THE IDENTIFICATION OF MATHEMATICAL CONTENT
REQUIRED BY SELECTED TECHNOLOGIES
AT EASTERN OKLAHOMA
STATE COLLEGE

By

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CHAPTER I

INTRODUCTION

Central to the education of many technicians is the ability to use mathematics in their technical program. Mathematics can be presented in a number of different ways. One is to use an approach where a predetermined number of concepts are presented in a traditional sequence. Traditional mathematics does not stress immediate applications but instead is rather abstract in nature. Alternately, the mathematics topics can be interwoven with the technical course work and be taught by the technical instructor without a formal math class. The most popular approach is that of "technical mathematics". Technical mathematics involves only those math concepts from the traditional approach that are immediately needed in the technical program. These math concepts are identified and sequenced as they are needed in the technical courses.

Statement of the Problem

At Eastern Oklahoma State College, the technical mathematics approach is employed. These courses could be most effective if the content were connected directly to the mathematical requirements of the various technical programs offered there. This study deals with the identification of appropriate mathematics topics on a program by program basis.

Purpose of the Study

The lack of information concerning specific mathematics as required by the different technologies generates a problem for both the mathematics instructor as well as the technology instructor. Specifically, the purpose of this study is to identify the mathematics used at Eastern Oklahoma State College in selected technical programs.

Research Questions

The following research questions are to be examined in this study:

1. What are the specific mathematical needs of each technology included in the study?
2. Are there any similarities among the mathematical needs of the included technology programs?

Scope of the Study

At Eastern Oklahoma State College the technology programs in;

(AUTO) - Automotive Technology
(BC) - Building Construction Technology
(CIVIL) - Civil and Highway Technology
(DRAFT) - Design Drafting Technology
(EMT) - Electromechanical Technology
(ELECT) - Electronics Technology
(FORST) - Forestry Technology
(MACH) - Machine Technology
(WELD) - Welding Technology

require their students to take technical mathematics. This study was limited to identifying the mathematics content of these programs only.

Further, it was not within the scope of this study to collect data for the design of technical mathematics courses. Evaluation of the level of each technology according to mathematical content is also beyond the scope of this study.

Each technology program in the study could have included required related courses which would require additional mathematics content. Such additional mathematics content was not included within the scope of this study.

CHAPTER II

REVIEW OF LITERATURE

Technicians whose specialties require considerable application of principles from engineering and the physical sciences need relatively more mathematics than is usually needed by technicians in other areas. However, this is not to say that mathematics is not required at all in other technologies. Mathematics courses for technicians should include all of the concepts necessary for the student to go through a particular program and meet the curriculum objectives.

McHale and Witzle (3) conducted a project that involved teaching technical mathematics in several technology programs. The course content was carefully selected by a team of instructors. This team was made up of non-mathematically oriented faculty. Mathematical achievement levels went from 50 percent to between 85 and 90 percent. The mathematic requirements of each technology were carefully studied before the topic areas were finalized for the project. It was found that various technologies required mathematics of varying levels and some required concepts not found in the other technologies. Students in this study were not required to cover those math concepts that did not apply to their program.

According to a report by HEW (1), a technician's ability to use mathematics as it applies to his technology is an important part of his education. Course content should be closely coordinated with the technical specialty courses. In order to accomplish these ends, the mathematics instructor should have a clear understanding of the needs of each technology.

Technical mathematics as taught by non-technical instructors tend to use traditional topic sequences. As a result, some irrelevant topics are covered, some relevant ones ignored, and the exposition of topics is too definitional and abstract for the interest level of the students. The topics in the mathematics course need be dictated primarily by the needs of each technical specialty.

From the standpoint of continuity, the student requires a unified presentation which ranges over the whole mathematical spectrum, from a review of arithmetic to the beginning fundamental calculus, depending on the demands of the technology.

The content of a "complete" mathematics course for technical specialties, is to some extent, debatable. However, experience with student needs in past studies, indicates that inclusion of certain topics, usually omitted, is definitely warranted.

In a study made by Zurfich (11) in 1976, the findings indicated that retention of technical students was greatly increased by the inclusion of technical mathematics courses in the engineering technologies.

Zurfich stated:

> Anyone setting up a technical education program must at some point decide whether to include math in the course offerings and, if so, what kind. Considerable attention must be devoted to this matter, for different types of technical education rely on mathematics to varying degrees. Some programs require students only to work simple arithmetic computations, while others require differential equations. The topics included in the technical subjects and the depth of their coverage are largely governed by the mathematics called for in the program (p. 56).

Zurfich further commented:

> Although most technology programs usually provide for some mathematics in the first semester, the suitability of this math to other courses is often questionable. For instance, if technology students take regular general college math, algebra, or trigonometry, very often the content, level and style of the course is not compatible with other engineering technology courses (p. 57).

A close coordination of mathematics courses has the added advantage of greatly increasing the students' interest in mathematics and his understanding of its functional value.

Mathematics is required to quantify and provide precise definition and interpretation of basic scientific phenomena and observation. As pointed out in the HEW report, mathematics is required in varying degrees. The depth of mathematics is primarily dictated by each technology.

Mathematical description greatly extends the learning obtained from each laboratory experience. By means of mathematical definition, each demonstration of the application of a scientific principle can be shown to be useful in many similar or related applications. Some of the mathematics required in a particular technical curriculum may well be covered in other mathematics courses.

Graney (2) points out that mathematics facility underlies the true comprehension of the physical sciences. These underlying principles are the foundations upon which the technical specialities are based. The technology investigated will determine the content of the required mathematic courses and these requirements will vary among the various technologies. Electronic technology may easily place the greatest demands upon mathematical knowledge, while others, such as industrial technical might place the emphasis on different mathematical concepts.

McHale (3) states that the level of mathematical proficiency of the technical students sets a limit on the level of all other technical courses and the quality of the whole program depends on that of the mathematics instruction. Various technical programs do not require either the same level of mathematical sophistication or even the same mathematical topics. At the time Zurfich made the report, only informal conclusions by the writer were presented. Statistical analysis was not complete at the time and hence was a weak point of the report. Statistical figures were reportedly to be made available at a later time.

Summary

A number of related studies have been made to determine the mathematics requirement, generally in the form of credit hours or number of courses. Others have performed occupational analysis in an attempt to ascertain necessary math skills. Studies of this nature tend to indicate mathematics requirements of lesser sophistication than are actually needed in the technical courses.

