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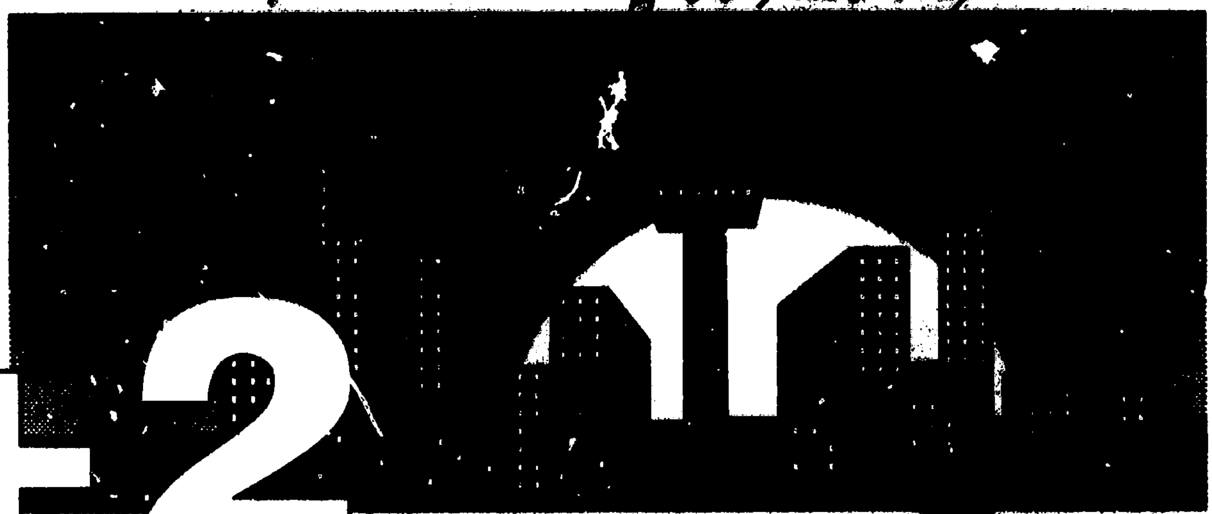
ABSTRACT

This document contains all pertinent information and essential background data necessary to implement the 2+2 electronics program at the high school level. An introduction describes development of the electronics technology 2+2 project that was a joint effort among San Antonio College and Judson, Northside, and North East Independent School Districts (Texas). A section on project design discusses three activities: business survey to ascertain labor needs, site visits to larger employers, and DACUM (Developing a Curriculum) analyses. Information is provided on course description and revised course outline, essential elements, and competencies. Lists of essential elements common to all vocational programs and electronics technology 2+2 essential elements are provided. Recommended high school course selection guides follow. Competencies for 2+2 electronics are listed by the semester in which they receive the most emphasis; college prerequisites are noted. A recommended secondary course outline is provided for instruction in DC electronics, AC electronics, semiconductors, and digital electronics. Lesson plans with content outlines are followed by a line drawing of the physical plant, equipment list, student follow-up form to be completed by the employer, and articulation agreement. Appendixes include information on development of curriculum for community colleges, letters of support, and a list of 43 print and 22 video references. (YLB)



2+2

ELECTRONICS TECHNOLOGY

LOOKING FORWARD TO THE FUTURE

2+2 ELECTRONICS TECHNOLOGY GRANT
TEXAS EDUCATION AGENCY
PROJECT NUMBER: 380-05-31-89-024

The project reported herein was performed through a contract with the Texas Education Agency under the provisions of the Carl D. Perkins Vocational Education Act (Public Law 98-524). Contractees undertaking such projects are encouraged to express freely their professional judgement in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Texas Education Agency position or policy.

A MODEL SECONDARY/POST-SECONDARY 2+2 PROGRAM

TO PREPARE STUDENTS FOR EMPLOYMENT

CURRICULUM WRITERS:
BOB ALBERS, JUDSON HIGH SCHOOL, JUDSON ISD
JOHN BROTHERMAN, MACARTHUR HIGH SCHOOL, NORTH EAST ISD
JOE RODRIGUEZ, LEE HIGH SCHOOL, NORTH EAST ISD
CHARLES BENNETT, CLARK HIGH SCHOOL, NORTHSIDE ISD
MARK BOWMAN, MARSHALL HIGH SCHOOL, NORTHSIDE ISD
CHARLES SOLANIK, JAY HIGH SCHOOL, NORTHSIDE ISD
ANDREA TERRELL, SAN ANTONIO COLLEGE

SPONSORED COOPERATIVELY BY

TEXAS EDUCATION AGENCY
AND
NORTH EAST ISD, STEVEN L. FOSTER
NORTHSIDE ISD, CHARLIE BARNETT
JUDSON ISD, PAT WINGO

WITH SUPPORT AND
CONTRIBUTIONS FROM

ALBERT B. GRUBBS, JR., PH.D.
TEXAS A&M UNIVERSITY

JUNE 30, 1990

PROJECT NUMBER 380/05/31/89-024

'NDI TAYLOR KRIER
STATE SENATOR
DISTRICT 26

mmittees:
:DUCATION
'INANCE
Chairman:
Subcommittee on Education
URISPRUDENCE

The Senate of The State of Texas

CAPITOL OFFICE
P.O. Box 12068
Austin, Texas 78711
512/463-0126

DISTRICT OFFICE:
Business and Technology Center
301 S. Frio
San Antonio, Texas 78207
512/270-4535

June 27, 1990

Dear Friends:

Moving into its second year, the 2+2+2 Electronics Technology Project is progressing well. A new and innovative approach to keeping students in school, 2+2+2 gives them a clear and positive goal through their high school and college careers.

What makes this project so successful is the enthusiastic commitment to cooperation among those involved with the project -- Northeast, Northside and Judson School Districts, San Antonio Community College and Texas A & M, as well as the various local industry representatives who share their time and expertise with these students.

There is no substitute for a good education. This project instills motivation for students to continue their studies while providing an educated workforce for the future of our community and state.

I commend your work and look forward to future opportunities to work with you and the 2+2+2 program.

With best wishes, I am

Sincerely yours,

Cyndi Krier

Cyndi Taylor Krier

CTK/sew

North East Independent School District
10333 BROADWAY - SAN ANTONIO, TEXAS 78217

Office of
Vocational Education

June 1990

To the People of Texas:

Since 1988, the North East, Northside, and Judson Independent School Districts, San Antonio College, and Texas A&M University have made a team effort to develop an Electronics Technology 2+2+2 curriculum based upon competencies required for employment in private industry and government. The advisory committee members and educators have worked together to build recommended course outlines with added emphasis on math and the sciences.

I am proud of the district's participation in the building of the 2+2+2 program, and I commend the cooperation between the schools and committee members. The enthusiasm and dedication that enabled the committee to build this advanced Electronics Technology curriculum will be rewarded by the satisfaction of seeing the student continue his/her post-secondary education. Also, those students that want to, or must work to finance their education will be employable immediately after high school. I anticipate that this articulation agreement will become an exemplary example of the "marriage" of vocational and academic education by facilitating the students' successful entry into the workforce.

Sincerely yours,

Virginia Collier

Virginia Collier, Ph.D.
Associate Superintendent

COOKE ENTERPRISES CONSULTING
Development Strategies and Plans
■ Research Parks ■ New-Tech Business Ventures ■ University Research Programs
12907 Country Creek, San Antonio, Texas 78216 ■ (512) 496-6535

July 10, 1990

Mr. Steve Foster
Office of Vocational Education
NEISD
10333 Broadway
San Antonio, Texas 78217

Dear Steve,

Thanks for including me in the review of your "2+2+2 progress report" to the TEA.

As Chairman of the "2+2+2 Business Steering Group, I believe important and challenging steps were taken this year by your School districts, SAC, and Texas A&M (under direction of Dr. Grubbs and participating faculty).

The Business Steering Group has been intimately involved in the work on the DACUM analysis which serves a guide to all our efforts, and leads to performance based education at all levels.

The Steering Group is on record as recognizing the importance of, and merit in, indeed the necessity for, student choices and decisions at each level of the 2+2+2 educational ladder.

The educational program must recognize the need in flexibility for student decision. The student must see in the program an opportunity to receive higher level credit for exceptional performance at the lower level -- college credit for knowledge obtained in high school, university credit for exceptional work in the two-year college. Your program provides the student and the counselors opportunities for hard decisions early in high school.

This is not to imply that the six year education should be shortened by pushing higher level material to the lower level schools. Rather both student and institutions should see this as an opportunity to increase the content of the 2+2+2 technology courses -- at each o the three levels. Both student and institution must accept the fact that the knowledge base of technology professions is increasing so fast that curricula must be "pruned" in order to graduate students at the traditional high school, Associate Baccalaureate, and Baccalaureate level. All businessmen are painfully aware of the post graduate training cost which is passed from the educational institutions to the private industrial, government and business sector.

The program must be such that the student clearly sees the advantages in participating in the fully articulated 2+2+2 program, that he can get higher level work done in high school and at SAC. And if he follows the full 6 year program, he can have a superior education, with more performance related content, than the 4 year engineering technology program. Your progress report reflects a recognition of this value and moves in this direction.

Another observation needs saying. The time has arrived for institutional recognition of the status and importance of technological education in the high schools. Certainly no one can say that tele-communications mechanics is like it was 50 years ago. Today the electronic and tele-communication technician must deal with computer math, and he must deal with the English language in a way never before expected. He cannot study his material, nor follow his technical manuals, nor keep up with continuing education without a full grounding in language, communication and mathematical skills. Your progress report takes this into account, especially in the "honors" and "advanced" curricula.

During this past year your work and the others has progressed in recognition of the foregoing. Our objectives have been shaped by the necessity to "pack" more content, with more relevance into the traditional time frames. This basic truth has served as a guide for your 2+2 articulation agreement with SAC.

This report illustrates the strong support of the technological educators (vocational education) in your respective Districts. You, Pat Wingo-Macune, and Charlie Barnett have done an excellent job of leadership and coordination, bringing together the various faculties, administrations and curriculum experts. According to our telephone conversation, the articulation agreement has now been signed by the San Antonio College. Please pass my appreciation for a job well done to Pat and Charlie.

We know how tough these changes, and cooperative arrangements can be, on the part of parents, students, faculties, institutions, etc., but we are on the right path in this case. The technological demands of our economy will force this. Those who resist educational reforms of this nature will be pushed aside by the reality in the business world.

Thanks again for asking me to participate.

Sincerely,

GERRY

Gerry Cooke, Ph.D.
Major General USAF(Ret)
Chairman, 2+2+2 Business Steering Committee

ACKNOWLEDGEMENTS

We would like to express our thanks for the support from the following Texas Education Agency staff members:

Robert S. Patterson - Director, Vocational Ed. Programs

James M. Cogdell - Director of Programs, Trade and Ind. Ed.

Jack Risinger - Occupational Education Specialist

Dorothea Monroe - Trade & Industrial Education Specialist

Their encouragement and continued support have been greatly appreciated during the development of the Electronics Technology Curriculum.

Steve Foster
Program Director

ACKNOWLEDGEMENTS

Many people have been involved in making this project a successful venture. I wish first to commend the curriculum writers, who in addition to their busy teaching schedules found time to work together as a group to develop the secondary portion of the 2+2 curriculum. These writers are:

Bob Albers - Judson High School
John Brotherman - MacArthur High School
Joe Rodriguez - Lee High School
Charles Bennett - Clark High School
Mark Bowman - Marshall High School
Charles Solanik - John Jay High School

Russ Greiner of San Antonio Community College have, through his support and direction, been a valuable link between the secondary and post secondary institutions. My thanks are extended to Dr. Albert Grubbs of Texas A&M University, for his help in analyzing the DACUM information and placing it into a workable document. The Steering Committee, headed by Dr. Gerry Cooke, has been an invaluable source of information and ideas.

Steve Foster
Project Director

STEERING COMMITTEE MEMBERS

Gerry Cooke, PH.D., Chairman
Cooke Enterprises

INDUSTRY REPRESENTATIVES

Mr. Charles Becker, President..Technical Concepts Corporation
Mr. Dennis Bosserman, Staff Engineer...Data Point Corporation
Ms. Rebecca Clark, Area Personnel Manager...Southwestern Bell
Mr. W.E. Cory, Vice President of
Electronic Research..........Southwest Research Institute
Mr. George Cox, President.......Automatic Control Electronics
Mr. L.G. DeAnda, Director of Training.....City Public Service
Mr. Steve Denney, President....Info. Systems & Networks Corp.
Mr Aubrey Duelem, Chief of Biomedical
Engineering.........U.S.A.F. School of Aerospace Medicine
Mr. David Gent, President.....................SofTest Designs
Mr. Dave Ives, Director of Tech. Operations...Intelogic Trace
Mr. Grant Lamphere, Production Mgr.....Advanced Micro Devices
Mr. David Lopez...................H. Dell Foster & Associates
Mr. Larry Magee, Sales Manager........Hewlett-Packard Company
Mr. Don Mann, Service Manager..............Wang Laboratories
Dr. Gilbert Persyn, President.............Praxis Corporation
Mr. Glenn A. Pierce Jr., Pres.& CEO....Image Data Corporation
Mr. Frank Ramert Jr., Pres.& CEO...Power Controls Corporation
Mr. Bob Rhodes, District Manager.............NCR Corporation
Mr. Gordon Sommers, Executive Advisor to the
Commander.........Electronics Security Command (U.S.A.F.)
Ms. Marty Taylor, Human Resource Director
...............................Power Controls Corporation
Mr. John Wilson, V.P. of Manufacturing....... Xytronics, Inc.

SECONDARY EDUCATION

Ms. Dorothea Monroe, Trade & Ind. Ed. Specialist....TEA Staff
Ms. Pat Wingo, Director of Career Studies..........Judson ISD
Mr. Steven Foster, Vocational Director.........North East ISD
Mr. Charles Barnett, Vocational Supervisor......Northside ISD
Mr. Bob Albers, Teacher, Judson High School........Judson ISD
Mr. John Brotherman, Teacher, MacArthur High...North East ISD
Mr. Joe Rodriguez, Teacher, Lee High School....North East ISD
Mr. Charles Bennett, Teacher, Clark High........Northside ISD
Mr. Mark Bowman, Teacher, Marsnall High School..Northside ISD
Mr. Charles Solanik, Teacher, John Jay..........Northside ISD

POST-SECONDARY EDUCATION

Ms. Andrea Terrell..........................Project Director
Mr. Homer Hayes, Dean of Voc. & Cont.Education............SAC
Mr. Russell Greiner, Instructor & Curricula Developer.....SAC

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INTRODUCTION

This project is the result of development and refinement of the 2+2+2 Secondary/Post-Secondary Program to prepare students for employment in electronics technology. The Electronics 2+2 Program is a joint effort between San Antonio College, Judson I.S.D., Northside I.S.D., and North East I.S.D. The project development program, which was initiated in the fall of 1988, is based on careful analysis of the needs of industry in the San Antonio area and is designed to eliminate duplication of course work while preparing students for entry level employment in the electronics industry.

The first year of development of the 2+2+2 program is documented in the following publications:

> A MODEL SECONDARY/POST-SECONDARY 2+2 PROGRAM TO PREPARE STUDENTS FOR EMPLOYMENT, PROJECT NUMBER 99420067, JUNE 30, 1989.
>
> 2+2+2 ELECTRONICS ENGINEERING TECHNOLOGY CURRICULUM DEVELOPMENT PROJECT, PROJECT NUMBER 99103021, June 30, 1989.

The essential elements, course objectives, and course outline that were developed in the June 1989 project were implemented to the maximum extent possible in the 1989-90 school year. Experience with the program in the six participating San Antonio high schools revealed that the 2+2+2 Electronics Technology courses in the high school could be articulated with the program at San Antonio College and that the new curriculum had the promise of fulfilling the objective of serving the student that chose to continue his or her formal education in a post-secondary institution. It was also revealed that the program had potential for refining the competencies for the student seeking entry level employment in the electronics industry. Although the one year experience with the program revealed that the concept and course outline were basically sound, numerous minor revisions and improvements have been incorporated in this follow-up project. The essential elements, course objectives, and course outline were all revised to reflect these improvements. An extensive search for instructional materials was conducted and numerous documents from a variety of sources were reviewed for possible inclusion in the 2+2+2 lesson recommendations. The course was broken down into a number of suggested lessons along with a list of proposed lesson objectives, as well as an estimate of the approximate time that might be dedicated to each lesson.

It is the objective and hope of the writers of this document that others will find the information applicable to their own educational and community environment and thus be able to adapt the 2+2+2 Electronics Technology Program for the benefit of their students and community. To preclude the necessity of continually referring to the previous information published for this program, and to ensure that the reader is presented the updated and revised curriculum material, all pertinent information and essential background data that are needed to implement the 2+2+2 Electronics Program at the high school level is included in this new document.

BACKGROUND FOR THE 2+2 DEVELOPMENT
YEAR 1: 1988-1989

The Electronics Technology 2+2 project was conceived as a method of coordinating the curriculum of high school vocational electronics programs with the electronics technology curriculum. The program was seen to be a method of improving the efficiency of the educational resources by avoiding duplication and expanding the career opportunities and educational options for the student. The project would culminate in the publication of a curriculum that would provide for transfer of credit from one level to the next as defined by formal articulation agreements between the various institutions. The new curriculum was also to provide the student with competencies and skills desired by employers in the electronics industry, thus allowing the student the option of entering the workforce and/or continuing his or her formal education at the next higher level. Specifically this 2+2 project presented here will refer to a coordinated two years of secondary vocational education course work that will apply directly to a two year post-secondary program at San Antonio College. The community college curriculum that has been developed to articulate with this secondary Electronics Technology Program is presented as an attachment to this document for information only. It is recommended that those that are interested in adapting the 2+2+2 Electronics Program at the community college level and four year university level consult the companion document, 2+2+2 CURRICULUM DEVELOPMENT IN ELECTRONICS ENGINEERING TECHNOLOGY, PROJECT NUMBER 11110008, July 1990, that was developed concurrently for application at the community college level.

