	12 6.8
DS	0	106	106	0	4	4	0.0	1 4.2	1 4.2
ECON	0	42	42	0	4	4	0.0	53.3	53.3
ED	0	82	82	0	6	6	0.0	3 20.2	3 20.2
EDTES	0	43	43	0	1	1	0.0	56.0	56.0
EE	977	524	1501	11	18	29	6 38.8	11 43.0	18 21.8
FIN	0	39	39	0	2	2	0.0	26.3	26.3
GENE	22	8	30	1	1	2	47.9	24.5	1 12.5
GEOG	0	18	18	0	1	1	0.0	32.8	32.8
GEOL	0	19	19	0	2	2	0.0	8.9	8.9
GSBA	208	69	277	3	1	4	3 50.2	1 20.6	5 10.8
HORT	0	2	2	0	1	1	0.0	5.3	5.3
ICR	0	91	91	0	3	3	0.0	4 49.2	4 49.2
IE	50	3	53	3	1	4	14.5	0.4	14.9
IGPA	0	14	14	0	1	1	0.0	25.6	25.6
INADM	0	62	62	0	2	2	0.0	35.1	35.1
INSTT	0	1	1	0	1	1	0.0	0.0	0.0
IREC	0	2	2	0	1	1	0.0	2.0	2.0
MATH	2089	0	2089	3	0	3	18 41.7	0.0	18 41.7
ME	470	689	1159	7	22	29	3 19.7	18 9.6	21 29.3

Dept[1]	Number of Runs			Number of Specs			7094 Usage in Hours-Minutes		
	TandE[2]	RES	Total	TandE[2]	Res	Total	TandE[2]	Res	Total
MEDIC	0	4	4	0	1	1	0.0	9.5	9.5
MKTG	0	6	6	0	1	1	0.0	5.5	5.5
MMPE	0	118	118	0	6	6	0.0	1 24.6	1 24.6
MUSIC	0	43	43	0	1	1	0.0	40.5	40.5
NHS	0	4	4	0	2	2	0.0	5.8	5.8
NUCE	18	138	156	3	9	12	6.2	3 43.0	3 49.3
OIR	0	79	79	0	4	4	0.0	2 13.8	2 13.8
PEM	0	19	19	0	2	2	0.0	34.6	34.6
PHYCS	50	1940	1990	1	38	39	1 55.8	143 4.3	145 0.2
PHYSL	0	2	2	0	1	1	0.0	0.3	0.3
POLS	0	5	5	0	1	1	0.0	7.4	7.4
PROVS	0	5	5	0	1	1	0.0	8.5	8.5
PSYCH	0	446	446	0	25	25	0.0	13 33.8	13 33.8
SCONS	0	38	38	0	1	1	0.0	26.8	26.8
SCS	0	17	17	0	2	2	0.0	32.7	32.7
SGS	0	30	30	0	1	1	0.0	8.3	8.3
SHCBR	0	10	10	0	1	1	0.0	10.2	10.2
SOC	0	38	38	0	4	4	0.0	5 30.3	5 30.3
SSU	0	365	365	0	2	2	0.0	9 22.7	9 22.7
SWS	0	112	112	0	13	13	0.0	1 54.2	1 54.2
TAM	37	139	176	2	9	11	22.3	1 22.7	1 45.1
VMS	0	1	1	0	1	1	0.0	0.9	0.9
XSSS[3]	0	246	246	0	1	1	0.0	1 21.2	1 21.2
Subtotal	5785	8830	15615	48	355	403	62 17.3	394 45.2	457 02.6
DCLSY[4]	0	1514	1514	0	19	19	0.0	57 5.8	57 5.8
XDCL[5]	0	73	73	0	1	1	0.0	5 35.2	5 35.2
Total	5785	10448	16233	48	375	423	62 17.3	457 26.2	519 43.6

1 See list of departmental codes following
2 Training and Education
3 Special short shots
4 System Improvement and Modifications
5 System Updating

4.4 List of Department Codes

IF YOUR DEPARTMENT OR OFFICE DOES NOT APPEAR ON THIS LIST, PLEASE WRITE ITS FULL NAME IN THE DEPARTMENT FIELD (8) ON THE PROBLEM SPECIFICATION FORM EVEN THOUGH IT WILL REQUIRE MORE THAN 6 CHARACTERS.