Failing to choose appropriate topics for technical mathematics courses can result in reduced effectiveness for both the mathematics and the technical teacher. The inclusion of inappropriate topics causes the math teacher to divert much needed time from more fruitful topics and at the same time causes the technology teacher to use some of his time dealing with omitted topics. This point was made very well by Roney (7):

> Teachers in technical courses reviewed or retaught the mathematics forms needed in the solution of problems, especially in beginning technical courses. The amount of time devoted to this review and reteaching ranged from 10 to 20 percent of the scheduled class time. The time required for this

> reteaching and review was greatest in curricula with non-specialized mathematics courses and was least in curricula with carefully correlated mathematics and technical courses (p. 130).

The need to further explore this area in search of a more appropriate choice of technical mathematics topics was also attested to by Roney:

> Research is needed to identify specific elements of mathematics, science, and technical study that can be coordinated effectively by a careful scheduling of the subject matter in concurrent courses (p. 141).

CHAPTER III

METHODOLOGY

The purpose of this study was to identify the mathematics used at Eastern Oklahoma State College in selected technical programs. The research questions selected for this study were:

1. What are the specific mathematical needs of each technology included in the study?
2. Are there any similarities among the mathematical needs of the included technology programs?

In this chapter we will consider the methodology used in examining these research questions.

In order to examine these questions, instructors in the various programs were surveyed to determine the mathematics needed for each program.

Selection of the Technology Programs

At the time this study was made, there were 16 technical programs offered by the institution. Of these 16 programs, seven did not require a technical mathematics course and were omitted from the study. Only those programs requiring a technical mathematics course were included. Information about the various curricula was obtained from the school catalog for the school year 1974-75. Table I contains the mathematical requirements of the technologies.

TABLE I

MATHEMATIC REQUIREMENTS BY PROGRAM

Technology	Technical Mathematics	General College Mathematics
Automotive	6 Hours	0
Building Design and Construction	6 Hours	0
Civil Highway	9 Hours	0
Design Drafting	9 Hours	0
Eletromechanical	6 Hours	0
Electronics	6 Hours	0
Forestry	6 Hours	0
Machine	6 Hours	0
Welding	3 Hours	0

Forestry was the only program requiring different mathematics among the various options offered and the one with the greatest math demands was selected.

Development of the Instrument

In order to equate those mathematics concepts used by each technical program to those universally accepted in the mathematics, several math books were used as sources. A mathematics checklist was developed from these sources and appears in Appendix A along with selected examples of each concept. This checklist was used as a reference as each program was examined.

It was subsequently found that the checklist was not complete enough and had to be revised as additional math concepts were encountered. The sequence of the topics as they appear in the checklist was not intended to have any significance.

Collection of the Data

Instructors in the various technical specialties were interviewed to identify the math content of their program. The mathematics checklist in Appendix A was available to each instructor at the time the interviews were conducted. Homework problems typifying student assignments were examined to verify the accuracy of the math content identified. The math content was then tabulated for each technology and appears in Appendix B. Selected examples in the checklist were used to draw comparisons in identifying the appropriate selection of math titles that best described the homework problems.

Analysis of the Data

The data gathered from each technical program was tabulated and appears in Appendix B. This data describes the specific mathematical needs of each technology examined. The data is used in making a comparative analysis to determine if there are similarities among the various technologies.

Limitations

The study was limited to nine technologies at Eastern Oklahoma State College. Since those programs might differ from those offered by other institutions, the results should not be generalized for the needs of other programs.

In the process of curriculum growth, homework problems may be changed. This study cannot anticipate such changes.

CHAPTER IV

FINDINGS OF THE STUDY

The purpose of this study was to identify the mathematics used at Eastern Oklahoma State College in selected technical programs. Only that math content thought necessary to support the technical courses was included in the study.

Information for the study was obtained from nine technologies which required one or more courses in technical mathematics to fulfill their program requirements. The technical programs included in the study represent some 286 college credit hours in technical specialty course work, in 80 technical courses.

The findings of the study are presented in this chapter in two sections. The first section deals with the identification of the mathematics content of each of the nine technical programs. Section two considers the extent to which similarities exist amont the mathematical content of the various technical programs. The detailed findings are contained in Appendix B.

Mathematical Content by Program

The mathematical checklist contains 204 concepts used in identifying the math needs of each program. Table II shows the percent math requirement by program based on the total items contained in the checklist. The lowest percentage was Automotive at 17 percent and the high was 76 percent for Electronics and Electromechanical with a mean of 50.7 percent.

TABLE II

PROGRAM VS. PERCENT OF THE TOTAL CHECKLIST CONTENT

Program	Percent of Checklist Content
AUTO	17
WELD	21
MACH	35
BC	39
DRAFT	61
FORST	63
CIVIL	68
ELECT	76
EMT	76

It should be observed that the data in Table II represents only the percentage of the 204 mathematics content topics that were found in each individual technical program. These data do not represent the extent to which topics are shared by more than one program.

Similarities Among the Programs

A comparative analysis was made on the data contained in Appendix B to determine if any similarities existed among the various programs. It was found that similarities did exist and these are presented in Table III. All nine technologies required 16 percent of the total mathematical checklist, with two programs, Electronics and Electro-mechanical, sharing 73 percent of the list.

TABLE III

SIMILARITIES AMONG PROGRAMS

Number of Programs Sharing Content	Percent of Checklist Content
9	16
8	21
7	25
6	28
5	48
4	55
3	55
2	73
1	76
0	9

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of this study was to identify the mathematics used at Eastern Oklahoma State College in selected technical programs. This study was seeking answers to the following research questions:

1. What are the specific mathematical needs of each technology included in the study?
2. Are there any similarities among the mathematical needs of the included technology programs?

Instructors in the various programs were interviewed to identify the mathematics content thought to be necessary for each technology. Homework problems were used to verify the accuracy of the identified content.

The results indicated that Automotive required a low of 17 percent of the total checklist content. A high of 76 percent was required by Electronics and Electromechanical and the mean was 50.7 percent. Similarities were found to exist among the mathematical needs with Electronics and Electromechanical sharing the highest content of 73 percent of the total mathematical checklist.

Conclusions

From the data gathered, it was found that there are specific mathematical needs of the selected technical programs. This data is presented in Appendix B. The mathematical checklist contained 204 mathematics topics and is found in Appendix A. Based on the percent of total content of this list, Automotive required 17 percent and Electronics and Electromechanical each required a high of 76 percent. The arithmetic mean was 50.7 percent.