On October 5, 1988, all parties concerned met at San Antonio College and established a working agenda. A list of business /industry members was developed for the Steering Committee. In December of 1988, the secondary participants were briefed as to their duties. The procedure for the DACUM was established. Three separate DACUM analyses were conducted utilizing approximately 50 business leaders from the San

Antonio area. The three areas analyzed were Manufacturing Electronics, Information Systems Technology, and Telecommunications Systems. A questionnaire was also distributed to electronic companies in the San Antonio area. The results from the questionnaires, in addition to the information obtained from the DACUM analyses, were then analyzed by Dr. Grubbs of Texas A&M, Mr. Clay Laster of SAC, and the writers from the three school districts. These provided an extensive pool of information to draw upon when developing the course outlines. The skills that industry requires for competency when entering the workforce after high school, as well as those required after exiting the post-secondary institution, have been reviewed by industry representatives. The post-secondary institution's prerequisites for course requirements and grades have been agreed upon. The objectives of developing a course outline, assembling an equipment list, and designing a functional facility have been accomplished.

YEAR 2: 1989-1990

The second year of the project was devoted to three principle efforts:

(1) The new essential elements, course outline, and competencies were implemented, updated, and tested for applicability in the six participating high schools.
(2) A comprehensive review of existing course material was conducted in order to determine if the 2+2 curriculum could be supported, and also to assist in developing individual lesson plans.
(3) A sequence of specific lessons complete with competency based objectives was developed.

The experience with the 2+2 curriculum was quite positive. The secondary Electronics teachers found that the new curriculum contained no obstacles and that transition to the new essential elements and competencies did not represent an extreme departure from the existing programs. Review of the available instructional material indicated that the 2+2 curriculum was representative of other current, well-developed programs throughout the country and that it was in general agreement in content with the majority of recent textbooks that were designed for this level of instruction. The instructors that are involved in this effort and individuals that have reviewed the curriculum are confident that the 2+2 Electronics Program presented here is a development that has taken the best features of the available material, and the competencies are an expression of the standards, not only in San Antonio, but probably throughout the electronics industry.

The personnel involved with this program have been very enthusiastic, community involvement has been encouraging, and student interest appears to be positive; therefore, the three independent school districts agree that the 2+2 Electronics Technology Program has potential for wide application, and given proper administrative support, the project has great potential for improving the service to the student and to the community.

**OVERVIEW OF THE ABSTRACT
METHODS AND ACTIVITIES TO ACHIEVE
THE GOALS OF THE PROGRAM**

1. The 1989-1990 school year was the first year that the teachers in the three involved school districts phased in the new Electronics Technology course. The main thrust of the second phase of the 2+2 project was to refine and develop the course to articulate with year three and four. Equally important, effort was continued to ensure that the course was complete and relevant for those that seek employment after the second year of the electronics program.

2. In order for the students to achieve the competencies listed for the high school phase of the 2+2 Electronics Program, they must be capable of reading and understanding scientific and technical material. Computer skills, as well as occupational and employability skills, are addressed in the course outline and essential elements. Writing skills must be considered as part of the employability skills and should be part of the instructional process throughout the high school experience.

   The Steering Committee was intact throughout the second phase of the 2+2 program. The scheduled meetings and other frequent communications allowed the committee to be actively involved and in agreement with the project as it developed.

3. The products to be delivered to interested agencies will be in accordance with the abstract. In addition to the reports, a suggested public relations pamphlet will be included.

4. The Steering Committee, representatives from government and private industry, have validated the competency based curriculum and many of the associated lesson plans. In addition, the competencies and course outlines were reviewed and critiqued by officials of the member schools of the Texas Association of Schools of Engineering Technology. The Electronics Department of San Antonio College was closely involved in all changes and development of the curriculum. Dr. Albert B. Grubbs of Texas A&M University was a participant in

reviewing the revised outline and competency list, as well as samples of specific lessons.

The instructors are enthusiastic about implementing the revised program in the 1990-1991 school year. There is enough flexibility in the program to allow for continued refinement and improvement. Steve Foster of N.E.I.S.D. has offered his office as a place to maintain and manage instructional and reference materials. He will also serve as a contact person for including and disseminating information on improvements and refinements as they develop from experience with the Electronics Technology 2+2 Program.

OTHER COMMENTS

1. The equipment list and recommended physical plant were reviewed, and some minor changes were incorporated. The instructors generally feel that the items and features listed would provide for a first class electronics instructional facility that would give students knowledge and insight into the electronics industry.

2. The electronics industry and the electronics elements of many other industries are extremely diverse. There are many unique opportunities for handicapped individuals. For example, many of the most challenging and rewarding responsibilities are not compromised by limits in strength and/or mobility. ARD proceedings will find that it will be relatively easy to adapt electronics technology instruction to individual needs.

3. The Steering Committee will remain active and will be used to evaluate the progress of the program and to recommend changes or solutions to problems as they arise. The established follow-up program will be utilized to determine the progress of secondary students and to evaluate the program in terms of actual benefit to the student and to the industry.

PROJECT DESIGN

Three school districts were utilized for this project: North East I.S.D., Northside I.S.D., and Judson I.S.D. These school districts are located in the more affluent sections of the greater San Antonio area. The district populations are as follows:

North East I.S.D.	37,000
Northside I.S.D.	50,000
Judson I.S.D.	12,600

The staff used to prepare this report are all veteran participants in the electronic industries and education.

In developing a program of this nature, it was necessary to have a steering committee that would involve managerial and executive level industry representatives. Mayor Henry Cisneros was asked to aid in soliciting these volunteers from the community. A survey was then developed and mailed to local businesses to determine:

1. The ratio of engineers to technicians, and the historical trend between the two roles.
2. The types of positions within the organization that require an Electronics Engineering background.
3. The educational prerequisites and experience qualifications for each position.
4. Specific bodies of knowledge utilized by employees.

On-site Visits and DACUM Analyses

A series of on-site visits were made to the larger employers to tour offices, plants and other facilities, as well as to ask more specific questions about job competencies, problems recruiting skilled personnel, career paths, and expectations regarding in-house versus formal training, etc.

Decisions were made to categorize positions according to perceived commonalities in similar occupations across organizations. On the basis of the foregoing, three DACUM analyses were conducted in the following areas: (1) Computers (2) Communications (3) Manufacturing The DACUM panelists were selected accordingly from those organizations as follows:

1. <u>COMPUTERS</u>
   Electronics Security Command (U.S. Air Force)
   Hewlett-Packard
   IBM

Intelogic Trace
NCR
Wang Laboratories

2. COMMUNICATIONS
City Public Service
Electronics Security Command (U.S. Air Force)
KSAT TV, Channel 12
School of Cryptographic Training (U.S.A.F.)
Southwest Research Institute

3. MANUFACTURING
Advanced Micro Devices
Datapoint Corporation
Harris Corporation, Farinon Division
Motorola, Inc.
VLSI Technology, Inc.
Xytronics, Inc.

Each analysis was two days, or approximately fourteen hours, in duration. The resulting charts were then mailed to all listed companies for validation, and the respondents were then asked to assign a numerical value to indicate the importance of that particular skill in their respective companies.

The DACUM results were then sent to Texas A&M University for further analysis, elaboration, and conversion into specific competencies. In collaboration with A&M and both secondary and post-secondary faculty, they were subsequently examined and initially grouped into entry, mid, and advanced-level exit points with direct implication for course content and articulation of curricula. The results of this effort were again sent to Texas A&M for further refinement and organization into basic, core, and specialty areas. In addition, all competencies were input into a computerized database with a coding system to allow periodic review and updating of the curricula in response to the changing needs of industry. For an elaboration of this methodology, information on the computerized database, and the entire list of competencies, see the following publication: A MODEL SECONDARY/POST-SECONDARY 2+2 PROGRAM TO PREPARE STUDENTS FOR EMPLOYMENT, PROJECT NUMBER 99420067, June 30, 1989.

Content areas for courses were circumscribed, specific student competencies were enumerated for each course from the database and course outlines constructed accordingly. Course equivalancies were analyzed between institutions and duplication eliminated where appropriate. Each course was constructed according to

Competency-Based Vocational Education (CBVE) guidelines. While electronics as a field is grounded in a large body of theory, the curriculum contains observable and measurable activities as evidence of the students' knowledge. If necessary, this assures that learning takes place by the repetition of tasks associated with each competency. An advantage of a CBVE is that the student's abilities are defined by the competency itself and not by comparison to other students.

ELECTRONICS TECHNOLOGY 2+2 COURSE DESCRIPTION

Electronics Technology 2+2 is a theory and laboratory course designed to serve students with occupationally specific training for entry level employment or training in the electronics industry as well as those planning to pursue post-secondary engineering or technical education. Included are:

- Basic electronic theory
- Circuit theory
- Designing and building electronic circuits
- Utilizing schematic diagrams
- Testing semiconductor devices
- Working with digital electronic circuits and microprocessors
- Entrepreneurship
- Safety
- Leadership
- Career Opportunities

The course material is designed for those students that have demonstrated an aptitude for technical vocations. The classes are organized to be offered in two hour blocks over a period of four semesters. Students will be offered extensive instruction that addresses the material presented in traditional community college technical electronics programs.

By prior agreement, students that are successful in this course of study will be awarded full college credit when they complete a series of college courses especially designed to build on the material offered in this course.

Student Eligibility: The program is designed for regular students enrolled in grades 11 and 12. It is highly recommended that each student have a solid background in mathematics, including two years of algebra and satisfactory grades in science. The student must be physically and mentally competent to satisfy the requirements of the program.

Qualifications of Teachers: A teacher for the Electronics Technology 2+2 class must be occupationally competent. The teacher should have three years of recent (within the last four years) full-time experience in the field of electronics. The teachers must have an Associate Degree in Electronics or be a high school graduate with equivalent formal electronics education in approved technical or trade schools.

Textbooks: There are several excellent textbooks on the market. We recommend that these be placed on the state adoption list. Individual school districts should be allowed to select the text best suited for the program in their geographic areas.

Jobs That Students Could Acquire Without Continuing at the Post-Secondary Institution: The high school electronics technology essential elements and competencies are based on the survey of San Antonio employers (DACUM). Students completing the high school Electronics 2+2 Program will be acquainted with standard terminology, tools, and techniques that will be encountered in the workplace. Though students would be considered entry-level, all would be able to read and understand technical data, research parts, operate test equipment, and understand instructions. The employment opportunities would include jobs such as the repair, service, and installation of telecommunications systems, business machines, computers, TVs, VCRs, and other consumer electronics.

Students could also readily learn the repair and maintenance of electro-mechanical devices such as vending machines, video games, advertising signs, and manufacturing and transportation systems. Students may find employment with distribution concerns and defense contractors. We should assume that our high school graduates would be introduced to the more elementary tasks and systems until they have gained the confidence of the employer and have sufficient experience in working with some of the more complex devices. It would be unrealistic to expect someone who is relatively new to the career to arrive ready to operate and repair some of the electronic devices now available. Employers find that even their more experienced technicians often require specific training on new systems and that more and more are specializing in order to be effective. An honest appraisal might reveal that most community college and technical school graduates must follow the same sort of specific training that will face high school graduates in order to become productive in the workplace.

REVISED COURSE OUTLINE, ESSENTIAL ELEMENTS, AND COMPETENCIES

The course outline, essential elements, and competencies that were proposed for the high school curriculum in phase one of the 2+2+2 project have been reviewed by a number of post-secondary electronics departments. In addition, the six high school instructors have had some opportunity to review and evaluate the essential elements and competencies while incorporating the new curriculum. The general reaction to the 2+2+2 program was quite positive, and you will notice that there have been very few revisions to the original document. The general consensus of those involved in the review was that the new curriculum represented a significant step in the right direction, and that the program should have potential for wide application. It should be reemphasized that the course outline is offered as a suggestion and may be adapted to the local situation; therefore, it is expanded to include many of the desired and optional items noted in the essential elements and competencies.

When each change was considered, careful attention was given to the list of requirements from San Antonio College to insure that the students would continue to learn and demonstrate competency in all material that was specified for qualification for the 2+2 credit; thus, the spirit of the original articulation agreement would remain intact.

ESSENTIAL ELEMENTS
COMMON TO ALL VOCATIONAL PROGRAMS

1. <u>Leadership Concepts and Skills</u> The student shall be provided opportunities to:

   A. Demonstrate skills, characteristics, and responsibilities of leaders and effective group members.
   B. Demonstrate a knowledge of parliamentary procedure principles.
   C. Plan and conduct leadership activities.
   D. Prepare for effective citizenship and for participation in our democratic society.

2. <u>Concepts and Skills Related to Successful Employment and/or Post-secondary Training</u> The student shall be provided opportunities to:

   A. Identify employment opportunities and preparation requirements in chosen fields.
   B. Identify effective methods to secure and terminate employment.
   C. Demonstrate effective communication skills both oral and written, and follow through on assigned tasks.
   D. Demonstrate dependability and punctuality.
   E. Demonstrate productive work habits and attitudes.
   F. Understand the importance of taking pride in the quality of work performed.
   G. Recognize the dignity in work.
   H. Develop skills in planning and organizing work.
   I. Apply required methods and sequences when performing tasks.
   J. Apply principles of time management and work simplification when performing assigned tasks.
   K. Identify ethical practices and responsibilities.
   L. Understand the importance of the application of organizational policies and procedures.

3. <u>Concepts and Skills Associated with Entrepreneurship</u> The student shall be provided opportunities to:

   A. Identify opportunities for business ownership.
   B. Understand the risk and profit motive factor.
   C. Understand the elements and advantages of the free enterprise system.
   D. Explain the role of small business in the free

enterprise system.

4. <u>Concepts and Skills Related to Safety and Safe Working Conditions</u> The student shall be provided opportunities to identify and apply safe working practices to all training situations.

5. <u>Concepts and Skills Associated with Human Relations and Personality Development</u> The student shall be provided opportunities to:

   A. Understand the importance of maintaining good health and proper appearance for effective job performance.
   B. Understand oneself and others.
   C. Exercise self-control.
   D. Accept and use criticism.
   E. Recognize basic human relationships as they relate to business success.
   F. Demonstrate characteristics for successful working relationships.

6. <u>Concepts and Skills Related to Personal and Business Management</u> The student shall be provided opportunities to:

   A. Explain how management assists in reaching personal and family goals.
   B. Explain the management process.
   C. Describe the role of management in controlling stress.
   D. Identify and understand personal checking accounts.
   E. Identify and understand the personal loan application process.
   F. Identify and understand different financial institutions.
   G. Identify the role and function of business management.
   H. Understand the lines of authority.
   I. Identify effective supervisory techniques.

7. <u>Concepts and Skills Associated with the Specific Occupation Being Taught</u> The student shall be provided opportunities to:

   A. Understand the basic concepts of and develop proficiency in the occupational area for which instruction/training is provided.
   B. Develop a fundamental understanding of mathematical principle and scientific procedures.
   C. Understand terminology utilized.
   D. Identify tools, equipment, and materials used.
   E. Develop and demonstrate appropriate techniques

for the selection, use, maintenance, and storage of tools, equipment, and materials.

ELECTRONICS TECHNOLOGY 2+2 ESSENTIAL ELEMENTS

1. Investigate the physical properties of electronic materials and theory of semiconductors.

2. Apply Ohm's Law and power theory.

3. Analyze DC and AC circuits.

4. Compute reactance, impedance, and phase relationships.

5. Understand the process of induction and understand magnetism as it relates to electricity.

6. Construct electronic circuits with discrete components and integrated circuits.

7. Utilize test equipment to determine the properties of components and circuits.

8. Understand the theory of operation and application of: power supplies, amplifiers, oscillators, and filters.

9. Investigate semiconducto devices.

10. Investigate optoelectronic devices.

11. Investigate communications systems.

12. Investigate the construction and application of integrated circuits.

13. Investigate the theory of operation and function of logic gates, combinational, and sequential logic circuits.

14. Construct and troubleshoot digital circuits.

15. Investigate microprocessor applications.

16. Demonstrate correct soldering technique.

17. Use basic electronic test equipment.

18. Demonstrate ability to use basic hand tools associated with electronics.

19. Read and understand electronic technical data.

RECOMMENDED HIGH SCHOOL COURSE SELECTION

ELECTRONICS 2+2

HONORS

9TH GRADE	10TH GRADE	11TH GRADE	12TH GRADE
ENGLISH I	ENGLISH II	ENGLISH III	ENGLISH IV
GEOMETRY*	ALGEBRA II*	TRIG/EMA*	CALCULUS
BIOLOGY I	CHEMISTRY I	PHYSICS I	TYPING
US HISTORY*	COMPUTER SCIENCE I	WLD HISTORY OR WLD GEOGRAPHY*	GOVERNMENT/ ECONOMICS*
LANGUAGE	LANGUAGE	ELECTRONICS I	ELECTRONICS II
HEALTH/P.E.*	P.E.	ELECTRONICS I	ELECTRONICS II

TECHNICIAN

9TH GRADE	10TH GRADE	11TH GRADE	12TH GRADE
ENGLISH I*	ENGLISH II*	ENGLISH III*	ENGLISH IV*
PRE-ALGEBRA	ALGEBRA I*	GEOMETRY*	ALGEBRA II*
PHYSICAL SCIENCE*	BIOLOGY I*	COMPUTER SCIENCE I	CHEMISTRY I
US HISTORY*	P.E.	WLD HISTORY or WLD GEOGRAPHY*	GOVERNMENT/ ECONOMICS*
ELECTIVE	ELECTIVE	ELECTRONICS I	ELECTRONICS II
HEALTH/P.E.*	MFG. Graphics	ELECTRONICS I	ELECTRONICS II

*Required Courses

RECOMMENDED HIGH SCHOOL COURSE SELECTION

ELECTRONICS 2+2

ADVANCED

9TH GRADE	10TH GRADE	11TH GRADE	12TH GRADE
ENGLISH I*	ENGLISH II*	ENGLISH III*	ENGLISH IV*
ALGEBRA I	GEOMETRY*	ALGEBRA II*	TRIG/EMA
PHYSICAL SCIENCE	BIOLOGY I*	COMPUTER SCIENCE I	CHEMISTRY I
US HISTORY*	P.E.	WLD HISTORY or WLD GEOGRAPHY*	GOVERNMENT/ ECONOMICS*
ELECTIVE	ELECTIVE	ELECTRONICS I	ELECTRONICS II
HEALTH/P.E.*	MFG. GRAPHICS	ELECTRONICS I	ELECTRONICS II

* Required Courses

COMPETENCIES FOR 2+2 ELECTRONICS TECHNOLOGY

Individual competencies are generally listed by the semester in which they receive the most emphasis: competencies annotated by "»" are addressed, expanded, and/or receive continuing attention over more than one semester. Items marked with an "*" are optional but are encouraged as a prerequisite for compliance with the community college credit program, and are desirable for those students who elect to enter the workforce directly from high school.