ACCY	ACCOUNTANCY
ACTGDV	ACCOUNTING DIVISION
ACCREC	ACCOUNTS RECEIVABLE
ADMREC	ADMISSIONS AND RECORDS
ADV	ADVERTISING
AAE	AERONAUTICAL AND ASTRONAUTICAL ENGINEERING
AGEC	AGRICULTURAL ECONOMICS
AGED	AGRICULTURAL EDUCATION
AGE	AGRICULTURAL ENGINEERING
AGREXT	AGRICULTURAL EXTENSION
AGR	AGRICULTURE
AGRON	AGRONOMY
AFS	AIR FORCE SCIENCE
ALUMNI	ALUMNI ASSOCIATION
AMCIV	AMERICAN CIVILIZATION
AMLIT	AMERICAN LITERATURE
ANGEN	ANIMAL GENETICS
ANNU	ANIMAL NUTRITION
ANS	ANIMAL SCIENCE
ANTH	ANTHROPOLOGY
ARCH	ARCHITECTURE
ART	ART
ASTR	ASTRONOMY
AUDIT	AUDITING DIVISION
AVI	AVIATION
BAND	BANDS
BIOPH	BIOPHYSICS
BOT	BOTANY
BCMPL	BUREAU OF COMMUNITY PLANNING
BECBSR	BUREAU OF ECONOMIC AND BUSINESS RESEARCH
BEDRES	BUREAU OF EDUCATIONAL RESEARCH
BINRES	BUREAU OF INSTITUTIONAL RESEARCH
BURSAR	BURSAR'S OFFICE
GSBA	BUSINESS ADMINISTRATION, GRADUATE SCHOOL
BED	BUSINESS EDUCATION
BLAW	BUSINESS LAW
CZR	CENTER FOR ZOONOSES RESEARCH
CERE	CERAMIC ENGINEERING
CHE	CHEMISTRY AND CHEMICAL ENGINEERING
CP	CITY PLANNING
CE	CIVIL ENGINEERING
CRC	CHILDREN'S RESEARCH CENTER
CLASS	CLASSICS
COMM	COMMUNICATIONS
CMPTOL	COMPTROLLER'S OFFICE
CSL	COORDINATED SCIENCE LABORATORY
DHIA	DAIRY HERD IMPROVEMENT ASSOCIATION
DS	DAIRY SCIENCE
DT	DAIRY TECHNOLOGY
DANCE	DANCE
DCS	DEPARTMENT OF COMPUTER SCIENCE

DCLSYS	DIGITAL COMPUTER LABORATORY SYSTEM DEVELOPMENT
DGS	DIVISION OF GENERAL STUDIES L A S
ECON	ECONOMICS
ED	EDUCATION
EDTEST	EDUCATIONAL TESTING
EE	ELECTRICAL ENGINEERING
ENGLSH	ENGLISH
ENGL	ENGLISH LITERATURE
ENTOM	ENTOMOLOGY
EOC	EXTENSION DIVISION, COUNSELING
FIN	FINANCE
FT	FOOD SCIENCE
FOR	FORESTRY
FR	FRENCH
GENE	GENERAL ENGINEERING
GEOG	GEOGRAPHY
GEOL	GEOLOGY
GER	GERMAN
GRDCOL	GRADUATE COLLEGE
GRK	GREEK
HED	HEALTH EDUCATION
HLTHSV	HEALTH SERVICE
HIST	HISTORY
HEC	HOME ECONOMICS
HORT	HORTICULTURE
HUMAN	HUMANITIES
HYG	HYGIENE
INADM	INDUSTRIAL ADMINISTRATION
IED	INDUSTRIAL EDUCATION
IE	INDUSTRIAL ENGINEERING
IREC	INSTITUTE FOR RESEARCH ON EXCEPTIONAL CHILDREN
ICR	INSTITUTE OF COMMUNICATIONS RESEARCH
IGPA	INSTITUTE OF GOVERNMENT AND PUBLIC AFFAIRS
ILR	INSTITUTE OF LABOR AND INDUSTRIAL RELATIONS
INSURE	INSURANCE OFFICE
ITAL	ITALIAN
JOURN	JOURNALISM
LIR	LABOR AND INDUSTRIAL RELATIONS
LA	LANDSCAPE ARCHITECTURE
LAT	LATIN
LAW	LAW
LAS	LIBERAL ARTS AND SCIENCES
LIBS	LIBRARY SCIENCE
LING	LINGUISTICS
MKTG	MARKETING
MATH	MATHEMATICS
MKNLY	MC KINLEY HOSPITAL
ME	MECHANICAL ENGINEERING
MEDIC	MEDICINE
MRHA	MEN'S RESIDENCE HALL ASSOCIATION
MRHARC	MEN'S RESIDENCE HALL ASSOCIATION ROCKET CLUB
MCBIO	MICROBIOLOGY
MILS	MILITARY SCIENCE
MMPE	MINING, METALLURGY AND PETROLEUM ENGINEERING
MUSIC	MUSIC
NHS	NATURAL HISTORY SURVEY
NS	NAVAL SCIENCE