Similarities were found to exist with Electronics and Electromechanical sharing 73 percent of the total mathematical checklist.

Recommendations

After reviewing the data contained in this study, the following recommendations are made:

1. In order for the technical mathematics course to be an effective tool for use by technicians in the programs, a similar study should be made to determine the <u>sequence</u> of the topics as they are needed by the technical curricula.
2. The technical mathematics instructors can use this study to construct practical exercises for the math class involving those concepts thought to be necessary.
3. That steps be taken to insure that at least those math concepts appearing in Appendix B be included in the technical mathematics course for each technology.
4. That the mathematics department evaluate the results indicated in Appendix B in ascertaining the possibility of tailoring specific courses for those programs with very similar mathematics content.

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APPENDIX A

MATHEMATICAL CHECKLIST

MATHEMATICS CHECKLIST

No.	Mathematical Competency	Selected Example
1	Simple Numbers	3; 4; 254 25
2	Place Value	34 = 4 (units) + 3 (tens)
3	Addition of Integers	23 + 42 = 65
4	Subtraction of Integers	42 - 32 = 10
5	Multiplication of Integers	42 x 32 = 1344
6	Division of Integers	672/12 = 56
7	Negative Integers	-58; -241; -2; -18
8	Addition of Negative Integers	-5-10-8= -23
9	Subtraction of Negative Integers	5-(-10) = +15
10	Multiplication of Negative Integers	(-5)x(-4) = +20
11	Division of Negative Integers	-25/-5= +5
12	Common Fractions	1/4; 3/9; 42/80; 128/420

MATHEMATICS CHECKLIST (CONTINUED)

No.	Mathematical Competency	Selected Example
13	Fractional Operations	(x) (.) (/) () ()
14	Mixed Numbers	1 1/4; 2 3/4
15	Prime Numbers	No whole-number factors
16	Addition of Fractions	1/4 + 5/3 = 23/12
17	Subtraction of Fractions	3/4 - 1/2 = 1/4
18	Multiplication of Fractions	(3/4) x (1/2) = 3/8
19	Division of Fractions	(3/4)/(1/2) = (3/4)x(2/1) = 3/2
20	Decimals and Common Fractions	.25 = 25/100 = 1/4
21	Rounding Off Numbers	3.4568 = 3.46
22	Addition of Decimal Fractions	0.4015 + 0.0750 = 0.4765
23	Subtraction of Decimal Fractions	0.4015 - 0.0750 = 0.3265
24	Multiplication of Decimal Fractions	0.42 x 0.35 = 0.147

MATHEMATICS CHECKLIST (CONTINUED)

No.	Mathematical Competency	Selected Example
25	Division of Decimal Fractions	$0.075/0.125 = 0.600$
26	Percentage	$23\% = 23/100 = .23$
27	Ratios	$2 : 3 = 2/3 = .667$
28	Square Roots	$\sqrt{16} = \pm 4$
29	Square Roots of Common Fractions	$\sqrt{1/4} = \sqrt{1}/\sqrt{4} = \pm 1/2$
30	Operations with Radicals	$\sqrt{8} = \sqrt{4 \times 2} = \sqrt{4} \times \sqrt{2} = 2\sqrt{2}$
31	Higher Roots	$\sqrt[3]{27} = 3;\ \sqrt[3]{64} = 4$
32	Exponents and Signs	$4^3 = 4x4x4 = 64;\ 2^{-2} = 1/2^2 = .25$
33	Scientific Notation	$2384.625 = 2.384625 \times 10^3$
34	Multiplying with Powers of Ten	$(1.2 \times 10^2)\ (2.4 \times 10^4) = 2.88x10^6$
35	Dividing with Powers of Ten	$(2.4 \times 10^4)/(1.2 \times 10^2)=2x10^2$
36	Metric System Conversion	20 ft. = 6.096 meters

MATHEMATICS CHECKLIST (CONTINUED)

No.	Mathematical Competency	Selected Example
37	Algebra and Generalization of Numbers	x = denotes any number
38	Expressed Signs of Algebra Operations	+; −; x; /; ÷
39	Implied Signs of Algebraic Operations	() () = x; . = x
40	Numerical Algebraic Expressions	2 (3−0.5) + 1.5 = 6.5
41	Terms in Algebraic Expressions	E+IR−0.5E (3 terms)
42	Subscript Notations	X_2 = X sub 2
43	Prime Notations	X' = X Prime
44	Substitution of Numerical Values and Evaluation	2X + 3Y = 2(2) + 3(4) = 16 X = 2; Y =4
45	Absolute Value of a Number	$\|6\| + \|-4\| = 10$
46	Algebraic Addition	175+100−200 = 75
47	Algebraic Subtraction	1.23−(+.59) = +0.64

MATHEMATICS CHECKLIST (CONTINUED)

No.	Mathematical Competency	Selected Example
48	Addition of Polynomials	$(4X+2Y+4)+(3X+5Y+5)=7X+7Y+9$
49	Subtraction of Polynomials	$(4X+2Y+4)-(3X+5Y+5)=X-3Y-1$
50	Operations with Symbols of Grouping	$x-(a-b) = x-a+b$
51	Algebraic Multiplication of Signed Numbers	$(+x)(-y) = -xy$; $(-x)\ (-y) = +xy$
52	Algebraic Multiplication of Numbers with Exponents	$3^2 \times 3^5 = 3^{2+5} = 3^7$
53	Albebraic Multiplication of Monomials w/Exponents	$(2x^2y)\ (3xy^3) = 6x^3y^4$
54	Multiplication of Polynomials by Monomials	$2x(4x+2y+4)\ (x+y+1)=8x^2+4xy+8x$
55	Multiplication of Polynomials by Monomials	$(4x+2y+4)\ (x+y+1)= 4x^2+6xy+8x+6y+4$
56	Multiplication of Polynomials by Polynomials	$x^2x^3 = x^5$; $x^5/x^2 = x^3$; $x^2/x^5 = x^{-3}$
57	Albebraic Division of Monomials	$(4x^2y)/(2xy^3) = 2xy^{-2}$
58	Division of Polynomials by Monomials	$\frac{3x^3y^4+2x^4y^2}{x^2y^2} = 3xy^2+2x^2$

MATHEMATICAL CHECKLIST (CONTINUED)