THE SPECIFIC COMPETENCIES ARE:

SEMESTER ONE

1. Define electricity.
2. Label and describe each part of an atom.
3. Explain the relationship of electrons to EMF and current.
4. Define static electricity.
5. Identify conductors, insulators, and semiconductors from their atomic structures.
6. Describe the characteristics of static electricity.
7. List and give examples for each of the sources of electricity.
8. List and categorize the characteristics of batteries.
9. Describe and define current, voltage, resistance, and power.
10. Define and explain polarity.
11. Draw the schematic diagram for and construct a simple circuit.
12. Define electrical power.
13. Use a hand held scientific calculator.»
14. Use electrical units; volts, ohm's, wat , amps.»
15. Identify all voltage drops, currents, d power consumptions in series, parallel, and series parallel circuits using Ohm's Law and the power formulas.»
16. Explain the concept of ground and common.
17. Define the terms short and open.
18. Measure electrical units using a digital multimeter.»
19. Measure electrical units using an analog vom.»
20. Solder wires, terminals, components and PC boards.»
21. Strip wire.
22. Use tools associated with electronics.»
23. Desolder components.»

24. List the factors that effect resistance.
25. Identify resistors.
26. Determine resistor values by color code.
27. Use metric prefixes.»
28. Use scientific notation.»
29. State Kirchhoff's Laws.
* 30. Analyze circuits using basic theorems.»
* 31. Analyze bridge circuits.»
32. Analyze voltage divider circuits.

SEMESTER TWO

33. State the characteristics of alternating current.
34. Contrast AC with DC.
35. List and describe the applications of AC.
36. Describe a sine wave and identify the AC units and measurements used to define alternating current and voltage.»
37. Compute and define effective, peak, and average AC values.
38. Solve for frequency and time of AC waveforms.
39. Use an oscilliscope to measure frequency.»
40. Use an oscilliscope to measure voltage.»
41. Use an oscilliscope to observe waveform.»
42. Use an oscilliscope to observe phase relationships.»
43. Explain the electricity/magnetism relationship.»
44. Explain the operator of a generator.
45. Define induction.
46. Identify inductors.
47. List the factors that effect induction.»
48. Explain self induction.
49. Explain mutual induction.
50. Compute inductive reactance.
51. Explain capacitance.
52. Identify capacitors.
53. List the factors that effect capacitance.
54. Compute capacitance reactance.
55. Explain transformer action.
56. Compute transformer currents and voltages.
57. Compute transformer impedances.
58. Define and compute impedance in RCL series and RCL parallel circuits.
59. Compute frequency of resonance in RCL circuits.
60. Recognize high pass and low pass filters.
61. Recognize band pass and band stop filters.
62. Compute bandwidth and Q.

SEMESTER THREE

63. Describe the properties of semiconductor material.

64. Explain the action of a diode.
65. List the applications for diodes.»
66. Test diodes.»
67. Explain the action of transistors.
68. Identify transistors.
69. Describe bipolar compared to FET transistors.
70. Describe PNP compared to NPN transistors.
71. Test transistors.»
72. Describe thyristors and list their applications.
73. Recognize symbols for electronic components.»
74. Interpret schematics.»
75. Construct circuits using descrete components.»
76. Explain the relationship of semiconductors and light.
77. Construct and explain circuits using optoelectronic components.
78. Describe integrated circuits.
79. List the characteristics of ICs.
80. Construct circuits using wave shaping ICs.»
81. Construct and analyze amplifier and OP amp circuits.
82. Construct and analyze a power supply.
* 83. Develop printed circuit art work from a circuit schematic.»
84. Fabricate printed circuits.»
85. Correct defects in circuit projects.»
* 86. Compute amplifier and transistor gain.
87. Explain oscillator action.
* 88. Describe the production of nonsinusoidal wave forms.
* 89. Describe radio transmission and reception.
* 90. Compute wavelength and discuss antenna design.
* 91. Use decibels, dBm, and volume units.

SEMESTER FOUR

* 92. Explain the difference between analog and digital.
* 93. Recognize binary codes.
* 94. Convert binary and decimal numbers.
* 95. Explain the operation of logic gates.
* 96. Construct truth tables for the logic gates.
* 97. Write the Boolean expression for the logic gates.
* 98. Construct truth tables for the logic circuits.
* 99. Construct logic circuits.
* 100. Explain the operation of multivibrators.
* 101. Contrast serial and parallel data presentation.
* 102. Explain the operation and function of flip-flops.
* 103. Use flip-flop ICs in digital circuits.
* 104. Explain the operation of decoders and encoders.

* 105. Construct encoder and decoder circuits.
* 106. Explain the operation of registers and counters.
* 107. Construct registers and counters.
* 108. Recognize and explain multiplexers and demultiplexers.
* 109. Simplify circuits by using Karnaugh maps.
* 110. Construct a logic probe.
* 111. Troubleshoot IC circuits with a logic probe.
* 112. Use a logic pulser to troubleshoot IC circuits.
* 113. Describe ADC and DAC circuits.
* 114. Describe memory circuits.
* 115. Construct circuits using memory integrated circuits.
* 116. Describe the basic function of microprocessors.
* 117. Describe methods of learning of new technology.»
* 118. Read and understand electronic technical data.»

ELECTRONICS TECHNOLOGY 2+2
SECONDARY COURSE OUTLINE

This is a recommended course outline. However, it must be understood that the actual sequence of instruction may be adjusted to meet the requirements of individual school districts. In order for the student to be eligible for 2+2 credit in the junior college program, all essential elements must be accomplished as specified in the 2+2 General Articulation Agreement.

SEMESTER I: DC ELECTRONICS

1. INTRODUCTION

   A. Orientation
   B. Survey of electronics

2. ELECTRONICS LABORATORY SAFETY

3. ELECTRONIC PHYSICS

   A. Atomic structure
   B. Electrostatics

4. CURRENT AND VOLTAGE

   A. Electron flow and current
   B. Voltage
   C. Producing electricity

5. BASIC ELECTRICAL CIRCUITS

   A. Schematic diagrams
   B. The electronic circuit
   C. Batteries
   D. Voltage rise and voltage drop

6. RESISTANCE

   A. Opposition to current
   B. Resistors
   C. Resistance in series and parallel

7. ELECTRICAL MEASUREMENTS

   A. Scientific notation
   B. Metric prefixes
   C. Measuring current
   D. Measuring voltage
   E. Measuring resistance

8. OHM'S LAW

   A. Relationship of current, voltage, and resistance
   B. DC resistive circuit analysis using Ohm's Law

9. POWER

   A. Power and work

B. Power current and voltage
C. Power dissipation
D. Power transfer

10. DC CIRCUITS

A. Series, parallel and series parallel circuits
B. Bridge circuits
C. Kirchoff's Law

11. THEOREM'S

A. Superposition theorem
B. Thevenin's theorem
C. Norton's theorem

12. SHOP PRACTICES AND TOOLS

A. Hand tools
B. Power tools
C. Soldering for electronics
D. Desoldering components

13. ELECTRONIC FABRICATION

A. Printed circuit board technology
B. Artwork layout and design
C. Printed circuit board fabrication
D. Cable fabrication

14. MAGNETISM

A. Properties of magnetism
B. Electricity and magnetism
C. Induction

15. REACTIVE COMPONENTS

A. Inductance
B. Inductors
C. Capacitance
D. Capacitors
E. Time constants

SEMESTER II: AC ELECTRONICS

1. INTRODUCTION TO AC

   A. Applications of AC
   B. Generation of AC
   C. The sine wave
   D. AC values
   E. Nonsinusoidal waveforms

2. AC MEASUREMENTS

   A. AC meter operation
   B. AC meter construction
   C. The oscilliscope

3. AC CAPACITANCE

   A. The capacitor in AC circuits
   B. Capacitive reactance
   C. RC circuits
   D. RC circuit analysis
   E. RC circuit applications

4. AC INDUCTANCE

   A. Inductance in AC circuits
   B. Inductive reactance
   C. RL circuits
   D. RL circuit analysis
   E. RL circuit applications

5. RCL CIRCUITS

   A. Basic RCL circuits
   B. Resonance
   C. Series resonance
   D. Parallel resonance
   E. Bandwidth and " Q "
   F. Filter circuits

6. TRANSFORMERS

   A. Transformer theory
   B. Transformer losses
   C. Transformer applications

SEMESTER III: SEMICONDUCTORS

1. SEMICONDUCTOR PHYSICS

   A. Semiconductor materials
   B. Atomic structure
   C. Electron movement in semiconductors

2. DIODES

   A. PN Junction
   B. Biasing
   C. Characteristics
   D. Special purpose diodes

3. BIPOLAR TRANSISTORS

   A. Basic transistor operation
   B. Amplification
   C. Amplifier circuits

4. FIELD EFFECT TRANSISTORS

   A. The junction FET
   B. Insulated gate FET
   C. The MOS-FET

5. GATE CONTROLLED SWITCHES

   A. SCR's
   B. Triac's
   C. UJT's

6. PHOTO ELECTRONICS

   A. Light principles
   B. Light sensing devices
   C. LED's
   D. LCD's

7. AMPLIFIERS

   A. Application of amplifiers
   B. Biasing
   C. Circuit configurations
   D. Saturation and cutoff
   E. Coupling

8. TYPES OF AMPLIFIERS

   A. Audio amplifiers

B. Video amplifiers
C. Differential amplifiers

9. OPERATIONAL AMPLIFIERS

A. Characteristics
B. Closed-loop operation
C. Applications

10. POWER SUPPLIES

A. Rectifier circuits
B. Power supply circuits
C. Regulation
D. Series voltage regulation

11. OSCILLATORS

A. Fundamentals
B. Transformer oscillators
C. LC oscillators
D. Crystal oscillators
E. RC oscillators
F. Nonsinusoidal

12. PULSE CIRCUITS

A. Waveshaping
B. Multivibrators
C. Sawtooth and ramp generators

SEMESTER IV: DIGITAL ELECTRONICS

1. INTRODUCTION TO DIGITAL ELECTRONICS

   A. Overview of digital technology
   B. Binary numbering system
   C. Binary codes
   D. Digital data representation

2. LOGIC CIRCUITS

   A. Types of logic circuits
   B. Basic logic gates
   C. NAND and NOR gates
   D. XOR and XNOR gates

3. DIGITAL INTEGRATED CIRCUITS

   A. Logic circuit characteristics
   B. Integrated circuits
   C. Transistor-transistor logic
   D. Emitter coupled logic
   E. Metal oxide semiconductor integrated circuits
   F. Integrated circuit applications

4. BOOLEAN ALGEBRA

   A. Boolean equations for logic circuits
   B. Boolean rules
   C. Minimizing logic expressions

5. FLIP-FLOPS AND REGISTORS

   A. Flip-flop operation and circuits
   B. RS flip-flops
   C. D flip-flops
   D. JK flip-flops

6. SEQUENTIAL LOGIC CIRCUITS

   A. Counters
   B. Counter applications
   C. Shift registors
   D. Shift registor applications
   E. Clocks and one shots

7. COMBINATIONAL LOGIC CIRCUITS

   A. Decoders
   B. Encoders
   C. Multiplexers

D. Demultiplexers
E. Parity circuits
F. Code converters
G. Memories
H. Data conversion

8. TEST EQUIPMENT AND TROUBLESHOOTING

A. Typical problems in digital circuits
B. Test equipment

9. APPLICATIONS OF DIGITAL DEVICES AND MICROPROCESSORS

A. Digital multimeter
B. Microprocessors
C. Computers

LESSON PLANS

SEMESTER I

I. INTRODUCTION

Lesson 1: Orientation **2 Hours**

A. Accomplish administrative tasks as required.
B. Be acquainted with tne teacher and other students.
C. Internalize course objectives, procedures, requirements and purpose.
D. State relationship between personal goals and electronics education.
E. List and explain class rules.
F. Explain grading system.
G. Demonstrate lab facilities and storage system.

Lesson 2: Survey of Electronics **4 Hours**

A. Define electricity, electronics and technology.
B. Outline the development of electronics.
C. Discuss the impact of the electronic revolution on society.
D. List and compare the principal branches of the electronics industry.
E. Describe the principle applications of electronics technology.
F. Recognize standard resistors, coils, capacitors, diodes, transistors, vacuum tubes, integrated circuits, switches, connectors, and electronic hardware.

II. SAFETY

Lesson 3: General Shop Safety **1.5 Hours**

A. Discuss the cause and prevention of accidents.
B. List and explain safety rules.
C. Explain the necessity of proper safety attitudes and habits.
D. Explain the elements of first aid, including CPR procedures that apply to the electronics lab.
E. Demonstrate the use of general safety equipment and devices.
F. Identify the types of fire extinguishers; explain their operation and purpose.
G. Practice safety in lab activities.

Lesson 4: Electrical Safety **1 Hour**

A. Discuss the hazards associated with electricity and explain means of avoiding and removing potential electrical hazards.
B. Explain the procedures for rescue of shock victims.
C. Practice safety in lab activities.

Lesson 5: Safety With Chemicals **.5 Hour**

A. Discuss the hazards associated with chemicals and substances associated with the electronics industry.
B. Demonstrate proper safety precautions for chemical hazards in he electronics lab.
C. Explain proper handling and disposal of chemicals and toxic material.
D. Practice safety in lab activities.

III. ELECTRONIC PHYSICS

Lesson 6: Atomic Structure **1 Hour**

A. Define and describe: atom, element, compound, molecule, and matter.
B. Describe an electron and explain the role of electrons in electrical energy.
C. Draw and label a diagram of the Bohr Model of an atom.
D. Explain why different elements have different properties.

Lesson 7: Electrostatics **1 Hour**

A. Define static electricity.
B. Describe electrostatic force.
C. Explain the concept of negative and positive charges.
D. State the law of electrical charges (Coulomb's Law).
E. Explain the concept of an electrostatic field.
F. Describe the effects of an electrostatic field.
G. Define and describe an ion.
H. List the methods by which an object can become charged.

IV. CURRENT AND VOLTAGE

Lesson 8: Electron Flow **1 Hour**

A. Explain the role of electrons and ions in electrical current.

B. Identify the valance shell and explain the characteristics of an atom that is a conductor, insulator and semiconductor.

Lesson 9: Current Flow **1 Hour**

A. Define and describe electrical current.
B. State the relationship between a coulomb and an ampere.
C. Explain how charges as well as electrons can be current.
D. Explain the historical origin of conventional current and contrast conventional current with electron flow.

Lesson 10: Voltage **1 Hour**

A. Explain the relationship between electrical charge and EMF.
B. Define the unit "volt".
C. Define "potential".
D. State the difference between voltage and current.

Lesson 11: Producing Electricity **1 Hour + Lab**

A. Name and describe the six principle methods of producing EMF.
B. Explain how each of the six methods actually produce EMF and give an example of each method.

V. BASIC ELECTRICAL CIRCUITS

Lesson 12: Schematic Diagrams **.5 Hour**

A. List and identify the principle parts of a basic circuit.
B. Equate the electronic symbols and schematic with the physical circuit parts.

Lesson 13: The Electronic Circuit **1 Hour + Lab**

A. Trace the flow of electrons in a simple circuit schematic.
B. Define the terms: earth ground, chassis ground, common, open, closed, and short.

Lesson 14: Batteries **1 Hour + Lab**

A. Identify the schematic symbols for a power source.
B. Draw and label a diagram of a dry cell battery.

C. Compare and contrast dry cell, wet cell and nicad batteries.
D. Draw a schematic and explain how to connect batteries in series and in parallel to increase voltage or current.

Lesson 15: Voltage Rise and Voltage Drop 1 Hour + Lab

A. Define voltage drop.
B. Define voltage rise and state the relationship to voltage drop.

VI. RESISTANCE

Lesson 16: Opposition to Current 1.5 Hrs. + Lab

A. Define resistance, resistivity and conductance.
B. List the four properties that determine the resistance of an object.
C. Discuss temperature coefficient.
D. State the units of resistance.
E. Explain the relationship between OHMS and Siemens (MHOS).
F. Explain the meaning of the symbol "R", "G" and the Greek letter Omega.