NUCE	NUCLEAR ENGINEERING
OT	OCCUPATIONAL THERAPY
OIR	OFFICE OF INSTRUCTIONAL RESOURCES
PHIL	PHILOSOPHY
PEM	PHYSICAL EDUCATION FOR MEN AND GRADUATE PE
PEW	PHYSICAL EDUCATION FOR WOMEN
PHYPLA	PHYSICAL PLANT
PHYCS	PHYSICS
PHYSL	PHYSIOLOGY
PLPA	PLANT PATHOLOGY
POLS	POLITICAL SCIENCE
PORT	PORTUGUESE
PROVST	PROVOST'S OFFICE
PSYTRY	PSYCHIATRY
PSYCH	PSYCHOLOGY
PUR	PURCHASING DIVISION
RTV	RADIO AND TELEVISION
REC	RECREATION
RHET	RHETORIC
RSOC	RURAL SOCIOLOGY
RUSS	RUSSIAN
RUSHIS	RUSSIAN LANGUAGE AND AREA STUDIES
SED	SAFETY EDUCATION
SHCBRC	SMALL HOMES COUNCIL, BUREAU OF RESIDENTIAL CONSTRUCTION
SOCS	SOCIAL SCIENCES
SOCW	SOCIAL WORK
SOC	SOCIOLOGY
SCONS	SOIL CONSERVATION SERVICE
SPAN	SPANISH
SPCH	SPEECH AND THEATRE
SCONSV	STATE DEPARTMENT OF CONSERVATION
SGS	STATE GEOLOGICAL SURVEY
SWS	STATE WATER SURVEY
SSU	STATISTICAL SERVICES UNIT
SCS	STUDENT COUNSELING SERVICE
TCHRPL	TEACHER PLACEMENT
TAM	THEORETICAL AND APPLIED MECHANICS
UNIHI	UNIVERSITY HIGH SCHOOL
UIFOUN	UNIVERSITY OF ILLINOIS FOUNDATION
VAH	VETERINARY ANATOMY AND HISTOLOGY
VCM	VETERINARY CLINICAL MEDICINE
VMS	VETERINARY MEDICAL SCIENCE
VPH	VETERINARY PATHOLOGY AND HYGIENE
VPP	VETERINARY PHYSIOLOGY AND PHARMACOLOGY
VTED	VOCATIONAL AND TECHNICAL EDUCATION
ZOOL	ZOOLOGY

5. GENERAL LABORATORY INFORMATION

5.1 Colloquia

"A Table-Driven Compiler-Compiler," by Robert S. Northcote, Digital Computer Laboratory, University of Illinois, Urbana, Illinois, October 5, 1964.

"A Search by Computer for Orthogonal Latin Squares of Order 10," by Professor Ernest Parker, Department of Mathematics, University of Illinois, Urbana, Illinois, October 19, 1964.

"Computing Functions Efficiently," by Professor John R. Rice, Department of Mathematics, Purdue University, West Lafayette, Indiana, October 26, 1964.

"Computer Based Teaching," by Professor Lawrence M. Stolurow, Department of Psychology, University of Illinois, Urbana, Illinois, November 2, 1964.

"Design of a Signed-Digit Arithmetic Processor," by Professor Algirdas Avizienis, Department of Engineering, Jet Propulsion Laboratory, University of California at Los Angeles, Pasadena, California, November 9, 1964.

"Simple Minded Programs," by Professor John Myhill, Digital Computer Laboratory, University of Illinois, Urbana, Illinois, November 16, 1964.

"Modes of Sequential Circuit Operation," by Professor Edward J. McCluskey, Department of Electrical Engineering, Princeton University, Princeton, New Jersey, November 23, 1964.

"Polynomial Approximation of Analytic Functions," by Professor Lee Rubel, Department of Mathematics, University of Illinois, Urbana, Illinois, December 7, 1964.

"The GE600 Series," by Robert G. Claussen, Consultant for Large Computer Systems, General Electric Corporation, Chicago, Illinois, December 14, 1964.

5.2 Personnel

The number of people associated with the Department in various capacities is given in the following table:

	Full-time	Part-time	Full-time Equivalent
Faculty	15	2	15.83
Visiting Faculty	2	0	2.00
Research Associates	2	0	2.00
Graduate Research Assistants	7	57	34.46
Graduate Teaching Assistants	0	3	1.25
Professional Personnel	4	2	5.00
Administrative and Clerical	13	1	13.50
Other Nonacademic Personnel	58	113	106.17
Total	101	178	180.21

The Computer Advisory Committee consists of Professors H. C. Brearley, J. R. Ehrman, L. D. Fosdick, C. W. Gear, D. B. Gillies, N. T. Hamilton, B. H. McCormick, S. Muroga, T. A. Murrell, J. R. Pasta, W. J. Poppelbaum, S. R. Ray, J. E. Robertson, K. C. Smith and J. N. Snyder.

5.3 Drafting

During the quarter, a total of 413 drawings were processed by both drafting sections.

	General and ILLIAC II	Pattern Recognition
Large Drawings	5	12
Medium Drawings	3	4
Small Drawings	10	5
Report Drawings (415)	39	0
Report Drawings (1018)	0	28
Report Drawings (T15)	47	0
Change Orders	76	19
Change Orders (1018 Report)	0	3
Gear Group	147	0
Miscellaneous	14	1
Total	341	72