No.	Mathematical Competency	Selected Example
59	Division of a Polynomial by Another Polynomial	$\frac{a^3+a^2x-ax^2-x^3}{a+x} = a^2-x^2$
60	Identical Equations and Formulas	$\frac{ax^2+by+c+y}{xy} = \frac{ax}{y} + \frac{b}{x} + \frac{c}{xy} + \frac{1}{x}$
61	Conditional Equations and Formulas	$x-5 = 2$
62	Solution of Equations and Formulas	$x-5 = 10$ $x + 10+5 = 15$
63	Manipulating Equations and Formulas	$2x+5y = 8z-3p$ $x = \frac{8z-3p-5y}{x}$
64	Powers and Roots of Monomials	$(4x^2y)^2=16x^4y^2$; $\sqrt{4x^4y^2}=2x^2y$
65	Monomial Factors of Polynomials	$8xy+10xyz+16xy= 2xy(4+5z+8)$
66	Square of a Binomial	$(x+1)^2= (x+1)(x+1=$ x^2+2x+1
67	Product of Two Binomials	$(x+1)(x-2)= x^2-x-2$
68	Square Root of a Trinomial	$\sqrt{x^2+2xy+y^2}= \pm x \pm y$
69	Factors of the Difference of two Algebraic Numbers	$x^2-y^2= (x+1)(x-1)$

MATHEMATICAL CHECKLIST (CONTINUED)

No.	Mathematical Competency	Selected Example
70	Prime Factors of Polynomial	$x^2+cx+dx+cd = \underline{(x+d)(x+c)}$ Prime Factors
71	Degrees of Monomials and Polynomials	$x^3y^2+2xy^3+3y^4 =$ 5th degree
72	Highest Common Factor of Monomials and Polynomials	$4x^2y^3(a-b)^2$ & $8xy^2(a+b)(a-b)$ HCF $= 4xy^2(a-b)$
73	Lowest Common Multiples of Monomials and Polynomials	$12ax^2+3ax+42a$ & $24x^3+60x^2+24x$ LCM $= 6ax(x+2)(2x+1(4x-7)$
74	Numerators and Denominator of Algebraic Fractions	$\frac{a+b \text{ (numerator)}}{a-b \text{ (denominator)}}$
75	Conversion of Mixed Expressions to Fractions	$x+\frac{1}{x} = \frac{x^2+1}{x}$
76	Lowest Common Denominator of Algebraic Fractions	$\frac{a-2b}{a^2-b^2}+\frac{2}{a-b}$ LCD $= (a-b)(a+b)$
77	Addition of Algebraic Fractions	$\frac{2}{a-b}+\frac{4x}{a-b} = \frac{2+4x}{a-b}$
78	Subtraction of Algebraic Fractions	$\frac{2a}{a+b}-\frac{4x}{a-b} = \frac{2a(a-b)-4x(a+b)}{(a+b)(a-b)}$
79	Multiplication of Algebraic Fractions	$\frac{2a}{a+b} \times \frac{4b}{a-b} = \frac{8ab}{a^2-b^2}$

MATHEMATICAL CHECKLIST (CONTINUED)

No.	Mathematical Competency	Selected Example
80	Division of Algebraic Fractions	$\frac{2a}{a+b} \div \frac{4b}{a-b} = \frac{2a(a-b)}{4b(a+b)}$
81	Simultaneous Equations and Formulas	$2x+4y+2=0$ $10x-4y+8=0$ 2 unknowns
82	Graphical Solutions	Graph for intersection coordinates
83	Algebraic Solutions of Simultaneous Equations	$x+y=5$ $x=4$ $x-y=3$ $y=1$
84	Simultaneous Solutions of Three Unknowns	$x+y-z=2$ $x=?$ $x-y+z=5$ $y=?$ $x-y+z=8$ $z=?$
85	Determinants	$x = \begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}$
86	Quadratic Equations	$ax^2+bx+c=0$
87	Factorable Quadratic Equations	$x^2-1=0=(x+1)(x-1)$ $x=\pm 1$
88	Completing the Square	solve: $ax +bx+c=0$ for x gives; $x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$
89	Quadratic Formula	$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$
90	The Discriminant	b^2-4ac = Discriminant

MATHEMATICAL CHECKLIST (CONTINUED)

No.	Mathematical Competency	Selected Example
91	Graphic Solution for Real Roots	$y= ax^2+bx+c$ (graph)
92	Fundamentals of Complex Algebra	$\sqrt{-1}= i$ (imaginary) $i^2= -1;\ i^3= -i$
93	Geometrical Representation of Imaginary Numbers	x-axis real; y-axis imaginary
94	Pure Imaginary Numbers	$\sqrt{-n}$
95	Complex Numbers and Operations	(2-3i)(4-5i) etc.,
96	Division of Complex Numbers	$\frac{2-3i}{4-5i} + \frac{(2-3i)(4+5i)}{(4-5i)(4+5i)} = \frac{23-2i}{41}$
97	Multiplication of Complex Numbers	$(4-5i)(4+5i)= 16-25i^2= 41$
98	The Conjugate	4-5i = 4+5i (conjugate)
99	Binary Number System	$1011= 1x2^3+0x2^2+1x2^1+1x2^0=$ 11 (decimal)
100	Number System Conversion	1011 = 11 decimal
101	Binary Addition	1001 + 0101 = 1110

MATHEMATICAL CHECKLIST (CONTINUED)

No.	Mathematical Competency	Selected Example
102	Binary Subtraction	1011-101=110
103	1's Complement	11010=00101
104	2's Complement	11010=00101+1=00110
105	9's Complement	6291=9999-6291=3708 9's Complement
106	Subtraction Using the 1's Complement	1011-101=110
107	Subtraction Using the 2's Complement	1011-101=110
108	Multiplication Using Repeated Addition	2x4 = 2+2+2+2 = 8
109	Division Using Repeated Subtraction	4/2=4-2=2-2=0 = 1 + 1 =2
110	Hexadecimal Number System and Conversion	0,1,2,3,...,9,A,B,C,D,E,F 11110111 = F7
111	Octal Number System and Conversion	0,1,2,3,4,5,6,7 45 (octal) = 100101 (binary)
112	Fundamentals of Boolean Algebra	A + B = C (A "or" B = C)

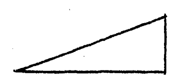
MATHEMATICAL CHECKLIST (CONTINUED)