Lesson 17: Resistors 1 Hour

A. Identify typical resistors.
B. Describe how the various types of resistors are constructed.
C. Draw the symbols for fixed and variable resistors.
D. Determine resistor values using the color code.
E. Make judgments concerning a resistor's power rating based on physical characteristics.

Lesson 18: Connecting Resistance 1 Hour + Lab

A. Define series and parallel connections, draw a schematic of each.
B. Explain the current flow in series and in parallel circuits.
C. Compute total resistance in series and parallel resistance circuits .
D. Describe a series parallel circuit.
E. Compute total resistance in series parallel circuits.

VII. ELECTRICAL MEASUREMENTS

Lesson 19: Scientific Notation **2 Hours**

A. Explain the reason for using scientific notation in electronic measurements and computations.
B. Describe the scientific notation system.
C. Use a hand held scientific calculator to convert very large and very small numbers to the powers of ten and convert numbers given in scientific notation to standard numbers.

Lesson 20: Metric Prefixes **2 Hours**

A. Explain the meaning of metric prefixes.
B. Use metric prefixes to express very large or very small numbers.
C. Describe the relationship between metric prefixes and scientific notation.
D. Convert numbers between the various levels of metric prefixes.

Lesson 21: Measuring Current **1 Hour + Lab**

A. Describe an ammeter.
B. Define ampere.
C. Write the symbol for current.
D. List precautions that must be observed in measuring current.
E. Explain the process of measuring current and use an ampmeter (or multimeter) to measure current in a circuit.

Lesson 22: Measuring Voltage **1 Hour + Lab**

A. Describe a voltmeter.
B. Define the term "volt".
C. Write the symbol for voltage.
E. List the precautions that must be observed in measuring voltage.
F. Explain the process of measuring voltage and use a voltmeter to measure voltage in a circuit.

Lesson 23: Measuring Resistance **1 Hour + Lab**

A. Describe an ohmmeter.
B. Define "Ohm".
C. Write the symbol for resistance.
D. List the precautions that must be observed in measuring resistance.

measuring resistance.

VIII. OHM'S LAW

Lesson 24: Relationship of Current, Voltage, Resistance **2 Hours**

A. State Ohm's Law.
B. Express Ohm's Law in three equations.
C. Use Ohm's Law to compute current.
D. Use Ohm's Law to compute voltage.
E. Use Ohm's Law to compute resistance.

Lesson 25: DC Resistive Circuit Analysis **2 Hours**

A. Compute voltage drops when given current and resistance.
B. Compute current in series circuits and branches.
C. Compute resistance when given current and voltage.
D. Select proper equations to compute the unknown quantities in simple DC circuits.

IX. POWER

Lesson 26: Power and Work **1 Hour**

A. Define power.
B. Explain the difference between power and work.
C. Explain how power is related to electrical energy.

Lesson 27: Power Current and Voltage **1 Hour + Lab**

A. List the units of measurement for power.
B. Write the power formulas.
C. Explain the relationship between current, voltage and power.
D. Compute power current and voltage in resistive DC circuits.

Lesson 28: Power Dissipation **.5 Hour + Lab**

A. Define power dissipation.
B. Explain the relationship between resistance and power dissipation.

Lesson 29: Power Transfer **1 Hour + Lab**

A. Explain the concept of internal resistance.
B. Define impedance matching.

C. Prove by calculations that maximum power transfer occurs when RS=RL.

X. DC CIRCUITS

Lesson 30: Series, Parallel and Series Parallel Circuits 3 Hours

A. Recognize parallel, series, and series parallel circuits and branches.
B. Compute currents, voltages, and resistances in series, parallel, and series parallel DC circuits.
C. Analyze voltage divider circuits.
D. Compute resistance to construct loaded voltage divider circuits.

Lesson 31: Bridge Circuits 2 Hours + Lab

A. Explain the operation and characteristics of bridge circuits.
B. Compute currents and voltages in balanced and unbalanced bridge circuits.
C. Explain the operation of the wheatstone bridge.
D. Describe the applications of bridge circuits.

Lesson 32: Kirchoff's Law 1 Hour

A. State Kirchoff's Laws of voltage and current.
B. Explain how Kirchoff's Laws aid in circuit analysis.
C. Solve complex circuit problems using Kirchoff's Laws.

XI. THEOREMS

Lesson 33: Superposition Theorem 1 Hour

A. Explain the supposition Theorem.
B. Analyze circuits with multiple power sources using the superposition theorem.

Lesson 34: Thevenin's Theorem 1 Hour

A. Explain Thevenin's Theorem.
B. Analyze circuits using Thevenin's Theorem methods.

Lesson 35: Norton's Theorem 1 Hour

A. Explain Norton's Theorem.
B. Analyze circuits using Norton's Theorem Methods.

XII. SHOP PRACTICES AND TOOLS

Lesson 36: Hand Tools **1 Hour**

A. Identify hand tools that are representative of those used in the electronics industry.
B. Use hand tools sagely and correctly.

Lesson 37: Power Tools **.5 Hour**

A. Identify power tools representative of those found in the electronics industry.
B. Use power tools safely and correctly.

Lesson 38: Soldering for Electronics **2 Hours + Lab**

A. Explain the importance of soldering to the electronics industry.
B. Select proper suppliers and tools for electronic soldering.
C. Describe the soldering process.
D. Demonstrate methods to protect components from heat.
E. List the essential factors for successful soldering.
F. Practice safety in soldering.
G. Solder wires, terminals, components, and PC boards.
H. Inspect and evaluate solder joints.

Lesson 39: Desoldering Components **1 Hour + Lab**

A. Describe the proper procedure for desoldering.
B. Select proper tools and supplies for desoldering.
C. Practice safety in desoldering.
D. Remove components from PC boards without damage.

XIII. ELECTRONIC FABRICATION

Lesson 40: Printed Circuit Board Technology **1 Hour**

A. Describe PC board construction.
B. Explain how PC boards are manufactured.

Lesson 41: Artwork Design And Layout **2 Hours + Lab**

A. Design a PC Board from a circuit schematic.
B. Produce a PC Board diagram suitable for transfer to copper board.

Lesson 42: Printed Circuit Board Fabrication 1 Hour + Lab

A. Fabricate a printed circuit board.
B. Construct an operating circuit using PC fabrication technology.

Lesson 43: Cable Fabrication 1 Hour + Lab

A. Describe correct procedures for cable fabrication.
B. Select proper tools for fabricating power, audio, video and computer interface cables.
C. Fabricate cables using electronics industry techniques, procedures and standards.

XIV. MAGNETISM

Lesson 44: Properties of Magnetism 1 Hour

A. Describe a magnet.
B. List how magnets can be classified.
C. Describe the properties of flux lines and of magnetic field.
D. List and define the units of measurement that define the properties of magnets.

Lesson 45: Electricity and Magnetism .5 Hour + Lab

A. Explain the relationship between electricity and magnetism.
B. Draw and label a diagram of the magnetic field surrounding a conductor.
C. Explain why a coil will alter the magnetic characteristics of a conductor.

Lesson 46: Induction 1 Hour + Lab

A. Define induction.
B. List the factors that influence the amount of EMF induced into a conductor.
C. Explain how induction can be increased or decreased.

XV. REACTIVE COMPONENTS

Lesson 47: Inductance 1 Hour

A. List and explain the three factors that determine the

inductance of a coil.
B. Explain the difference between the terms: induction, inductance, and inductor.
C. Describe the sequence of self inductance.
D. Define and explain counter EMF.
E. Name the unit of inductance.

Lesson 48: Inductors **2 Hours + Lab**

A. Describe an inductor and explain how inductors are constructed .
B. Identify common inductors.
C. Draw the symbols for the various types of inductors.
D. Explain how energy is stored in a coil.
E. Explain how a coil reacts in a DC circuit.
F. Define and explain the phenomenon of inductive kick.
G. Define and give the formula for an RL time constant.
H. Compute how coils react in series and parallel combinations.

Lesson 49: Capacitance **2 Hours**

A. Define capacitance.
B. Explain the role of the plates and the dielectric in determining capacitance.
C. List the three factors that determine the amount of capacitance.
D. Name the unit of capacitance.
E. Explain how a capacitor stores energy.
F. Explain how a capacitor reacts in a DC circuit.

Lesson 50: Capacitors **1 Hour + Lab**

A. Identify Capacitors.
B. Describe how capacitors are constructed.
C. List and describe the various types of capacitors.
D. Draw the symbols for the various types of capacitors.
E. State the safety precautions to be observed when working with capacitors.
F. Compute total capacitance when capacitors are placed in series and parallel combinations.

Lesson 51: Time Constants **.5 Hour + Lab**

A. Describe an RC time constant.
B. Interpret time constant curves.
C. List the principal applications for RC time constant circuits.
D. Computer RC time constants.
E. Circuit properties of time and voltage.

SEMESTER II
AC ELECTRONICS

I. INTRODUCTION TO AC

Lesson 1: Applications of AC 1 Hour

A. Describe alternating current.
B. State the difference between AC and DC.
C. List and discuss the characteristics of AC that contribute to its versatility and wide use.

Lesson 2: Generation of AC 1.5 Hrs.+ Lab

A. Describe the induction process that occurs in an AC generator.
B. List the factors that determine the voltage induced in a generator.
C. Draw and label a diagram of a simple AC generator.
D. Explain the cause of the constantly changing voltage and the polarity reversal in an AC generator.
E. Draw and label a graph that plots the output of an AC generator.
F. Explain the relationship between current and voltage in an AC generator output.

Lesson 3: The Sine Wave 2 Hours

A. Draw and label a graph that plots one cycle of a sine wave.
B. Explain how a sine wave is a function of rotation.
C. Explain how a sine wave is described by the trigonometric (sine) function.
D. Compute sine wave values for various degrees of rotation when peak values are given.

Lesson 4: AC Values 1.5 Hours

A. Draw and label a graph that depicts the units and values that are used to describe AC current, voltage, and time measurements.
B. Define and compute peak, peak to peak, effective/RMS, and average values for voltage and current.
C. Explain why AC values are used in electronic computations and where the different values are used.
D. Define alternation, cycle, and period; state how they are related to frequency.
E. Define frequency and express the unit of measurement for frequency.
F. Compute frequency and period for AC waveforms.

Lesson 5: Nonsinusoidal Waveforms **1 Hour**

A. Discuss generally how nonsinusoidal waveforms are produced.
B. Draw a graph of square, triangular, and sawtooth waveforms.
C. Describe a square wave and list several applications for square waves.
D. Describe a sawtooth wave and discuss the principle application for a sawtooth wave.
E. Compare a triangular wave to a sawtooth wave.
F. Describe fluctuating DC and explain its relationship to AC.
G. Discuss the implications of measuring nonsinusoidal waveform signals and precautions in making circuit computations involving nonsinusoidal waveforms.

II. AC MEASUREMENTS

Lesson 6: AC Meter Operation **2 Hrs.+ Lab**

A. Describe the methods for measuring AC current with an ammeter and contrast measuring AC and DC current.
B. State the precautions to be observed when measuring AC current.
C. Describe the methods for measuring AC voltage and contrast measuring AC and DC voltage.
D. State the precautions to be observed when measuring AC voltage.
E. Measure AC voltage and current.

Lesson 7: AC Meter Construction **3 Hrs.+ Lab**

A. Identify the various types of AC current and voltage meters.
B. Describe the construction and operation of AC meters.
C. List the characteristics, advantages, and disadvantages of the various types of AC meters.
D. Describe and demonstrate the preferred uses and application of the various types of AC meters.

Lesson 8: The Oscilloscope **4 Hrs.+ Lab**

A. List the measurements that can be performed on an oscilloscope.
B. Draw, label, and explain a basic block diagram of an oscilloscope.
C. Explain the purpose and effect of each control on an oscilloscope.
D. Explain, in basic terms, how an oscilloscope works.
E. Make proper measurements to compute voltages,

times, frequency, and phase relationships.

F. Discuss the use of oscilloscopes in the electronic industry and the role of the oscilloscope in trouble-shooting.

III. AC CAPACITANCE

Lesson 9: The Capacitor in AC Circuits **1.5 Hrs.+ Lab**

A. List and explain the factors affecting capacitance.
B. Describe how a capacitor affects AC current.
C. Compare the action of a capacitor in an AC circuit with a capacitor in a DC circuit.
D. Explain the current voltage relationships in an AC capacitive circuit.
E. Draw and label a graph showing current and voltage relationships in an AC capacitive circuit.

Lesson 10: Capacitive Reactance **2 Hrs.+ Lab**

A. Define capacitive reactance.
B. List the factors affecting capacitive reactance.
C. Compare reactance to resistance.
D. Compute capacitive reactance.
E. Explain the relationship between reactance and resistance in applying Ohm's Law.
F. Compute the current in purely capacitive circuits.

Lesson 11: RC Circuits **4 Hrs.+ Lab**

A. Describe the current and voltage drops in series and parallel RC circuits.
B. Draw and label a wave form diagram that shows the phase relationships in RC circuits.
C. Construct and explain a typical AC vector diagram.
D. Define impedance and explain the difference between impedance and resistance.
E. Explain how power is dissipated in RC circuits.
F. Define true power and apparent power.

Lesson 12: RC Circuit Analysis **3 Hrs.+ Lab**

A. Use the Pythagorean Theorem to analyze RC circuits.
B. Compute impedance.
C. Compute current and voltages in series and parallel RC circuits.
D. Compute power dissipation and power factor.
E. Use trigonometric functions to compute phase angles.

Lesson 13: RC Circuit Applications **4 Hrs.+ Lab**

A. Describe capacitive voltage dividers.

B. List the applications of capacitive voltage dividers.
C. Compute voltage outputs of capacitive voltage dividers.
D. Explain the operation of RC filters.
E. Demonstrate how to construct high pass and low pass filters.
F. Draw and label a high pass and low pass frequency response curve.
G. Compute frequency of cut off.
H. List the applications for high pass and low pass filters.
I. Describe and explain phase shift networks.
J. Draw the schematic for capacitive phase shift networks.
K. Compute the phase shift angles and calculate the values of components to achieve desired phase shifts.
L. Explain the features of a cascaded phase shift network.
M. List the applications of phase shift networks.

IV. AC INDUCTANCE

Lesson 14: Inductance In AC Circuits **2 Hrs.+ Lab**

A. List and explain the factors that affect inductance.
B. Describe how an inductor affects AC current.
C. Compare the action of an inductor in an AC circuit with that of an inductor in a DC circuit.
D. Explain the current voltage relationships in an AC inductive circuit.
E. Draw and label a graph showing current and voltage relationships in AC inductive circuits.

Lesson 15: Inductive Reactance **2 Hrs.+ Lab**

A. Define inductive reactance.
B. List the factors affecting inductive reactance.
C. Compare inductive reactance to resistance and capacitive reactance.
D. Compute inductive reactance.
E. Compute the current in purely capacitive circuits.
F. Define "Q"
G. Compute "Q"

Lesson 16: RL Circuits **2 Hrs.+ Lab**

A. Describe the current and voltage drops in series and parallel RL circuits.
B. Draw and label a wave form diagram that shows the phase relationships in RL circuits.
C. Construct AC vector diagrams for RL circuits.
D. Explain the difference between impedance in RC and RL circuits.
E. Explain how power is dissipated in Rl circuits.

Lesson 17: RL Circuit Analysis **2 Hrs.+ Lab**

A. Use the Pythagorean theorem to analize RL circuits.
B. Compute impedance.
C. Compute current and voltages in series and parallel RL circuits.
D. Compute power dissipation and power factor.
E. Use trigonometric functions to compute phase angles.

Lesson 18: RL Circuit Applications **2 Hrs.+ Lab**

A. Compare inductive reactive circuits to capacitive reactive circuits and list the advantages and disadvantages of each.
B. Explain and draw the schematic for low and high pass inductive filter circuits.
C. Compute frequency of cut off.
D. Explain and draw the schematic for inductive phase shifters.
E. Calculate the amount of phase shift and compute the values of components required for a desired phase shift.

V. RCL Circuits

Lesson 19: Basic RCL Circuits **2.5 Hrs.+ Lab**

A. Compute impedance in RCL series circuits.
B. Construct vector diagrams for series RCL circuits.
C. Compute impedance in RCL parallel circuits.
D. Construct vector diagrams for RCL circuits.

Lesson 20: Resonance **2 Hours**

A. Define resonance.
B. Explain how resonance is achieved.
C. Explain the effect of frequency on current in RCL circuits.
D. Compute frequency of resonance.
E. Explain the relationship of resonance to the power factor.

Lesson 21: Series Resonance **3 Hrs.+ Lab**

A. Draw a schematic and vector diagram for a series resonance circuit.
B. Explain why a total of individual voltage drop can exceed applied voltage.
C. List the important characteristics of a series resonant circuit.
D. Compute current and voltage in series resonant circuits.

Lesson 22: Parallel Resonance **2.5 Hrs.+ Lab**

A. Draw a schematic and vector diagram for a parallel resonance circuit.
B. Explain why a total of currents in individual components can exceed applied current.
C. Describe the flywheel effect in a tank circuit and explain damping.
D. List the important characteristics of a parallel resonant circuit.
E. Compute current and voltages in parallel resonant circuits.