No.	Mathematical Competency	Selected Example
113	Boolean Theorems	A+A = A; A+1 = 1
114	Developing Boolean Equation	Deriving Boolean Equations From Logic Diagrams
115	Simplification by Basic Theorems	Using 113 & 114 Above
116	Simplification Using Karnaugh Maps	2 - 3 Variable Maps
117	Bases for Systems of Logarithms	$\log_{10} b = x$; $\log_e b = y$ where e= 2.71828...
118	Common Logarithms	$\log_{10} b = x$
119	Natural Logarithms	$\log_e b = y$ where e= 2.71828...
120	Exponential Functions and the Logarithm	e^{-x}; e^x; etc.,
121	The Antilogarithm	$10^x = b$ ($\log_{10} b = x$) $e^x = y$ (log b= y)
122	Tables of Common Logarithm	Table Look-up
123	Tables of Natural Logarithms	Table Look-up

MATHEMATICAL CHECKLIST (CONTINUED)

No.	Mathematical Competency	Selected Example
124	Calculations with Logarithm	$\log \frac{x}{y} = \log x - \log y$
125	Logarithmic Calculations with Negative Numbers	$-\log 40 = \log 1 - \log 40 = \log \frac{1}{40}$
126	Logarithmic Scales	Graphing
127	Multiplication of Numbers with Logarithms	$\log xy = \frac{\log x}{\log y}$
128	Division of Numbers by Logarithms	$\log \frac{x}{y} = \log x - \log y$
129	Logarithms of Numbers less Than 1	$\log_{10} .895 = -0.048176965...$
130	Angles	Circular Parts
131	Angles in Degrees, Minutes and Seconds	$30^\circ\ 25'\ 30''$
132	Addition of Angles in Degrees, Min., and Seconds	$30^\circ\ 25'\ 30'' + 15^\circ\ 40'\ 50'' = 45^\circ\ 65'\ 80'' = 46^\circ\ 06'\ 20''$
133	Subtraction of Angles in Degrees, Min., and Seconds	$30^\circ\ 25'\ 30'' - 15^\circ\ 40'\ 50'' = 14^\circ\ 44'\ 30''$
134	Conversion of Degrees, Min., and Seconds to Decimal Deg.	$30^\circ\ 25'\ 30'' = 30.425^\circ$

MATHEMATICAL CHECKLIST (CONTINUED)

No.	Mathematical Competency	Selected Example
135	Conversion of Decimal Deg. to Degrees, Min., and Sec.	$58.4589^{o} = 58^{o}\ 27'\ 32''$
136	Generalized Angles	Angle between any two lines of intersection
137	Measurement of Angles	Angle between two lines that intersect
138	Angles of Any Magnitude	245^{o}; 2341^{o}; 65^{o}; -325^{o}
139	Triangles	Sum of angles of a closed triangle = 180^{o}
140	The Right Triangle	
141	The Trigonometric Functions	sin, cos, tan; $\sin 30^{o} = 0.5$
142	Inverse Trigonometric Functions	arcsin, arccos, arctan $\arcsin 0.5 = 30^{o}$
143	Solving Right Triangles	$\tan \Theta = \frac{a}{b}$ $c = \sqrt{a^2+b^2}$
144	Relations Among the Functions	$\tan \frac{x}{y} = \frac{\sin x}{\cos y}$
145	Trigonometric Functions of Any Angle	$\sin 243^{o} = -0.89$; $\cos -76^{o} = 0.2419$

MATHEMATICAL CHECKLIST (CONTINUED)

No.	Mathematical Competency	Selected Example
146	Principal Values of Inverse Functions	30^{o}; 45^{o}; 90^{o}; etc.
147	Basic Trigonometric Identities	$\csc\theta = \frac{1}{\sin\theta}$
148	Polar Coordinate System	radius vector/vectorial angle
149	Vectors in Polar Notation	$30\underline{/-45^{o}}$ Vector length = 30 units vectorial angle = -45^{o}
150	Rectangular Coordinate VS. Polar Coordinates	$x=r\cos\theta$ & $y=r\sin\theta$; $\theta=\arctan\frac{y}{x}$
151	The Polar Triangle	If Vertices of a Spherical Triangle as poles arcs, another Spherical Triangle is Formed & is the Polar Triangle of the First
152	Formulas for Right Spherical Triangles	$\sin a = \tan b \cot B$ $\sin a = \sin A \sin c$ $\sin b = \tan a \cot A$
153	Napiers; Rule of Circular Parts	sine of any middle part = product of tan of two adjacent parts
154	Given Three Sides of Gen Spherical Triangle	Using 152 and 153 above
155	Conversion of Polar Vector to Rectangular Notation	$x = r\cos\theta$; $y = r\sin\theta$

MATHEMATICAL CHECKLIST (CONTINUED)

No.	Mathematical Competency	Selected Example
156	Conversion of Rectangular to Polar Notation	$r = \sqrt{x^2+y^2}$; $\theta = \arctan\frac{y}{x}$
157	Polar Form of Complex Numbers	resultant$\underline{/\theta^{\circ}}$ real $\pm$ i; vectorially added
158	j as an Operator	real $\pm$ j (j denotes imaginary as does i)
159	Multiplication of Polar Vectors	$(56\underline{/65^{\circ}})(48\underline{/-20^{\circ}} = 2685\underline{/45^{\circ}}$
160	Division of Polar Vectors	$\frac{56\underline{/+65^{\circ}}}{48\underline{/-20^{\circ}}} = 1.17\ \underline{/65^{\circ} - (-20^{\circ})} = 1.17\underline{/85^{\circ}}$
161	Geometric Interpretation of Vectors	vector has both magnitude and direction
162	Addition of Vectors	$(4,5)+(6,-5) = (10,0)$ $(x_1,y_1)+(x_2,-y_2) = (x,y)$
163	Subtraction of Vectors	$(4,5)-(6,-5) = (-2, 10)$ $(x_1,y_1)-(x_2,-y_2) = (-x,y)$
164	Multiplication of a Vector by a Scalar	$(25\underline{/30^{\circ}})$(scalar=2) = $50\underline{/30^{\circ}}$ Newton's second law of motion
165	Phasor Algebra	Phasor = vector that has a magnitude extending from origin

MATHEMATICAL CHECKLIST (CONTINUED)

No.	Mathematical Competency	Selected Example
166	Spherical Volumes	Volume = $4/3(\text{radius})^2 \pi = 4.189R^2$
167	Areas of Circles	Area = 1/2xcircumferencexradius
168	Areas of Eliptical Forms	Area = ab(center at origin) 2b = total y distance 2a = total x distance
169	Areas of Rectangular Forms	Area = length x width
170	Volumes of Rectangular Shapes	Volume = length x width x height
171	Areas of Triangles	area = 1/2(base)(height)
172	Volume of a Pyramid	Volume = 1/3(area of base) x (altitude)
173	The Limit Concept	$\lim_{x \to 1^+} f(x) = 2 \quad \lim_{x \to 1^-} f(x) = 0$
174	Special Limits	$\lim_{1 \to 0} \frac{\sin x}{x} \quad \lim_{x \to \infty} (1+\frac{1}{x})^x$
175	Average Rate of Change	$\frac{y_2-y_1}{x_2-x_1} = \frac{\Delta y}{\Delta x}$ rate of change of y w/respect to x
176	The Derivative	$\frac{dy}{dx} = \lim_{\Delta x \to 0} \frac{\Delta y}{\Delta x}$
177	Graphical Differentiation	Using a graphical method in determining the average slope of a curve (dy/dx)

MATHEMATIFAL CHECKLIST (CONTINUED)

No.	Mathematical Competency	Selected Example
178	Differentiation Formulas	$y = uv$; $dy/dx = u\frac{dv}{dx} + v\frac{du}{dx}$
179	Physical Applications of the Derivative	(distance) $s = 160+20t^2$ (t=time) 3sec. $v = \frac{ds}{dt} = \frac{d}{dt}(160+20t^2) = 40t$ for: t=3 sec.
180	Implicit Differentiation	$xy-2x+1=0$; $x\frac{dy}{dx}+y-2=0$ and: $\frac{dy}{dx} = \frac{2}{x} - \frac{y}{x}$
181	Newton's Method	$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$
182	Derivatives of Transcendental Functions	$\frac{d}{dx}(\sin x) = \cos x$
183	Second and Higher Derivatives	$\frac{d}{dx}$(1st Derivative)=2nd derivative
184	Notation for Higher Derivatives	$\frac{d^2y}{dx^2}$ (second derivative)
185	Physical Applications of the Higher Derivatives	$s=50-2t^2+3e^{-t/2}$ velocity = 1st Derivative Acceleration = 2nd Derivative jerk = 3rd Derivative
186	Maxima and Minima	Absolute Maximums Absolute Minimums

MATHETICAL CHECKLIST (CONTINUED)

No.	Mathematical Competency	Selected Example
187	The Differential	$f'(x)$ x differential of $y=f(x)$ $dy = f'(x)dx$
188	Using the Differential	$i=142e^{-.05t}$; $di = -7.10e^{-.05t}dt$ or: $\Delta i = -7.10e^{-.05t}\Delta t$
189	The Inverse of Differentiation	"undifferentiating" a derivative = <u>integration</u>
190	The Definite Integral	$\int_a^b f(x)dx$ b = upper limit a = lower limit (finite value)
191	Properties of the Definite Integral	$\int_b^a f(x)dx = -\int_a^b f(x)dx$
192	Evaluation of Integrals; The Indefinite Integral	$\int f(x)dx$ (no limits) (algebraic solutions)
193	Integration Formulas	$\int du = u + K$(constant)
194	Integrals of Algebraic Functions	$\int z^7 dz = \frac{z8}{8} + K$
195	Integrals of Other Function	$\int cosudu = sinu + K$
196	Non-Integrable Functions; Graphical Integration	$\int \frac{sinx}{x}dx = K+x- \frac{x^3}{18} + \frac{x^5}{600}$

MATHEMATICAL CHECKLIST (CONTINUED)

No.	Mathematical Competency	Selected Example
197	The Factorial	5! = 1+2+3+4+5 = 15
198	Three Dimentional Coordinate System (x,y,z)	x-axis, y-axis, and z-axis
199	Vectors in Three Dimentional System	Graphing Coordinates (x,y,z)
200	Graphs of Trigonometric Functions	y= sinx; y= cosx
201	Properties of a Spherical Cap with a Radius r and Height h	Volume = $1/3\pi h^2(3r-h)$
202	Frustrum of Right Circular Cone with Radii a,b and Height h	Volume = $1/3\pi h\ (a^2+ab+b^2)$
203	Properties of a Right Circular Cone of Radius r and Height h	Volume = $1/3\pi r^2h$
204	Properties of a Right Circular Cylinder of Radius r and Height h	Volume = πr^2h

APPENDIX B

MATHEMATICAL CONTENT BY TECHNOLOGY

MATHEMATICAL CONTENT

BY TECHNOLOGY

No.	Mathematical Concept	AUTO	WELD	MACH	BC	DRAFT	FORST	CIVIL	ELECT	EMT
1	Simple Numbers	X	X	X	X	X	X	X	X	X
2	Place Value	X	X	X	X	X	X	X	X	X
3	Addition of Integers	X	X	X	X	X	X	X	X	X
4	Subtraction of Integers	X	X	X	X	X	X	X	X	X
5	Division of Integers	X	X	X	X	X	X	X	X	X
6	Multiplication of Integers	X	X	X	X	X	X	X	X	X
7	Negative Numbers	X	X	X	X	X	X	X	X	X
8	Addition of Negative Integers	X	X	X	X	X	X	X	X	X
9	Subtraction of Negative Integers	X	X	X	X	X	X	X	X	X
10	Multiplication of Negative Integers	X	X	X	X	X	X	X	X	X
11	Division of Negative Integers	X	X	X	X	X	X	X	X	X
12	Common Fractions	X	X	X	X	X	X	X	X	X
13	Fractional Operations	X	X	X	X	X	X	X	X	X
14	Mixed Numbers	X	X	X	X	X	X	X	X	X
15	Prime Numbers	X	X	X	X	X	X	X	X	X
16	Addition of Fractions	X	X	X	X	X	X	X	X	X
17	Subtraction of Fractions	X	X	X	X	X	X	X	X	X
18	Multiplication of Fractions	X	X	X	X	X	X	X	X	X

MATHEMATICAL CONTENT

BY TECHNOLOGY

(CONTINUED)