Lesson 23: Bandwidth And "Q" **2 Hrs.+ Lab**

A. Define "Q" in a resonant circuit.
B. Compute "Q" in a series and parallel resonant circuit.
C. Define bandwidth.
D. Explain the relationship between bandwidth and "Q".
E. Draw a graph of a frequency response curve.
F. List and explain the effects of series and parallel resistors in changing bandwidth.
G. Compute bandwidth, bandpass, and half power points in series and parallel resonant circuits.

Lesson 24: Filter Circuits **2 Hrs.+ Lab**

A. Describe and draw schematics for series and parallel band pass filters.
B. Describe and draw schematics for series and parallel band stop filters.
C. Explain how the same circuit can behave as a band pass or band stop filter depending on the location of the output.
D. Compare and recognize high pass, low pass, band pass, and band stop filters.

VI. Transformers

Lesson 25: Transformer Theory **3 Hrs.+ Lab**

A. Explain what a transformer is and list the principal uses of transformers.
B. Describe mutual inductance and coefficient of coupling.
C. Explain and list the sequence of events in transformer action.
D. Describe transformer action in load and no load condition.
E. Describe how transformers are constructed.
F. Use transformer ratios to compute currents, voltages, and impedance.
G. Explain the power relationships in transformers.

Lesson 26: Transformer Losses **1 Hour**

A. Discuss transformer efficiency.
B. List the types and causes of transformer losses.
C. Explain the transformer construction techniques used to reduce transformer losses.
D. Compute transformer efficiency.

Lesson 27: Transformer Applications **1.5 hrs.+ Lab**

A. Explain how transformers provide phase selection.
B. Describe how phase splitting is used in full wave rectification.
C. Define isolation and explain a transformers role in isolation.
D. Explain why an isolation transformer is a safety device.
E. Describe autotransformers and discuss their advantages and disadvantages.
F. Discuss the impedance matching and explain why impedance matching is necessary.
G. List the applications of transformers.

SEMESTER III

I. INTRODUCTION TO SEMICONDUCTORS

Lesson 1: Semiconductor Physics **3 Hours**

A. Identify common semiconductor devices.
B. List the advantages of semiconductor devices in electronic equipment.
C. Compare the advantages of semiconductor devices to other components with similar capabilities.
D. Explain the crystal lattice structure of semiconductors.
E. Define the term "hole" as applied to semiconductors.
F. Explain majority and minority carriers in doped semiconductors.

Lesson 2: The PN Junction **4 Hrs.+ Lab**

A. Describe a semiconductor diode's PN junction.
B. Identify the schematic symbols of semiconductors.
C. Explain the electrical characteristics of a PN junction.
D. Explain forward and reverse bias of a PN junction.
E. Interpret the voltage and current characteristics using graphs of a diode.

Lesson 3: Zener Diodes **2 Hrs.+ Lab**

A. Describe the forward and reverse current and voltage characteristics of a zener diode.
B. Explain the voltage and current limitations of zener diodes.
C. Describe how impedance values are used to determine the amount of change that can occur in zener diode voltage.
D. Explain how the zener dio(are used to provide voltage regulation.

Lesson 4: Bipolar Transistors **2 Hrs.+ Lab**

A. Discuss the following terms: emitter, base, collector, amplifier, emitter current, base current, collector current, PNP, and NPN.
B. Describe the physical construction of the NPN and PNP transistors.
C. Describe how to bias a PNP or NPN transistor.
D. Explain the relationship between emitter, base, and collector current in a transistor.

Lesson 5: Field Effect Transistors **4 Hrs.+ Lab**

A. Explain the operation of a junction FET.
B. Describe how to determine the transconductance of FETs.
C. Explain how to bias N channel and P channel JFETs.
D. Describe what is meant by Vgs (off and Vp).
E. Explain the basic difference between various FETs.
F. List the three basic FET circuit arrangements.
G. Explain the advantages and disadvantages of FETs.

Lesson 6: Devices That Control **4 Hrs.+ Lab**

A. Describe the operation of silicon controlled rectifiers.
B. Explain what is meant by forward breakover and reverse breakdown voltage.
C. Describe the operation of thyristors.
D. Describe the operation of a unijunction transistor.
E. Explain what is meant by negative resistance in a UJT once it is turned "on".
F. Describe the difference between a UJT and a PUT.
G. List several applications of the SCR, the Triac, the UJT, and the PUT.

Lesson 7: Devices That Are Light-Sensitive **4 Hrs.+ Lab**

A. Explain the characteristics of light.
B. Briefly describe the operation and function of four light-sensitive devices.
C. Explain the basic operation of the light-emitting diode.
D. Name the advantage the LED has over the incandescent or neon lamp.
E. Describe the basic operation of a liquid crystal display.
F. Compare the advantages and disadvantages of various light-sensitive devices.

II. ADVANCED ELECTRONIC CIRCUITS

Lesson 8: Amplifier Basics **6 Hrs.+ Lab**

A. Describe the following terms: distortion, amplitude, thermal instability, biasing network, buffer amplifier, saturation, cutoff, clipping, and stages.
B. Explain the two basic amplifiers functions.
C. Describe the three basic amplifier circuit configurations.
D. Compare the characteristics of each basic

amplifier circuit configuration.

E. Describe the basic operation of each basic amplifier circuit configurations.
F. Explain the purpose of the emitter resistor.
G. Describe class A, AB, B, or C mode of transistor amplification.
H. List the advantages and disadvantages of each of the four basic amplifier coupling techniques.

Lesson 9: Application of Amplifiers **9 Hrs.+ Lab**

A. Describe the following terms: preamp, cascading stages, interstage transformer, damping factor, single-ended amplifier, complementary signals, frequency response, and swamping resistor.
B. Describe the operation of audio voltage amplifiers.
C. Explain the operation of the audio single ended power amplifier.
D. Describe a push-pull amplifier operation.
E. Explain the function of phase splitters.
F. Describe complementary amplifier operation.
G. Explain the methods for controlling volume and tone.
H. Describe the operation necessary to provide amplification of a video amplifier.
I. List the effects of Miller capacitance on an amplifier.
J. Explain series peaking, shunt peaking, and combination peaking in a video amplifier.
K. Describe the operation of differential amplifiers.

Lesson 10: Operational Amplifiers **6 Hrs.+ Lab**

A. Define the following terms: offset null, slew rate, closed-looped mode, and gain-bandwidth.
B. List the characteristics and typical values for operational amplifiers.
C. Explain the operation of an inverting and noninverting amplifiers.
D. Determine amplifier gain and input impedance.
E. Explain gain and bandwidth for open-loop and closed-loop modes.
F. Explain the operation of the summing amplifier and the scaling adder.
G. Describe the operation of the low-pass and high-pass active filters.
H. Name several applications of operational amplifiers.

Lesson 11: DC Power Supply **5 Hrs.+ Lab**

A. Define the following terms: rectification, ripple, and pulsating DC.
B. List the three main power supply circuits.

C. Describe the primary purpose of rectifiers.
D. Describe the characteristics of the half-wave, full-wave, and bridge rectifiers.
E. Explain the purpose of the input transformers.
F. Explain the operation of filter networks.
G. Describe the purpose of voltage and current regulators.
H. Describe how to short-circuit proof a power supply.

Lesson 12: Oscillators **4 Hrs.+ Lab**

A. Define the following terms: oscillator, tickler coil, tuned-base, tuned-collector, series-fed, shunt-fed, piezoelectricity, relaxation, and blocking.
B. Describe the requirements of an oscillator.
C. Explain the operation of the Armstrong, Hartley, and Colpits oscillators.
D. Explain the purpose of crystal oscillators.
E. Explain the operation of the Butler and Pierce oscillators.
F. Describe the operation of the phase-shift and Wien-bridge oscillators.
G. Explain the operation of the blocking and sawtooth blocking oscillators.

Lesson 13: Basic Waveshaping Circuits **4 Hrs.+ Lab**

A. Define the following terms: periodic waveform, aperiodic waveform, pulse width, duty cycle, rise and fall time, ringing, and steering diode.
B. Explain the operation of differentiator and integrator circuits.
C. Explain the general operation of a slicer circuit and a clamper circuit.
D. Explain the circuit fund-mentals of the astable, monostable, and bistable multivibrators.
E. Describe the operation of a Schmitt trigger.
F. Explain hcw to use an operational amplifier as a linear ramp.
G. Describe the operation of a sawtooth generator.

SEMESTER IV

I. INTRODUCTION TO DIGITAL ELECTRONICS

Lesson 1: Overview of Digital Technology 2 Hours

A. Define digital, analog, and linear as applied to electronics.
B. Trace the history and origin of digital techniques.
C. Contrast the applications and methods employed in analog and digital technology.
D. Classify examples of measurements, information, devices, and techniques as being analog or digital.
E. List examples of where digital techniques are presently used.

Lesson 2: Digital Electronics 1 Hour

A. Discuss the principal reasons for recent growth in digital technology.
B. List and explain the ways in which digital technology can provide advantages and applications beyond those provided by analog.
C. State the principal disadvantages of digital techniques and discuss the methods necessary to overcome them.

Lesson 3: Binary Numbering System 1 Hour

A. Define binary, decimal, base, and radix.
B. Explain the advantage of the binary system in electronic devices.
C. Compare the binary system with the decimal system.
D. Describe a weighted number system.
E. Explain how whole numbers and fractions are expressed in binary.

Lesson 4: Converting Binary and Decimal Numbers 2 Hours

A. Convert pure binary numbers to decimal.
B. Convert decimal numbers to pure binary.
C. Explain the relationship of word size to number magnitude.
D. Discuss the application of hexidecimal numbers and convert between hexidecimal and decimal.
E. Compute the number of states that can be represented by a given number of bits.

Lesson 5: Binary Codes **4 Hours**

A. Describe the binary coded decimal system.
B. List the advantages, disadvantages, and applications of binary coded decimal.
C. Convert between decimal, pure binary, and binary coded decimal numbers.
D. Describe the Gray code, XS3 code, and ASCII code.
E. Discuss the applications of special digital codes.
F. Convert decimal numbers and binary numbers to gray code, XS3, and ASCII codes.

Lesson 6: Digital Data Representation **1 Hour**

A. List the hardware devices that can be used to represent a digital bit.
B. Define logic level.
C. Draw and explain a schematic of bipolar transistor switching elements.
D. Define and explain positive and negative logic.
E. Describe and give examples of serial and parallel data representation.
F. Explain the advantages and disadvantages of serial and parallel data representation.

Lesson 7: Semiconductor Devices for Digital Circuits **2 Hrs.+ Lab**

A. Explain the operation of saturated bipolar transistor switches.
B. Discuss the relationship between saturation and switching speed.
C. Describe a non-saturated switching circuit.
D. State the bias requirements for saturated and non- saturated switching transistors.
E. Draw the schematic for inverting and non-inverting MOSFET transistor switching circuits.
F. Compare bipolar and MOSFET digital switching circuits.

II. LOGIC CIRCUITS

Lesson 8: Types of Logic Circuits **1 Hour**

A. Describe the two broad classification types of logic circuits.
B. List the characteristics and functions of gates and combinational logic circuits.
C. List the functions of and characteristics of sequential logic circuits.
D. Explain the difference between a combinational and a sequential logic circuit.

E. Name the three basic gates.
F. Describe the methods of distinguishing and identifying digital signals.

Lesson 9: Basic Logic Gates **2 Hrs.+ Lab**

A. Draw the symbol for the inverter, the AND gate, and OR gate.
B. Construct the truth table for the inverter, the AND gate, and OR gate.
C. Draw schematics that show how basic logic functions can be implemented with switches.
D. Show how transistor switches can perform the gate function.
E. Draw waveform diagrams of outputs of the basic gates.

Lesson 10: NAND and NOR Gates **2 Hrs.+ Lab**

A. Draw the symbol for NAND and NOR gates.
B. Construct the truth table for NAND and NOR gates.
C. Show how NAND and NOR gates can be constructed with the basic gates.
D. Explain the effects of negative logic on the nature of gates.
E. Describe the effect of inverting the inputs to logic gates.
F. Draw circuit diagrams and truth tables that demonstrate the process of performing the and, or, and inverter function using NAND and NOR gates.
G. Draw wave form diagrams of NAND and NOR logic gates.

Lesson 11: XOR and XNOR Gates **1/2 Hour**

A. Draw the symbols for XOR and XNOR gates.
B. Construct the truth table for XOR and XNOR gates.
C. Show how XOR and XNOR gates can be constructed from other gates.
D. Explain how XOR gates can be used to add binary numbers.

III. DIGITAL INTEGRATED CIRCUITS

Lesson 12: Logic Circuit Characteristics **2 Hrs.+ Lab**

A. Define logic level and explain the significance of knowing logic levels in analyzing circuit operation.
B. Define propagation delay.
C. Describe how propagation delay is measured.
D. Explain the significance of power dissipation in digital circuits and the relationship between power dissipation and propagation delay.

E. Define noise immunity and explain why it is an important consideration in digital design.
F. Define fan out.
G. Explain sinking and sourcing current.

Lesson 13: Integrated Circuits **2 Hours**

A. Describe the ways that integrated circuits are classified.
B. List and explain the processes used to manufacture integrated circuits.
C. Distinguish between linear and digital integrated circuits.
D. Explain the system that describes IC's as SSI, MSI, LSI, and VLSI.
E. Identify, describe, and explain the advantages of the basic types of IC packages.
F. Discuss the temperature range considerations in selecting IC packages.

Lesson 14: Transistor-Transistor Logic **1 Hour**

A. Describe the characteristics of TTL circuits.
B. List the advantages and design considerations for using TTL circuits.
C. Describe the operation of a typical TTL logic gate.
D. Explain the operation and applications for high power, low power, Schottky, and three state TTL integrated circuits.

Lesson 15: Emitter Coupled Logic **1/2 Hour**

A. Describe ECL circuit operation.
B. Explain why ECL circuits are high speed and list some typical applications for ECL integrated circuits.
C. List and describe the characteristics of ECL integrated circuits.

Lesson 16: Metal Oxide Semiconductor IC's **1 Hour**

A. List and explain the advantages and disadvantages of MOS digital IC's.
B. Describe the operation of PMOS, NMOS, and CMOS circuits.
C. List and describe the characteristics of CMOS IC's.

Lesson 17: Integrated Injection Logic **1/2 Hour**

A. Describe the operation of IIL circuits.
B. List and explain the advantages and applications of IIL circuits.

C. List and describe the characteristics of IIL circuits.

Lesson 18: Integrated Circuit Applications 1 Hour

A. Describe the factors involved in selecting integrated circuits.
B. Compare the characteristics of the most popular IC families.
C. Discuss the speed power trade-off.
D. Select the appropriate IC family for specific applications.

IV. BOOLEAN ALGEBRA

Lesson 19: Boolean Equations 2 Hours

A. Describe the Boolean Algebra System and explain its application to digital electronics.
B. Write Boolean expressions for each logic gate.
C. Write Boolean equations for combinational logic circuits.
D. Explain the difference between sum-of-products and product-of-sums.

Lesson 20: Circuit Definition 4 Hrs.+ Lab

A. Relate Boolean expressions to logic circuits.
B. Construct truth tables from Boolean expressions and Boolean expressions from truth tables.
C. Draw circuit diagrams from Boolean expressions and write Boolean expressions from circuit diagrams.

Lesson 21: Boolean Rules 4 Hours

A. State and explain the laws of intersection.
B. State and explain the laws of union.
C. State and explain the laws of tautology.
D. State and explain the law of complements.
E. State and explain the law of the double negative.
F. State and explain the law of commutation.
G. State and explain the law of association.
H. State and explain the law of distribution.
I. State and explain the laws of absorption.
J. Solve and simplify Boolean equations using the rules of Boolean Algebra.

Lesson 22: DeMorgan's Theorem 2 Hrs.+ Lab

A. State the rules that comprise DeMorgan's Theorem.
B. Prove DeMorgan's Theorem using truth tables and circuit diagrams.

C. Use NAND and NOR gates to construct all other types of gates.

Lesson 23: Karnaugh Maps **3 Hours**

A. Describe a Karnaugh map.
B. Explain the application of Karnaugh maps.
C. Define "adjacent cell".
D. Simplify Boolean expressions using Karnaugh maps.

V. FLIP-FLOPS AND REGISTERS

Lesson 24: Flip-Flop Introduction **1 Hour**

A. Describe a flip-flop circuit.
B. Explain the basic application of flip-flop circuits in digital electronics.
C. List and describe the inputs and outputs found in a basic flip-flop.
D. Describe a register.
E. Discuss the applications of flip-flops in computers.

Lesson 25: RS Flip-Flops **1 Hr.+ Lab**

A. Draw the symbol for a RS flip-flop.
B. Define the set, reset, and level triggering.
C. Show how a RS flip-flop is constructed with NAND gates.
D. Show how a RS flip-flop is constructed with NOR gates.
E. Draw timing diagrams and truth tables for SR flip- flops.
F. Explain the operation of a switch buffer.

Lesson 26: D Flip-Flops **1 Hr.+ Lab**

A. Draw the symbol for a D flip-flop.
B. Compare a D flip-flop to a RS flip-flop.
C. Explain the function of the T input.
D. Show how a D flip-flop is constructed using logic gates.
E. Draw timing diagrams and truth tables for D flip-flops.
F. Explain how D flip-flops can be used as a storage register.
G. Define LSB and MSB.
H. Draw and explain the diagram of a storage register.

Lesson 27: JK Flip-Flops **2 Hrs.+ Lab**

A. Draw the symbol and describe all inputs to a JK flip-flop.

B. Explain the master-slave arrangement in a JK flip-flop.
C. Show construction of a JK flip-flop with logic gates.
D. Draw truth tables and timing diagrams for JK flip-flops.
E. Explain "active low" and "active high".
F. Explain edge triggering.
G. Draw diagrams of JK flip-flops wired to serve as all other types of flip-flops.