No.	Mathematical Concept	AUTO	WELD	MACH	BC	DRAFT	FORST	CIVIL	ELECT	EMT
19	Division of Fractions	X	X	X	X	X	X	X	X	X
20	Decimals and Common Fractions	X	X	X	X	X	X	X	X	X
21	Rounding Off Numbers	X	X	X	X	X	X	X	X	X
22	Addition of Decimal Fractions	X	X	X	X	X	X	X	X	X
23	Subtraction of Decimal Fractions	X	X	X	X	X	X	X	X	X
24	Multiplication of Decimal Fractions	X	X	X	X	X	X	X	X	X
25	Division of Decimal Fractions	X	X	X	X	X	X	X	X	X
26	Percentage	X	X	X	X	X	X	X	X	X
27	Ratios	X	X	X	X	X	X	X	X	X
28	Metric System Conversions	X	X	X	X	X	X	X	X	X
29	Algebra and Generalization of Numbers	X	X	X	X	X	X	X	X	X
30	Expressed Signs of Algebraic Operations	X	X	X	X	X	X	X	X	X
31	Implied Signs of Algebraic Operations	X	X	X	X	X	X	X	X	X
32	Numerical Algebraic Expressions	X	X	X	X	X	X	X	X	X
33	Substitution of Numerical Values and Evaluation	X	X	X	X	X	X	X	X	X

MATHEMATICAL CONTENT

BY TECHNOLOGY

(CONTINUED)

No.	Mathematical Concept	AUTO	WELD	MACH	BC	DRAFT	FORST	CIVIL	ELECT	EMT
34	Operations with Symbols of Grouping		X	X	X	X	X	X	X	X
35	Terms in Algebraic Expression	X		X	X	X	X	X	X	X
36	Angles		X	X	X	X	X	X	X	X
37	Generalized Angles		X	X	X	X	X	X	X	X
38	Measurement of Angles		X	X	X	X	X	X	X	X
39	Angles of Any Magnitude		X	X	X	X	X	X	X	X
40	Triangles		X	X	X	X	X	X	X	X
41	The Right Triangle		X	X	X	X	X	X	X	X
42	The Trigonometric Functions		X	X	X	X	X	X	X	X
43	Solving Right Triangles		X	X	X	X	X	X	X	X
44	Square Roots		X	X	X	X	X	X	X	X
45	Absolute Value of a Number			X	X	X	X	X	X	X
46	Algebraic Addition			X	X	X	X	X	X	X
47	Algebraic Subtraction			X	X	X	X	X	X	X
48	Subscript Notations			X	X	X	X	X	X	X
49	Square Roots of Common Fractions			X	X	X	X	X	X	X
50	Exponents and Signs			X	X	X	X	X	X	X

MATHEMATICAL CONTENT

BY TECHNOLOGY

(CONTINUED)

No.	Mathematical Concept	AUTO	WELD	MACH	BC	DRAFT	FORST	CIVIL	ELECT	EMT
51	Conditional Equations and Formulas			X	X	X	X	X	X	X
52	Solution of Equations and Formulas			X	X	X	X	X	X	X
53	Manipulating Equations and Formulas			X	X	X	X	X	X	X
54	Numerators and Denominators of Algebraic Fractions			X		X	X	X	X	X
55	Scientific Notation			X		X	X	X	X	X
56	Multiplying with Powers of ten			X		X	X	X	X	X
57	Dividing with Powers of Ten			X		X	X	X	X	X
58	Algebraic Multiplication of Signed Numbers			X		X	X	X	X	X
59	Prime Notations				X	X	X	X	X	X
60	Operations with Exponents				X	X	X	X	X	X
61	Algebraic Division of Monomials				X	X	X	X	X	X
62	Division of Polynomials by a Monomial				X	X	X	X	X	X
63	Identical Equations and formulas				X	X	X	X	X	X
64	Powers and Roots of Monomials				X	X	X	X	X	X

MATHEMATICAL CONTENT

BY TECHNOLOGY

(CONTINUED)

No.	Mathematical Concept	AUTO	WELD	MACH	BC	DRAFT	FORST	CIVIL	ELECT	EMT
65	Monomial Factors of Polynomials				X	X	X	X	X	X
66	Square of a Binomial				X	X	X	X	X	X
67	Simultaneous Equations and Formulas				X	X	X	X	X	X
68	Algebraic Solutions of Simultaneous Equations				X	X	X	X	X	X
69	Bases for Systems of Logarithms				X		X	X	X	X
70	Common Logarithms				X		X	X	X	X
71	The Antilogarithm				X		X	X	X	X
72	Tables of Common Logarithms				X		X	X	X	X
73	Calculations with Logarithms				X		X	X	X	X
74	Multiplication of Numbers with Logarithms				X		X	X	X	X
75	Division of Numbers by Logarithms				X		X	X	X	X
76	Angles in Degrees, Minutes and Seconds				X	X	X	X	X	
77	Addition of Angles in Degrees, Min., and Seconds				X	X	X	X	X	
78	Subtraction of Angles in Degrees, Min., and Seconds				X	X	X	X	X	

MATHEMATICAL CONTENT

BY TECHNOLOGY

(CONTINUED)

No.	Mathematical Concept	AUTO	WELD	MACH	BC	DRAFT	FORST	CIVIL	ELECT	EMT
79	Conversion of Degrees, Minutes and Seconds to Decimal Degrees				X	X	X	X	X	
80	Conversion of Decimal Degrees to Degrees, Min., and Seconds				X	X	X	X	X	
81	Principal Values of Inverse Functions				X	X	X	X	X	X
82	Areas of Circles				X	X	X	X	X	X
83	Areas of Rectangular Shapes				X	X	X	X	X	X
84	Volumes of Rectangular Shapes				X	X	X	X	X	X
85	Areas of Triangles				X	X	X	X	X	X
86	Inverse Trigonometric Functions				X	X	X	X	X	X
87	Operations with Radicals					X	X	X	X	X
88	Higher Roots					X	X	X	X	X
89	Addition of Polynomials					X	X	X	X	X
90	Subtraction of Polynomials					X	X	X	X	X
91	Algebraic Multiplication of Numbers With Exponents					X	X	X	X	X
92	Algebraic Multiplication of Monomials with Exponents					X	X	X	X	X
93	Multiplication of Polynomials by Monomials					X	X	X	X	X

MATHEMATICAL CONTENT

BY TECHNOLOGY

(CONTINUED)

No.	Mathematical Concept	AUTO	WELD	MACH	BC	DRAFT	FORST	CIVIL	ELECT	EMT
94	Multiplication of Polynomials by Polynomials					X	X	X	X	X
95	Product of Two Binomials					X	X	X	X	X
96	Prime Factors of Polynomials					X	X	X	X	X
97	Highest Common Factor of Monomials and Polynomials					X	X	X	X	X
98	Lowest Common Multiples of Monomials and Polynomials					X	X	X	X	X
99	Conversion of Mixed Expressions to Fractions					X	X	X	X	X
100	Lowest Common Denominator of Algebraic Fractions					X	X	X	X	X
101	Addition of Algebraic Fractions					X	X	X	X	X
102	Subtraction of Algebraic Fractions					X	X	X	X	X
103	Multiplication of Algebraic Fractions					X	X	X	X	X
104	Division of Algebraic Fractions					X	X	X	X	X
105	Relations Among the Functions					X	X	X	X	X
106	Trigonometric Functions of any Angle					X	X	X	X	X