VI. SEQUENTIAL LOGIC CIRCUITS

Lesson 28: Counters **3 Hours**

A. Describe a digital counter.
B. Draw the diagram and explain the operation of binary counters.
C. Explain how counters divide frequency.
D. Show how a counter can count up or down.
E. Explain how a synchronous counter is different from a ripple counter.
F. Explain the logic diagram and control of typical IC counter circuits.
G. Construct timing diagrams of counter circuits.

Lesson 29: BCD Counters **1 Hr.+ Lab**

A. Explain the operation of BCD counters.
B. Construct timing diagrams of BCD counters.
C. Describe carry out and carry in.
D. Explain the logic diagram of typical IC BCD counters.
E. List and describe the applications of BCD counters.

Lesson 30: Special Counters **1 Hr.+ Lab**

A. Describe a mod three and mod five counter.
B. Draw a diagram and waveform charts of mod "N" counters.
C. Discuss the applications of mod "N" counters.

Lesson 31: Shift Registers **1 Hr.+ Lab**

A. Explain the operation of shift registers.
B. Draw logic diagrams and timing diagrams of shift registers.
C. Explain the logic diagram of typical IC shift registers.

Lesson 32: Shift Register Applications **1 Hr.+ Lab**

A. Explain how shift registers can convert serial to parallel and parallel to serial.

B. Explain how shift registers can be used for scaling.
C. Explain how shift registers are used for memory.
D. Explain how shift registers perform multiplication and division.
E. Explain how shift registers can function as a sequencer.
F. Explain how shift registers can be used as counters.

Lesson 33: MOS Shift Registers **1 Hour**

A. Describe a MOS shift register.
B. Explain how a MOS shift register is a memory source.
C. Explain the difference between a static and a dynamic shift register.
D. Explain how binary ones and zeros are held in a MOS shift register.
E. Discuss the advantages and applications of MOS shift registers.

Lesson 34: Clocks and One Shot Multivibrators **1 Hr.+ Lab**

A. Describe a typical clock signal.
B. Explain the function of a clock pulse in a sequential logic circuit.
C. Describe a one shot multivibrator.
D. Show how to construct a clock circuit using TTL inverters.
E. Define duty cycle.
F. Discuss the applications of one shot integrated circuits.

VII. COMBINATIONAL LOGIC CIRCUITS

Lesson 35: Decoders **1 Hr.+ Lab**

A. Describe a decoder.
B. Explain the function of a decoder.
C. Show how a decoder is constructed with logic gates.
D. Explain the operation of a typical BCD to decimal decoder.
E. Explain the operation of BCD to seven segment decoder.

Lesson 36: Encoders **1 Hr.+ Lab**

A. Describe an encoder.
B. Explain the function of an encoder.
C. Show how an encoder is constructed of logic gates.
D. Discuss the applications of an encoder.

Lesson 37: Multiplexers **1 Hr.+ Lab**

A. Describe a multiplexer.
B. Show how to construct a multiplexer with logic gates.
C. List and explain the applications of a digital multi-plexer.

Lesson 38: Demultiplexers **1/2 Hr.**

A. Describe a demultiplexer.
B. Show how a demultiplexer is constructed with logic gates.
C. List and explain the applications of a digital demultiplexer.

Lesson 39: Parity Generator/Checker **1/2 Hr.**

A. Describe a parity generator.
B. Explain the logic diagram of a parity generator.
C. Explain the logic diagram of a parity checker.
D. Discuss the applications of a parity generator/checker system.

Lesson 40: Binary Comparators **1/2 Hr.**

A. Describe a binary comparator.
B. Show how a binary comparator is constructed of XNOR gates.
C. Discuss the applications of a binary comparator.

Lesson 41: Digital Co' 'onverters **1/2 Hr.**

A. Descr be a digital code converter.
B. Li t the commonly used code converters.
C. Explain the ways code conversion can be accomplished.

Lesson 42: Read Only Memories **2 Hrs.+ Lab**

A. Describe a read only memory.
B. Explain a general block diagram of a ROM.
C. List the components or circuits capable of implementing read only memories.
D. Describe a diode matrix ROM.
E. Compare a memory address to a decoder.
F. Describe a bipolar ROM.
G. Explain the standard methods of increasing memory size.
H. Describe a MOS ROM.
I. List and describe ROM applications.
J. Describe a microprogrammed controller.

Lesson 43: Programmable Logic Arrays **1 Hr.+ Lab**

A. Describe a PLA.

B. Explain how PLA IC's are constructed.
C. Explain how PLA IC's are programmed.
D. List the applications of PLS's.

Lesson 44: Semiconductor Memories **2 Hrs.+ Lab**

A. Draw a block diagram of the hierarchy of semiconductor memories.
B. Describe the organization of read write memories.
C. List and explain the characteristics and specifications of memory integrated circuits.
D. Describe the two major types of read write memories and explain how they operate.
E. Explain the operation of programmable read only memories.

Lesson 45: Dynamic Memories **1 Hour**

A. State the characteristics of dynamic memories.
B. Describe the basic storage element in dynamic memories.
C. List the characteristics of dynamic memories.
D. Compare dynamic memories with bipolar memories.
E. Discuss the considerations in designing circuits with dynamic memories.

Lesson 46: PROMS and EPROMS **1 Hour**

A. Describe PROMS.
B. Describe EPROMS.
C. List the characteristics of PROMS and EPROMS.
D. Explain the applications and advantages of PROMS and EPROMS.
E. Discuss the various types of PROMS and EPROMS.

Lesson 47: Magnetic Memories **1 Hour**

A. Explain how data is presented in a magnetic medium.
B. Describe the various types of magnetic memories and magnetic storage.
C. Discuss the characteristics, advantages, and disadvantages of magnetic memories.
D. Discuss the bubble memories and future trends in magnetic memories.

Lesson 48: Data Conversion **2 Hrs.+ Lab**

A. List and explain the reasons for converting between digital and analog data.
B. Describe the basic methods of D to A conversion.
C. Discuss the sources of errors in D to A conversion.
E. Explain how sampling rate affects accuracy.

F. Describe the methods of A to D conversion.
G. Discuss the sources of error in A to D conversion.
H. Describe an analog multiplexer.
I. Explain the operation of a sample and hold circuit.

VIII. DIGITAL TEST EQUIPMENT

Lesson 49: Typical Problems in Digital Circuits 1 Hr.+ Lab

A. List and explain the typical problems that can occur in digital circuits.
B. Explain the ways that digital equipment may fail.
C. Classify digital equipment failures; discuss the possible causes and troubleshooting methods.

Lesson 50: Test Equipment 1 Hr.+ Lab

A. Describe test equipment used to troubleshoot digital equipment.
B. Use oscilloscope, VMM, logic probe, and logic pulser to test digital circuits.
C. Describe and explain the operation of specific digital test devices.
D. Demonstrate common procedures for troubleshooting digital circuits.

IX. APPLICATIONS OF DIGITAL DEVICES AND MICROPROCESSORS

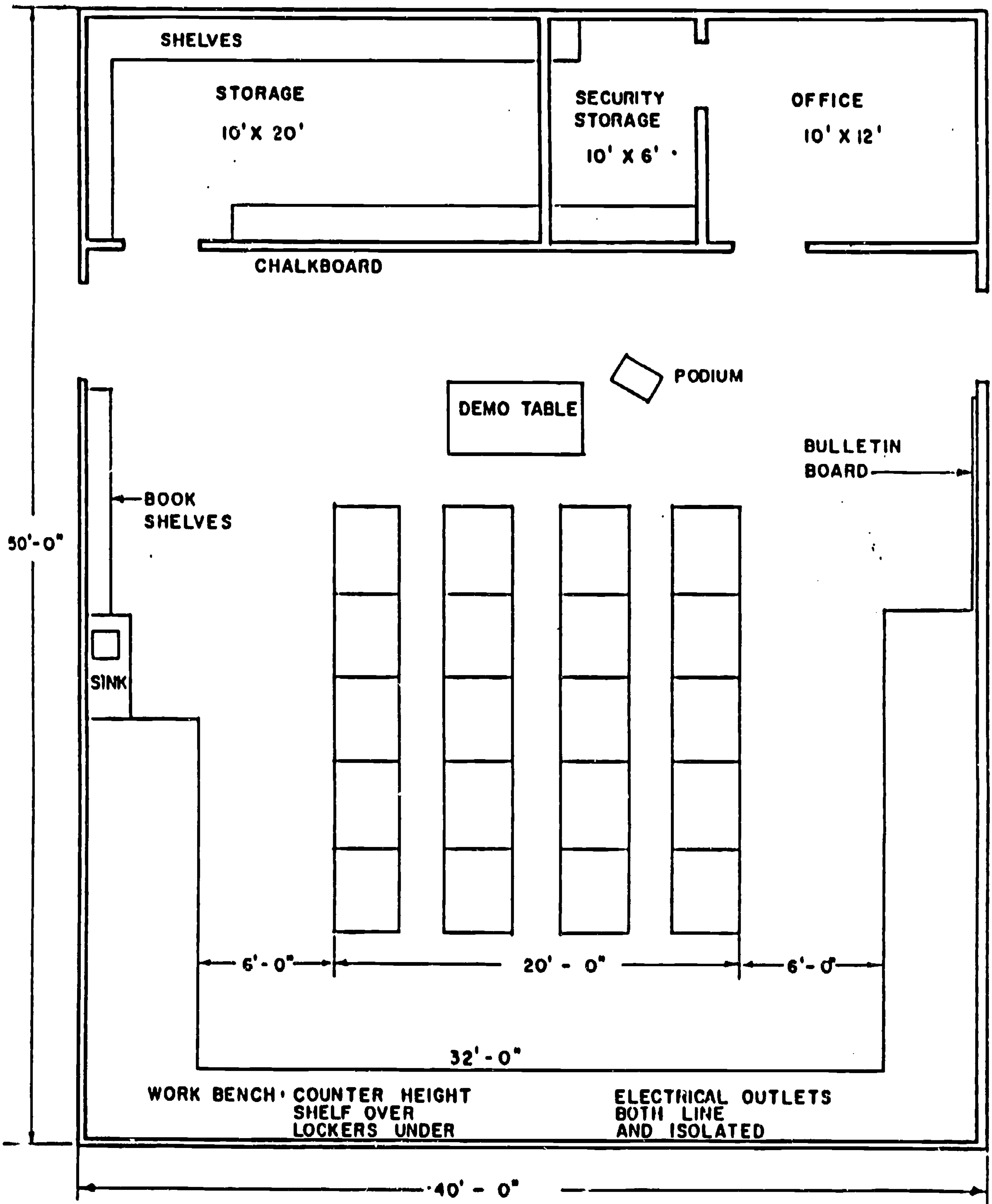
Lesson 51: Digital Measurement Devices 1 Hour

A. Describe the operation of a digital multimeter.
B. Explain the function of each part of the block diagram of a typical DMM.
C. Discuss the factors that contribute to the accuracy of a DMM.

Lesson 52: Computer Organization and Microprocessors 4 Hours

A. Describe the input and output devices for small computers.
B. Describe a microprocessor.
C. Explain the parts of a simplified block diagram for a small computer.
D. Follow the action of a microprocessor as the program is executed.
E. Explain the difference between machine language and high-level languages.
F. Discuss the applications of IC microprocessors.

2* 2 ELECTRONICS LAB



* DARKROOM REQUIRED IF CIRCUIT BOARD FABRICATION IS IN CURRICULUM.

ELECTRONICS TECHNOLOGY
RECOMMENDED EQUIPMENT AND TOOL LIST

EQUIPMENT AND TOOLS	QUANTITY	COST
1. Isolated variable AC power supply leakage test function (ex: Sencore PR57-495)	10	$ 495
2. Regulated DC power supply: +5V, -5A, and variable to 30V with a minimum output of 2 amps (ex: B&K model 1660)	10	$ 530
3. MS DOS PC/AT 386 VGA, 40 MEG hardrive mathco-processor, CAD/CAM ready, 3.5" 1.44 MEG drive, 5.5" 1.2 MEG drive	10	$4000
4. Audio/radio frequency signal generator (ex: Leader 110389)	2	$ 325
5. Function generator (ex: Leader 568604)	10	$ 495
6. Commercial quality digital multimeter (ex: B&K 2830)	10	$ 233
7. Commercial quality analog multimeter (ex: B&K 177)	10	$ 299
8. Frequency counter (ex: Sencore FC 71)	2	$1295
9. Oscilliscope, dual trace (ex: Tectronix 2205)	10	$ 500
10. Oscilliscope, dual trace 100 MHZ (ex: Sincore VC 61)	1	$3295
11. Pulse digitizer oscilliscope, IBM compatible, and computer	1	$3500
12. Digital transistor checker (ex: Sencore TF 46)	2	$ 495
13. Digital capacitance meter (ex: Sencore LC 102)	2	$1895
14. Analog experiment, circuit breadboard (ex: Power Ace)	20	$ 175
15. Digital logic probe (ex: Beckman LP 25)	20	$ 40

EQUIPMENT AND TOOLS	QUANTITY	COST
16. Digital pulser (ex: Beckman PR 41)	20	$ 46
17. Clamp on DMM (ex: Phillips DM 300)	1	$ 74
18. Heat gun (Ungar 6966C)	1	$ 114
19. Soldering station with adjustable thermostatically controlled temperature, grounded tip (ex: Weller EC 2001)	20	$ 232
20. Vacuum desoldering station (ex: Weller DS 600)	2	$ 561
21. Drill press (ex: Jet-orbit OR 1758F)	2	$ 330
22. Hand grinder (ex: Dumore 10-311)	2	$ 183
23. Cable and adapter set	4	$ 70
24. Digital trainer (ex: Health kit ET 3700)	20	$ 119
25. Microprocessor trainer (ex: Health kit EWS 6811)	20	$ 695
26 PC board photo processing and etching equipment	1	$ 129
27. Speaker and enclosure (ex: Arsos SD 1064)	10	$ 89
28. Antenna system (ex: Channel Master)	1	$ 200
29. Benches with security locks (ex: Broadhead-Garrett model 964)	10	$1391
30. Stools (ex: Broadhead-Garrett model 624)	10	$ 43
31. Static free workbench, space for 20 lab stations		$2400
32. PC Board vise (ex: Paar VISC 324)	20	$ 60
33. Parts storage ben (small parts storage drawers), (Broadhead-Garrett 11-124)		$ 25
34. Lamp with magnifying lens (ex: Aim)	10	$ 901

EQUIPMENT AND TOOLS		QUANTITY	COST
35.	Technical library	1	$1000
36.	Textbooks: DC, AC, semiconductors, circuits, digital, microprocessors (one for each student)	20	$ 100
37.	Safety goggles (ex: Sellstrom 20/20 77001)	20	$ 4
38.	Long-nose pliers (ex: Xcelite 51 GC)	10	$ 12
39.	Diagonal cutters (ex: Xcelite 55 GC)	10	$ 11
40.	Wire strippers (ex: Xcelite 660)	10	$ 20
41.	Screwdrivers, 1/8" blade (ex: Xcelite R 184)	10	$ 2
42.	Screwdrivers, 1/4" blade (ex: Xcelite R 144)	10	$ 4
43.	Phillips screwdriver #1 (ex: Xcelite X 101)	10	$ 3
44.	Phillips screwdriver #0 (ex: Xcelite X 100)	10	$ 2
45.	Hex wrenches (set) (ex: Xcelite 99 P 540)	1	$ 27
46.	Spline wrenches (set) (ex: Xcelite 99 P 60)	1	$ 27
47.	Nut drivers (set) (ex: Xcelite kit)	1	$ 100
48.	Vacuum desoldering pump	10	$ 12
49.	Bench drill press	1	$ 270
50.	IC pullers	10	$ 8
51.	Kepro model MS-6 precision multi-6 shear	1	$ 445
52.	Kepro model BTX-200A ultra violet exposure frame	1	$ 515
53.	Kepro model BTE-202 double sided spray etcher	1	$ 865

2+2 ELECTRONICS TECHNOLOGY
EMPLOYER FOLLOW-UP FORM

DISTRICT NAME ______________ CAMPUS ______________

____
NAME OF STUDENT

____
EIGHT-DIGIT COURSE CODE

NOTE: Your cooperation in completing this voluntary survey will provide the school district and the Texas Education Agency with valuable information that will be used to evaluate the Electronics Technology programs.

1. **VOCATIONAL TRAINING EVALUATION**
Please rate the vocational training received by the individual in the following areas:

	VERY GOOD	**GOOD**	**AVERAGE**	**POOR**	**VERY POOR**
a. Technical knowledge	☐	☐	☐	☐	☐
b. Work attitude	☐	☐	☐	☐	☐
c. Work quality	☐	☐	☐	☐	☐
	(5)	(4)	(3)	(2)	(1)

2. **OVERALL RATING**
What is your overall rating of the vocational training received by this individual as it relates to the requirements of his or her job?

VERY GOOD	**GOOD**	**AVERAGE**	**POOR**	**VERY POOR**
☐	☐	☐	☐	☐
(5)	(4)	(3)	(2)	(1)

3. **RELATIVE PREPARATION**
As a result of this person's vocational training, how would you rate his or her preparation in relation to other employees in his or her work group who did not receive the same training?

No basis for comparison

(5) Individual is better prepared
(3) Both are about the same
(1) Individual is less prepared

Thank you for your cooperation. Please return this form in the enclosed envelope.

2 + 2 ARTICULATION AGREEMENT

NORTH EAST INDEPENDENT SCHOOL DISTRICT

AND

SAN ANTONIO COLLEGE

ELECTRONICS ENGINEERING TECHNOLOGY/
ELECTRONICS TECHNOLOGY PROGRAMS

MAY 17, 1990

STATEMENT OF INTENT

The purpose of this **2 + 2 Articulation Agreement** is to provide a mechanism through which the Electronics Program at North East Independent School District, Northside Independent School District, Judson Independent School District and the Electronics Engineering Technology program at San Antonio College will interface, thereby granting students who have mastered agreed-upon task competencies in North East Independent School District, Northside Independent School District and Judson Independent School District to receive post-secondary credit at San Antonio College. The degrees granted by San Antonio College are the Associate of Applied Science Degree in Electronics Engineering Technology, and the Associate of Applied Science Degree in Electronics Technology.

DEFINITIONS:

The terms used in this document are herein agreed upon and defined:

ARTICULATION:

Articulation is a planned process linking programs and services in order to assist students in transferring from secondary to post-secondary institutional levels without experiencing delays or duplication of learning.

ARTICULATED CREDIT:

Articulated credit refers to post-secondary credit awarded to an individual student for having successfully completed specified approved course(s) at a secondary school under the authority and guidelines of the Articulation Agreement. The credit will be held in escrow until the student meets all of the applicable stipulations of the Articulation Agreement.

ASSESSMENT TEST:

An assessment test is a criterion-referenced multi-faceted screening tool designed to identify desired aptitudes of prospective students wishing to enter the programs outlined in this Agreement.

COMPETENCY-BASED CURRICULUM:

A competency-based curriculum identifies specific bodies of knowledge and skills to be learned and the specific level of competencies for each. The delivery method is designed to teach those specific bodies of knowledge and skills. The evaluation system is designed to evaluate and measure the level of learning for each of the specified competencies using a rating scale to reflect job readiness.

COMPETENCY PROFILE:

A competency profile is a formal record which lists the specific tasks which are to be accomplished by the student. It includes a five-point rating scale which indicated degrees of mastery of each task.

ESCROW:

Escrow is the holding in a secure place of eligible credit for courses taken at the secondary level, to be transferred to the post-secondary institution at a future date. Post-secondary credit for those courses is recorded after the student completes courses at the post-secondary institution, under the authority and stipulations of an Articulation Agreement.

POST-SECONDARY CREDIT:

Post-secondary credit is credit awarded to a student for successfully completing a specified course under the authority of a post-secondary institution and the Texas Higher Education Coordinating Board.

SECONDARY CREDIT:

Secondary credit is credit awarded to a student for successfully completing a specified course in grade level 9 through 12 under the authority of the Texas Education Agency.

SUBJECT MATTER EXPERT:

A subject matter expert is an individual who possesses the knowledge and skills associated with a defined occupational specialization.

2 + 2

2 + 2 refers to a collaboratively developed and formally articulated curriculum existing between the secondary school (first two years) and the community college (secondary two years).

2 + 2 + 2

2 + 2 + 2 refers to a collaboratively developed and formally articulated curriculum existing between the secondary school (first two years), the community college (second two years), and a four year university (final two years).

ARTICLES OF AGREEMENT:

A. GENERAL

1. The secondary institution agrees to incorporate all of the syllabi, course outlines, essential elements, and course competencies for secondary education in Electronics Technology and related fields (mathematics, algebra, and trigonometry) as developed and specified in the following report.

   A MODEL SECONDARY/POST-SECONDARY 2 + 2 PROGRAM TO PREPARE STUDENTS FOR EMPLOYMENT, JUDSON/NORTH EAST/NORTHSIDE INDEPENDENT SCHOOL DISTRICTS, SAN ANTONIO AREA, TEA PROJECT NUMBER 99420067, JUNE 30, 1989.

2. The post-secondary institution agrees to implement a 2 + 2 + 2 curriculum for Electronics Engineering Technology which interfaces with Grades 11 and 12, and with Texas A & M University. This curriculum is covered in the following report.:

   2 + 2 + 2 ELECTRONICS ENGINEERING TECHNOLOGY CURRICULUM DEVELOPMENT PROJECT, SAN ANTONIO COLLEGE, TEXAS HIGHER EDUCATION COORDINATING BOARD PROJECT NUMBER 99103021, JUNE 30, 1989.

3. This agreement will become effective on

   ____

   by signatures of the President of San Antonio College (SAC) and the Superintendent of ____________________ Independent School District (_ISD). _ISD AND SAC agree to accept the conditions set forth in this document until such time as mutual agreement is made to terminate.

4. _ISD and SAC will continue to utilize the established Steering Committee consisting of members from business, industry and education to assist in the continued development of the program.

5. All new faculty and administrators a both the secondary and post-secondary institutions involved with this Articulation Agreement will receive in-service training on the program and the conditions of this agreement.

6. Both parties agree to make every effort possible to insure that students in the process will be provided reasonable opportunity to successfully complete the program.

7. Petition to end this agreement must be submitted no less than six months in advance of the intend d date of termination. The petition

must be submitted in writing, signed by the college president or the school superintendent making the petition, and delivered to the second party to the agreement. Delivery of the intent to terminate will constitute formal notification and will serve as grounds for termination six months following the date of delivery.

B. STUDENT TRANSFER

1. All articulating students will meet and maintain all entrance standards, prerequisites, and academic standards of San Antonio College and the intended field of study.

2. Successful completion of the secondary portion of the program will become part of the student's permanent record and will be forwarded to the post-secondary institution upon request by the student.

3. Students will not be charged tuition or fees for articulated credit earned under this agreement.

4. High school graduates who successfully complete the secondary portion of the 2 + 2 program will receive articulated, advanced-placement credit for courses listed in Paragraph C. These graduates will enroll in Advanced DC/AC Electricity Topics and Advanced Semiconductor Topics in San Antonio College. Credit for the secondary courses in DC/AC Electronics and Semiconductors courses will be held in escrow until the student successfully completes the Advanced DC/AC Electricity and Semiconductor Topics Courses at San Antonio College.

5. After successfully completing the Advanced DC/AC Electricity Topics and Advanced Semiconductor Topics Courses at San Antonio College with a grade of "C" or better, the student will be granted post-secondary credit for the DC Electronics, AC Electronics and Semiconductors Courses.

6. Competency Profiles will be maintained by both the secondary institution and San Antonio College in a permanent file for credit earned under this agreement.

7. Articulated credit earned at the secondary institution under this agreement is valid and transferable to the post-secondary institution for a period of up to five years from the date of a student's graduation from the secondary institution.

8. Recognizing that both the secondary institution and San Antonio College will require approximately one year to implement the new 2 + 2 courses, and recognizing that current high school senior students may desire to transfer articulated credit to San Antonio College, San Antonio College agrees to administer an assessment test to these students at not cost to the students. Upon successful completion of this assessment test, the students will be granted credit for the current Electronics 1401 Principles of DC Electricity and Electronics 1402 Principles of AC Electricity. These students will enter the Electronics Technology or Electronics Engineering Technology Program by enrolling in Electronics 1403, Semiconductors I.

C. COURSES ELIGIBLE FOR ARTICULATED CREDIT

The following courses are approved as articulated program courses that will be offered at the secondary and post-secondary levels, and will be accepted for transfer credit by San Antonio College:

POST-SECONDARY COURSES	SECONDARY COURSES
ELTR 1302, Principles of Electricity Three (3) Semester Credit Hours	DC Electronics AC Electronics
ELTR 1303, Principles of Semiconductors Three (3) Semester Credit Hours	Semiconductors

D. ELIGIBILITY FOR ALL OTHER STUDENTS:

1. Students who have no prio experience in electronics may enroll in the electronics technology program at San Antonio College provided they meet all of the admission requirements of San Antonio College and the Electronics Department.

2. In general, the applicant for enrollment in the electronics technology program will start with the first basic electronics courses, namely, ELTR 1302, Principles of Electricity and ELTR 1303, Principles of Semiconductors.

3. Students enrolling at San Antonio College with prior education in the field of electronics technology may consult with the Department Chairperson to determine if credit may be granted for this prior educational credit.

4. Entering students at San Antonio College with extensive knowledge and/or prior experience in the field of electronics technology may elect to take challenge tests in order to by-pass certain electronics technology courses. A fee will be charged for each challenge test prior to the challenge test period. The Department Chairperson reserves the right to determine which courses may be bypassed and which courses must be taken at the post-secondary institution.

AUTHENTICATION

This document is accepted as the 2 + 2 Electronics Program Articulation Agreement existing between San Antonio College, San Antonio, Texas and North East Independent School District, San Antonio, Texas.

Dr. Max Castillo,
President
San Antonio College

Date: 6/26/90

Richard A. Middleton

Dr. Richard Middleton
Superintendent
North East Independent
School District

Date: June 7, 1990

D. ELIGIBILITY FOR ALL OTHER STUDENTS:

1. Students who have no prior experience in electronics may enroll in the electronics technology program at San Antonio College provided they meet all of the admission requirements of San Antonio College and the Electronics Department.

2. In general, the applicant for enrollment in the electronics technology program will start with the first basic electronics courses, namely, ELTR 1302, Principles of Electricity and ELTR 1303, Principles of Semiconductors.

3. Students enrolling at San Antonio College with prior education in the field of electronics technology may consult with the Department Chairperson to determine if credit may be granted for this prior educational credit.

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AUTHENTICATION

This document is accepted as the 2 + 2 Electronics Program Articulation Agreement existing between San Antonio College, San Antonio, Texas and Judson Independent School District, Converse, Texas.

Dr. Max Castillo,
President
San Antonio College

Date: 6/24/90

Dr. Galen R. Elolf
Superintendent
Judson Independent School District

Date:

D. ELIGIBILITY FOR ALL OTHER STUDENTS:

1. Students who have no prior experience in electronics may enroll in the electronics technology program at San Antonio College provided they meet all of the admission requirements of San Antonio College and the Electronics Department.

2. In general, the applicant for enrollment in the electronics technology program will start with the first basic electronics courses, namely, ELTR 1302, Principles of Electricity and ELTR 1303, Principles of Semiconductors.

3. Students enrolling at San Antonio College with prior education in the field of electronics technology may consult with the Department Chairperson to determine if credit may be granted for this prior educational credit.

4. Entering students at San Antonio College with extensive knowledge and/or prior experience in the field of electronics technology may elect to take challenge tests in order to by-pass certain electronics technology courses. A fee will be charged for each challenge test prior to the challenge test period. The Department Chairperson reserves the right to determine which courses may be bypassed and which courses must be taken at the post-secondary institution.

AUTHENTICATION

This document is accepted as the 2 + 2 Electronics Program Articulation Agreement existing between San Antonio College, San Antonio, Texas and Northside Independent School District, San Antonio, Texas.

Dr. Max Castillo,
President
San Antonio College

Date: 6/26/90

Dr. Jack C. Jordan
Superintendent
Northside Independent School District

Date: 5-29-90

CONCLUSIONS AND RECOMMENDATIONS

1. The Electronics Technology 2+2 program is a logical development that is a response to the changing environment in the modern workplace. As the requirement for education and technical training becomes more and more critical for employment, public schools must offer students the opportunity to prepare for and succeed in their chosen fields. Educators must also allow students the flexibility to select options for post-secondary education without spending time and resources on redundant course material.

2. The course is designed to provide the student with a broader, more general foundation in electronics than previous electronics courses. Because of the rapid expansion in technology and the continual developments and changes in types of test equipment, the emphasis must be on theory and the ability of the student to read and understand technical data so that he or she may use the information to learn and adapt to new developments. There will be <u>less emphasis</u> on specific pieces of equipment or the repair of specific electronic devices. However, it should be noted that in spite of the fact that the course will prepare the student for college level electronics courses, the elements that are designed to prepare a student for entry level employment in the electronics industry are likewise improved through incorporating the current needs of industry in the course design.

3. The Electronics Technology 2+2 program represents a significant departure from traditional vocational education. In effect, we have designed a program to specifically include students that have expressed that their primary goal is continuing their education at the college or university level. This places vocational education in the same arena with the "Academic Track" departments. **For this program to be successful, there are two critical factors that must be addressed by the school administrators:**

    A. Counselors must be knowledgeable of the program's accompanying math requirements and the unique opportunities that it affords the college-bound student. To be eligible for college credit, the student must be taking algebra prior to enrollment in the electronics courses. Students that may benefit from the Electronics 2+2 Program need to be advised of this and be encouraged to take algebra in the ninth and tenth grades.

B. Schools must provide flexibility in scheduling that will allow an "academic track" student the opportunity to enroll in a course that will take two class hours for each of the four semesters. In other words, there must be sufficient time for electives to allow this program to exist. It certainly would not serve the best interest of the student if he or she could not participate in the program because of other college preparatory course requirements or because of participation in the band, athletics, dance team, or similar extracurricular activities. **Experience may prove that this program will work only in those schools that have seven class periods per day.**

4. The Electronics Technology 2+2 Program should have a wide appeal for other school districts and community colleges. Although the program is just emerging from the developmental stages, early experiences have been quite positive, and it appears to have broad support and interest. There should be few, if any, obstacles presented to others who wish to adopt or build upon this project.

APPENDIX

DEVELOPMENT OF CURRICULUM MODELS FOR ELECTRONICS ENGINEERING TECHNOLOGY PROGRAMS COMMUNITY COLLEGE LEVEL

CURRICULUM DEVELOPMENT: The primary curriculum model is designed for students who enter the 2+2+2 program at the secondary school level and plan to continue at the community college level. These students may elect to continue their education at a four-year university or exit to the workforce. Adjustments were made for entering students who have no prior education in electronics and plan to continue their education at a four-year university, or exit to the workforce. In all tracks, the primary objective is to provide the student with an optimum combination of academic and technical courses to either exit to the workforce or pursue higher education. The following constraints and considerations were applied during the development of the curriculum models:

1. Participating secondary schools indicate that their 2+2+2 program will provide substantial instruction in DC/AC Electricity, Semiconductor Devices and Electronic Circuits. To avoid duplication of instruction graduates from the secondary school programs will bypass these areas of instruction at the community college level and will enter advanced courses in DC/AC Electricity and Semiconductor Devices. The secondary school will also provide additional selected instruction in areas of digital electronics, microcomputers, industrial electronics, radio and TV, and shop practices to enhance the graduate's potential for exiting to the workforce. However, the particular secondary schools' varying curriculum and level of instruction does not warrant bypassing of these areas in the community college curriculum.

2. Constraints of a two year curriculum with a maximum of 68 to 70 semester hours over a two year period dictate a compromise of subject materials to be included in the curriculum. Students who complete the first two years of the 2+2+2 Electronics Technology Program at the secondary level have the option of selecting advanced technical electives or additional academic courses. The electronics technology program requires completion of 40 semester hours of electronics courses as a minimum.

3. Each Electronics Technology Curriculum must provide an adequate core of electronics courses---basic fundamentals and specialty courses---to allow the graduate to exit to the workforce and be competitive for higher level positions as they gain work experience. The fundamentals and specialty courses were developed using the following criteria:

a. The electronics fundamentals and specialty courses were developed using the existing courses at San Antonio College as the foundation. The competencies developed from the DACUM analysis were assigned to these existing and proposed new courses. These courses have evolved over a period of some 20 years and satisfy the majority of the electronics technology requirements in the Greater San Antonio area. All the courses have been upgraded as a result of this curriculum development project to reflect modern electronics technology.

b. All electronics fundamental courses and most specialty courses must be readily transferable to other community colleges (and most four-year universities with engineering technology programs). This will allow students having to relocate to other geographical areas to continue their education with minimal disruption.

c. The specialty areas relate to second year advanced courses. Since all electronics fields use microprocessors and computers, all students are required to complete three courses in this area: Digital Electronics, Electronic Computer Principles and Data Communications. Students who elect the Computer Specialty are required to complete four courses: Digital Applications, Microcomputer Projects and two electronics or technical electives. Students who elect the Communications Specialty area are required to complete four courses: Radio Communications I and II and two electronics or technical electives. Electronics or technical electives include Industrial Electronics, Television Theory, Advanced Industrial Electronics, Opto-Electronics, and Computer Aided Drafting. Cooperative Education or Internship Courses may be substituted at the discretion of the department chairperson.

d. One exception relates to the area of Electronics Fabrication Technology. The DACUM panel identified competencies for this area. Two new courses were developed to accomplish the necessary training for students to demonstrate proficiency in these competencies. These courses would be specialty courses for a proposed Industrial or Manufacturing Specialty.

e. A small number of competencies addressing vacuum tube theory and operation were unassigned. These were either very specialized applications or are rapidly becoming obsolete. In several areas competencies (identified with an asterisk) were added as intermediate levels for some of the more advanced competencies. Further the necessity for students to be proficient in four programming Languages was considered excessive so only an introduction to those Languages is provided.

f. The curricula provides a wide range of academic courses to ensure a well-rounded education. This will enhance the graduate's ability to enter the workforce and/or progress to higher level education. The three R's of reading, writing and arithmetic, form the basis for the academics in each curriculum. One "loud and clear" message from the Project's Steering Committee, as well as contacts with industry, emphasized the need for "people skills". The English, Government, Mathematics, Physics and Speech Courses in the curriculum models will ensure a well-rounded education to supplement the electronics courses. Also, the electronics courses are designed to improve the students' skills in thinking, reasoning, writing and speaking. Cooperative education and internship courses are also available.