MATHEMATICAL CONTENT

BY TECHNOLOGY

(CONTINUED)

No.	Mathematical Concept	AUTO	WELD	MACH	BC	DRAFT	FORST	CIVIL	ELECT	EMT
107	Basic Trigonometric Identities					X	X	X	X	X
108	Polar Coordinate System					X	X	X	X	X
109	Vectors in Polar Notation					X	X	X	X	X
110	Rectangular Coordinate vs. Polar Coordinates					X	X	X	X	X
111	Conversion of Polar Vectors to Rectangular Notation					X	X	X	X	X
112	Conversion of Rectangular to Polar Notation					X	X	X	X	X
113	Natural Logarithms						X	X	X	X
114	Exponential Functions and the Logarithm						X	X	X	X
115	Tables of Natural Logarithms						X	X	X	X
116	Logarithmic Scales						X	X	X	X
117	Logarithms of Numbers less Than 1						X	X	X	X
118	Quadratic Equations					X	X	X		X
119	Quadratic Formula					X	X	X		X
120	Simultaneous Solutions of Three Unknowns					X		X	X	X
121	The Limit Concept					X		X	X	X

MATHEMATICAL CONTENT

BY TECHNOLOGY

(CONTINUED)

No.	Mathematical Concept	AUTO	WELD	MACH	BC	DRAFT	FORST	CIVIL	ELECT	EMT
122	Average Rate of Change					X		X	X	X
123	Spherical Volumes						X	X		X
124	Volume of a Pyramid						X	X		X
125	Areas of Eliptical Forms					X	X	X		
126	Three Dimensional Coordinate System (x,y,z)					X	X	X		
127	Graphs of Trigonometric Functions							X	X	X
128	Logarithmic Calculations with Negative Numbers							X	X	X
129	The Derivative					X		X		X
130	Graphical Differentiation					X				X
131	Differentiation Formulas					X		X		
132	Physical Applications of the Derivative					X				
133	Vectors in Three Dimensional System					X		X		
134	Spherical Cap with Radius r and Height h					X		X		
135	Frustrum Right Circle Cone w/ Radii a,b and Height h					X	X	X		
136	Right Circular Cone with Radius r and Height h					X	X	X		

MATHEMATICAL CONTENT

BY TECHNOLOGY

(CONTINUED)

No.	Mathematical Concept	AUTO	WELD	MACH	BC	DRAFT	FORST	CIVIL	ELECT	EMT
137	Right Circular Cylinder of Radius r and Height h					X	X			
138	Geometric Interpretation of Vectors					X			X	X
139	Addition of Vectors					X			X	X
140	Subtraction of Vectors					X			X	X
141	Multiplication of a Vector by a Scalar					X			X	X
142	Phasor Algebra					X			X	X
143	Factorable Quadratic Equations					X		X		
144	The Inverse of Differentiation					X				X
145	The Definite Integral					X				X
146	Notation for Higher Derivatives					X				
147	Physical Applications of the Higher Derivatives					X				
148	The Polar Triangle						X	X		
149	Formulas For Right Spherical Triangles						X	X		
150	Napiers; Rule of Circular Parts						X	X		

MATHEMATICAL CONTENT

BY TECHNOLOGY

(CONTINUED)

No.	Mathematical Concept	AUTO	WELD	MACH	BC	DRAFT	FORST	CIVIL	ELECT	EMT
151	Given Three Sides of General Spherical Triangle						X	X		
152	Division of a Polynomial by Another Polynomial							X		
153	Factors of the Difference of two Algebraic Numbers							X		
154	Degrees of Monomials and Polynomials							X		
155	Determinants							X		
156	Newton's Method							X		
157	Polar Form of Complex Numbers								X	X
158	J as an Operator								X	X
159	Multiplication of Polar Vectors								X	X
160	Division of Polar Vectors								X	X
161	Fundamentals of Complex Algebra								X	X
162	Geometrical Representation of Imaginary Numbers								X	X
163	Pure Imaginary Numbers								X	X
164	Complex Numbers and Operations								X	X
165	Division of Complex Numbers								X	X

MATHEMATICAL CONTENT

BY TECHNOLOGY

(CONTINUED)

No.	Mathematical Concept	AUTO	WELD	MACH	BC	DRAFT	FORST	CIVIL	ELECT	EMT
166	Multiplication of Complex Numbers								X	X
167	The Conjugate								X	X
168	Binary Number System								X	X
169	Number System Conversion								X	X
170	Binary Addition								X	X
171	Binary Subtraction								X	X
172	1's Complement								X	X
173	2's Complement								X	X
174	9's Complement								X	X
175	Subtraction Using the 1's Complement								X	X
176	Subtraction Using the 2's Complement								X	X
177	Multiplication Using Repeated Addition								X	X
178	Division Using Repeated Subtraction								X	X
179	Hexadecimal Number System and Conversion								X	X
180	Octal Number System and Conversion								X	X

MATHEMATICAL CONTENT

BY TECHNOLOGY

(CONTINUED)

No.	Mathematical Concept	AUTO	WELD	MACH	BC	DRAFT	FORST	CIVIL	ELECT	EMT
181	Fundamentals of Boolean Algebra								X	X
182	Boolean Theorems								X	X
183	Developing Boolean Equations								X	X
184	Simplification by Basic Theorems								X	X
185	Simplification Using Karnaugh Maps								X	X
186	The Differential								X	X

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Education: Attended grade and high school at Wright City High School, Wright City, Oklahoma, graduated in 1963; graduated from Eastern Oklahoma State College, Wilburton, Oklahoma in 1967; received the Bachelor of Science degree from Oklahoma State University, Stillwater, Oklahoma, with a Major in Technical Education in 1971; completed requirements for the Master of Science degree with a Major in Technical Education in July, 1976.

Professional Experience: Design Draftsman, Weyerhauser Company, Dierks Division, DeQueen, Arkansas, Summer 1968; Project Engineer, Weyerhauser Company, Dierks Division, Wright City, Oklahoma, Summer 1970; Instructor of Electronics Technology, Eastern Oklahoma State College, Wilburton, Oklahoma, 1971-76.