4. Articulation agreements are an important aspect of the 2+2+2 program. The planning and coordination necessary to complete these agreements ensures that the curriculum satisfies the needs of both parties. It eliminates duplication of instruction but ensures that the student receives the best education and preparation to enter the workforce or continue their education.

   a. Articulation agreements have been completed with Judson, North East, and Northside Independent School Districts. Secondary schools in those districts are actively recruiting students for the second year of implementation at the high school level. Students seem to be excited about the program. Work has begun with the San Antonio and Edgewood Independent School Districts to develop articulation agreements.

   b. An Articulation agreement has been completed with the University of Houston, Downtown Campus (see Appendix, page ___). Efforts are being continued to consummate an agreement with the Main Campus.

   c. The Texas A&M Transfer Articulation Plan for San Antonio College, (see Appendix, page ___) lists seven electronics courses that are transferable by title to the EET Curriculum at Texas A&M. Thus 28 hours of the 40 semester hours of electronics at San Antonio College may be transferred to Texas A&M. In the academics area, 17 hours, one English, one Government, and two Calculus courses, and a Physics course in the Electronics Technology Curriculum are transferable to Texas A&M. Additional academic electives may also be transferrable. (See course equivalency listing with the Transfer Articulation Plan.)

d. Other secondary school districts in the San Antonio area will be invited to negotiate articulation agreements. Some nine area high schools offer electronics programs. Also other four-year universities with engineering technology and related programs will be contacted to establish articulation agreements.

5. The curricula satisfies four basic categories of students:

   a. 2+2+2 graduates from high school electronics programs who plan to pursue the baccalaureate degree at the four-year university. These students have the option of completing the requirements of an associates degree or devoting their efforts to completing only courses which will transfer to the four-year university. In either case, these students will enroll in English, Government, Calculus, and Calculus-based Physics courses which are transferable to the four-year university.

   b. 2+2+2 graduates from high school electronics technology programs who plan to exit to the workforce after graduation from the community college. All electronics courses are retained in this curriculum. The primary difference in this curriculum is that lower level mathematics and physics courses are specified. However, the lower level courses still provide the basic competencies that are required for the workforce. Also, some four-year universities will accept the courses should the student decide to return to the educational track.

   c. The final two categories apply to high school graduates who do not complete the 2+2+2 program in high school. This entering student will be required to enroll in the Principles of Electricity and Principles of Semiconductors Courses. Furthermore, the student may select the particular curriculum for exiting to either the workforce or additional education at the four-year university.

6. All students should be encouraged to pursue advanced academic courses in High School. Completion of these advanced courses in some cases may enable students to receive credit or advanced placement for this work.

7. This model has been developed based on a DACUM analysis completed in 1988. There are continual advances in technology that require a frequent review and update of competencies, course description, course content and curricular materials. There are several areas that are currently receiving emphasis in industry that have been introduced but receive minimal coverage in this model. They are:

a. Schematic Capture - This is introduced and incorporated in the Drafting (Auto Cad) course which is a technical elective for Electronics. It is anticipated that as the proposed Electronics F rication courses are further developed and refined that this technology would be included as an important aspect of those courses.

b. Algorithmic State Machines (ASM) - This is an emerging technology that uses sequential logic to provide advanced techniques for solving complex technical expressions. Sequential Logic is covered in the Digital Electronics course and as this new technology continues to develop it should be covered in that course.

c. Mech-a-Tronics - This is another new technology that is taking a new and different approach to the merging of mechanical and Electronics Technology. As this Technology is developed and refined it could logically be included in the Advanced Industrial course in addition to the Robotic and Numerical Controlled Devices that are currently in this course or it could become part of the proposed Electronics Fabrications Courses.

8. The Data Base competencies used for this model were developed from the DACUM Analysis. It is currently maintained by the Electronics Department at San Antonio College and is available for use by other educational agencies and activities. For more Information contact San Antonio College, 1300 San Pedro Avenue, San Antonio, TX 78284, Attention: Electronics Department, phone 512 733-2881 (Format is R Base).

COMMUNITY COLLEGE CURRICULUM

(EXIT TO FOUR-YEAR UNIVERSITY)

FRESHMAN LEVEL

FIRST SEMESTER	CREDIT HOURS
Advanced DC/AC Electricity Topics *	4
Advanced Semiconductor Topics *	4
Electronics Problems	3
Orientation	1
Calculus I	3
	15

SECOND SEMESTER	
OPAMPS and Integrated Circuits	4
Digital Electronics	4
Calculus II	3
English Composition I	3
American Government	3
	17

SUMMER	
English Composition II	3
Electronic Computer Principles	4
	7

SOPHOMORE LEVEL

THIRD SEMESTER	
Data Communications	4
Technical Elective **	4
General Physics	4
Elective ***	3/4
	16

FOURTH SEMESTER	
Business Speech	3
Elective ***	3/4
Technical Elective **	4
Technical Elective **	4
	14/15

Total Hours 68 to 70

COMMUNITY COLLEGE CURRICULUM
(EXIT TO WORKFORCE)

FRESHMAN LEVEL

FIRST SEMESTER	CREDIT HOURS
Advanced DC/AC Electricity Topics *	4
Advanced Semiconductor Topics *	4
Electronics Problems	3
Technical Mathematics	3
Orientation	1
	15

SECOND SEMESTER	
OPAMPS and Linear Integrated Circuits	4
Digital Electronics	4
Introduction to Physics	3
English Composition I	3
American Government	3
	17

SUMMER	
English Composition II	3
Electronic Computer Principles	4
	7

SOPHOMORE LEVEL

THIRD SEMESTER	
Data Communications	4
Elective	3/4
Technical Elective **	4
Technical Elective **	4
	15/16

FOURTH SEMESTER	
Business Speech	3
Elective	3/4
Technical Elective **	4
Technical Elective **	4
	14/15
Total Hours	68 to 70

NOTES:

* Students with no credit from selected high school electronics programs will be required to complete Principles of Electricity (3 Hours Credit) and Principles of Semiconductors (3 Hours Credit) prior to enrolling in these courses.

** Students will select courses from areas of electronics specialties with approval of department chairperson. Optional Cooperative Education and Internship Program courses are available within these categories.

*** Students should consult the registrar of the University to which they propose to attend for assistance in selecting courses that can be transferred. Recommendations include Calculus I, Calculus II, General Physics I, and General Physics II.

SPECIALTY I
COMMUNICATIONS ELECTRONICS - REQUIRED COURSES

	HOURS
Radio Communications I	4
Radio Communications II	4

SPECIALTY II
COMPUTER ELECTRONICS - REQUIRED COURSES

	HOURS
Digital Applications	4
Microcomputer Projects	3

PROPOSED SPECIALTY III
INDUSTRIAL/MANUFACTURING - REQUIRED COURSES

	HOURS
Industrial Electronics	4
Electronic Fabrication I	4

ELECTRONICS TECHNOLOGY ELECTIVES

	HOURS
Television Theory	4
Industrial Electronics	4
Advanced Industrial Electronics	4
Opto-Electronics	4
Electronics Fabrication II	4
Electronic Drafting - CAD	3
Practicum and Internship	2/4
Cooperative Education	3

Dr. Grubbs, Associate Professor at A&M University, was a major consultant on this project. To ensure an unbiased opinion of the project, samples of the materials being developed were shared with some members of The Texas Association of Schools of Engineering Technology. Copies of their responses follow.

ALBERT B. GRUBBS JR., Ph.D.
ASSOCIATE PROFESSOR
ELECTRONICS AND TELECOMMUNICATIONS
DEPARTMENT OF ENGINEERING TECHNOLOGY
TEXAS A&M UNIVERSITY
COLLEGE STATION, TEXAS 77843-3367
PHONE: 409-845-5150

April 12, 1990

The participating secondary schools in this program were proud of their existing electronics programs. However, it was recognized that increased technological levels of knowledge and skills will be required of those who anticipate future employment in the electronics industry. It was this awareness that prompted the participants of this project to make changes that would enhance the existing programs in order to provide greater opportunities for its students. As a result, new technical to cs with updated practical experiences are being added to the programs to better prepare students for employment in fields which require greater technical preparation. In addition, as a result of interaction with the steering committee of this project, local industries directly affected the programs in a way that makes their graduates more employable.

As a result of the articulated program being implemented by this project, many topics that were previously not covered until the first or second semesters of a post-secondary program will be studied in the secondary program. In addition, the mathematics and science skills of the students will be enhanced. Both aspects will make the graduates of the secondary programs immediately employable in a industry.

The 2+2 project has been guided by an industrial steering committee from its inception. Prominent industries in the San Antonio area have provided representatives to participate in the DACUM analysis. During the DACUM analysis, industry representatives provided data regarding desired competencies for both entry level and advanced positions. They also participated in the work sessions providing valuable input to the project team. It was the steering committee that first emphasized the importance of increased general education as well as technical education at all academic levels. During one of the meetings involving the industry steering committee, Dr. Cook reinforced the concept that an open door philosophy be maintained at all levels from secondary to PHD levels. This would help each student to achieve their goals through a sound knowledge of generic principles and skills regardless of the level from which they exited the program.

At the same meeting, the complete steering committee expressed satisfaction with the project team's analysis of the DACUM. They also reviewed and approved its design of courses which included exit points at both high school and associate degree levels. Mr. Ramport of the steering committee praised the work and accomplishments of the project stating that the topic and course listing was excellent

Mr. Lasiter led a discussion which pointed out exit points for entry level employment by high school students of this program. The industry steering committee noted the need for assembly, soldering, and computer skills at the secondary level to make its graduates more employable. One of the steering committee members stated that although they did not recruit entry level electronics employees from high schools at the present time, the implementation of this program would likely change that policy.

A working philosophy has been developed by the project team as a result of input from the steering committee and consultants during Phase I. This philosophy recognizes that increased technical and general education will be beneficial to all students regardless of their final academic credentials or employment goals. It is felt that all students will have increased opportunities by preparing them for both advanced studies as well as immediate employment. This would open the doors for increased opportunities for each student. To do otherwise would be putting students in positions where it would be difficult to change career goals without penalty. Rapidly changing technology requires that future employees be able to learn new theory and skills using a solid academic base of mathematics, science, technical fundamentals, and general education.

Amarillo College

Established 1929

December 8, 1989

Dr. Albert B. Grubbs, Jr.
Texas A & M University
Department of Engineering Technology
College Station, Texas 77843-3367

Dear Dr. Grubbs:

This is my response to the appropriateness of the "essential elements" and list of competencies in the Phase I report from San Antonio College.

I have shared the report with my fellow faculty members and we all agree that the contents have been well prepared. The "essential elements" and competencies include everything that could be expected of students at the high school level. We would be happy to have beginning students with only a small fraction of those listed in the report.

The people in San Antonio have my commendation for doing such a fine job.

Sincerely,

Lonnie

A. F. (Lonnie) Adkins
Chairman, Electronics Engineering Technology

AFA/jma

P. O. Box 447 • Amarillo, Texas 79178-0001 • Phone 806/371-5000 • FAX 806/371-5370

MIDWESTERN STATE UNIVERSITY
3400 TAFT BOULEVARD WICHITA FALLS, TEXAS 76308-2099 (817) 692-6611

December 11, 1989

Dr. Albert B. Grubbs, Jr.
Texas A&M University
Dept. of Engineering Technology
College Station, TX 77843

Dear Professor Grubbs,

I apologize for the delay in answering your report. It appears as though your document suffered from a slight dislocation and just crossed my desk today.

From a historical view point, MSU initiated an associate degree in 1976 and has recently extended it to a bachelors degree. This was accomplished by utilizing the 2+2 concept. In looking through your report I was very pleased to note that your outline coincided with our program. Therefore, I am in complete agreement with your outline and recommendations. In particular, I think the mathematics requirements should be emphasized without any dilution.

I have included in a separate page a list of textbooks that we have used in this associate program. In addition, if you don't disagree, I would like to use your report as a basis for providing local articulation.

Sincerely,

Raymond Sims

Raymond Sims
Assistant Professor

RS:bp

Enclosure

TEXTBOOKS: [Title; Author; Publisher]
(#1 In Current Use)

A. DC+AC
1. Principles of Electric Circuits; Floyd; Merrill

B. ANALOG ELECTRONICS
1. Practical Transistors and Linear Integrated Circuits; Greenfield; Wiley

2. Essentials of Solid State Electronics; Faber; Wiley

3. Electronics Devices Discrete and IC; Seidman, Waintraub; Merrill

C. DIGITAL ELECTRONICS
1. Practical Digital Design Using ICs; Greenfield; Wiley

University of North Texas

College of Arts and Sciences
Department of Industrial Technology

November 29, 1989

Dr. Albert B. Grubbs
Engineering Technology
Texas A&M University
College Station, TX 77843-3367

Dear Dr. Grubbs:

Dr. Richards has asked me to respond to your letter of November 20 concerning the articulation program for electronic students. Let me say that this looks like a very innovative and exciting program. I believe that these types of curricula can be very instrumental in solving some of the manpower problems that this nation will face in both near and long term.

The list of "Common Elements" on page 23 is very complete; however, I would change #15 to include understand and apply the basic concepts of microprocessors. The last item #18 seems a little vague to me.

The list of competencies that start on page 24 is very good. If I could obtain Freshmen in either an Associate or B.S. program who had this background it would be a joy to teach them.

Let me wish you and your group success with this program.

Sincerely,

Perry R. McNeill

Perry R. McNeill, Ed.D., P.E.
Visiting Professor-Electronics

xc:Richards

P.O. Box 13198 • Denton, Texas 76203-3198
AC 817/565-2022

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Basic Car Audio Installation	"
Basic Circuit Principles I	"
Basic Circuit Principles II	"
Basic Electronic Repair	Vocational Media Assoc.
Binary Counters	RMI Media Productions
Car Speaker Installation	"
Comparator Counters	"
Current & Voltage	"
Decoders & Encoders	"
Diodes In AC & DC Circuits	"
Diodes & Current Flow	"
Electricity & Magnetism	"
Electronic Fundamentals & Terms	"
Electronic Measurement Using The CR Oscilloscope	"
Electronic Measurement Using VOM	"
Electronic Soldering Introduction	"
Electronic Soldering Margin Of Acceptability	"
Electronics: Soldering Printed Circuits	"
Fault-Finding W/Scope & VOM	"
Feet/Jfet/Mosfet	"
Flip-Flops	"

General Information On IC's	RMI Media Productions
High Technology Soldering	"
Instructional Guide For Industrial Electronics	"
Integrated Circuit Memories	"
Introduction & Logic Gates	"
Logic Conventions	"
Logic Expressions & Diagrams	"
Miscellaneous Devices	"
Multiplexers (MUX) & Demultipliers (DMUX)	"
Non-Binary Counters	"
Oscilloscope Synchronization and Measurement	"
Professional Car Audio Installation	"
Registers	"
Regulated Power Supply	"
SCR's	"
Semiconductor Principles	McIntyre Productions
Soldering Wire Joints & Terminals	RMI Media Productions
Solid State Motor Controls	"
Timing Circuits	"
Transistors	"
Transistor Amplifiers	"
Transistor Switches	"
Universal Asynchronous Receiver Transmitter	"
Using Dual Trace Oscilloscopes	Bergwall Video Prod.

COMPLIANCE STATEMENT

TITLE VI, CIVIL RIGHTS ACT OF 1964; THE MODIFIED COURT ORDER, CIVIL ACTION 5281, FEDERAL DISTRICT COURT, EASTERN DISTRICT OF TEXAS, TYLER DIVISION

Reviews of local education agencies pertaining to compliance with Title VI Civil Rights Act of 1964 and with specific requirements of the Modified Court Order, Civil Action No. 5281, Federal District Court, Eastern District of Texas, Tyler Division are conducted periodically by staff representatives of the Texas Education Agency. These reviews cover at least the following policies and practices:

(1) acceptance policies on student transfers from other school districts;

(2) operation of school bus routes or runs on a non-segregated basis;

(3) nondiscrimination in extracurricular activities and the use of school facilities;

(4) nondiscriminatory practices in the hiring, assigning, promoting, paying, demoting, reassigning, or dismissing of faculty and staff members who work with children;

(5) enrollment and assignment of students without discrimination on the basis of race, color, or national origin;

(6) nondiscriminatory practices relating to the use of a student's first language; and

(7) evidence of published procedures for hearing complaints and grievances.

In addition to conducting reviews, the Texas Education Agency staff representatives check complaints of discrimination made by a citizen or citizens residing in a school district where it is alleged discriminatory practices have occurred or are occurring.

Where a violation of Title VI of the Civil Rights Act is found, the findings are reported to the Office for Civil Rights, Department of Health, Education and Welfare.

If there is a direct violation of the Court Order in Civil Action No. 5281 that cannot be cleared through negotiation, the sanctions required by the Court Order are applied.

TITLE VII, CIVIL RIGHTS ACT OF 1964; EXECUTIVE ORDERS 11246 AND 11375; TITLE IX, 1973 EDUCATION AMENDMENTS; REHABILITATION ACT OF 1973 AS AMENDED; 1974 AMENDMENTS TO THE WAGE-HOUR LAW EXPANDING THE AGE DISCRIMINATION IN EMPLOYMENT ACT OF 1967; AND VIETNAM ERA VETERANS READJUSTMENT ASSISTANCE ACT OF 1972 AS AMENDED IN 1974.

It is the policy of the Texas Education Agency to comply fully with the nondiscrimination provisions of all federal and state laws and regulations by assuring that no person shall be excluded from consideration for recruitment, selection, appointment, training, promotion, retention, or any other personnel action, or be denied any benefits or participation in any programs or activities which it operates on the grounds of race, religion, color, national origin, sex, handicap, age, or veteran status (except where age, sex, or handicap constitute a bona fide occupational qualification necessary to proper and efficient administration). The Texas Education Agency makes positive efforts to employ and advance in employment all protected groups.