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A SUGGESTED CURRICULUM GUIDE FOR ELECTRO-MECHANICAL TECHNOLOGY ORIENTED SPECIFICALLY TO THE COMPUTER AND BUSINESS MACHINE FIELDS. INTERIM REPORT.

BY- LESCARBEAU, ROLAND F. AND OTHERS
HARTFORD UNIV., CONN., WARD TECHNICAL INSTITUTE

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A SUGGESTED POST-SECONDARY CURRICULUM GUIDE FOR ELECTRO-MECHANICAL TECHNOLOGY ORIENTED SPECIFICALLY TO THE COMPUTER AND BUSINESS MACHINE FIELDS WAS DEVELOPED BY A GROUP OF COOPERATING INSTITUTIONS, NOW INCORPORATED AS TECHNICAL EDUCATION CONSORTIUM, INCORPORATED. SPECIFIC NEEDS OF THE COMPUTER AND BUSINESS MACHINE INDUSTRY WERE DETERMINED FROM DATA SUPPLIED BY SEVERAL LARGE CORPORATIONS IN THE FIELD. THIS CURRICULUM GUIDE REPRESENTS MATERIAL SUBMITTED FOR REVIEW AND FINAL APPROVAL, AND IS COMPLETE EXCEPT FOR PHOTOGRAPHS, LABORATORY EXPERIMENTS, AND SCHEMATICS. GRADUATES OF THIS PROGRAM, AS COMPETENT ELECTRO-MECHANICAL TECHNICIANS, ARE EXPECTED TO FIND EMPLOYMENT WITH MINIMUM ON-THE-JOB TRAINING IN SUCH TECHNOLOGICAL FIELDS AS (1) CUSTOMER ENGINEERING, (2) RESEARCH, (3) QUALITY CONTROL, (4) TECHNICAL WRITING, (5) SALES ENGINEERING, (6) SPACE, (7) MEDICINE, (8) ATOMIC ENERGY, AND (9) CHEMISTRY. THEY WILL HAVE ATTAINED (1) SKILL IN MATHEMATICS (ALGEBRA, TRIGONOMETRY, AND HAVE ACQUAINTANCE WITH ANALYTIC GEOMETRY AND CALCULUS), (2) PROFICIENCY IN APPLICATIONS OF PHYSICAL SCIENCE PRINCIPLES, (3) UNDERSTANDING OF MATERIALS AND PROCESSES USED IN TECHNOLOGY, (4) EXTENSIVE KNOWLEDGE OF HIS FIELD OF SPECIALIZATION, (5) PROFICIENCY IN COMMUNICATION SKILLS, AND (6) ABILITY TO GET ALONG WITH PEOPLE. SPECIFIC SKILLS AND ABILITIES ARE DISCUSSED, AS WELL AS (1) FACULTY REQUIREMENTS, (2) STUDENT SELECTION, (3) TEXTBOOKS AND REFERENCES, (4) VISUAL AIDS, (5) LABORATORY EQUIPMENT, (6) PROFESSIONAL SOCIETIES, AND (7) CURRICULUM CONTENT AND OBJECTIVES. THE SUGGESTED FOUR SEMESTER CURRICULUM IS GIVEN AND FOR EACH COURSE THERE IS A COURSE OUTLINE. A LIST OF REFERENCES AND SUITABLE TEXTBOOKS IS INCLUDED. (DH)

RESEARCH-DEVELOPMENT REPORT

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A SUGGESTED CURRICULUM GUIDE FOR ELECTRO-MECHANICAL TECHNOLOGY ORIENTED SPECIFICALLY TO THE COMPUTER AND BUSINESS MACHINE FIELDS

AN INTERIM REPORT

Roland F. Lescarbeau and others

TECHNICAL EDUCATIONAL CONSORTIUM, INC.
Headquarters at
The Ward Technical Institute
University of Hartford

315 Hudson Street, Hartford, Conn. 06103

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U. S. DEPARTMENT OF
HEALTH, EDUCATION AND WELFARE

Office of Education
Bureau of Research

INTERIM REPORT
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ANALYSIS OF NEEDS AND REQUIREMENTS FOR TRAINED ELECTRO-MECHANICAL TECHNICIANS IN THE SPECIFIC AREA OF COMPUTER AND BUSINESS MACHINE TECHNOLOGIES

Developing

A SUGGESTED POST-SECONDARY CURRICULUM GUIDE FOR ELECTRO-MECHANICAL TECHNOLOGY ORIENTED SPECIFICALLY TO THE COMPUTER AND BUSINESS MACHINE FIELDS

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INTERIM REPORT
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In a jointly sponsored program funded by both the Federal Government and industry, a Consortium of schools was formed June 30, 1965, consisting of Oregon Technical Institute, Dunwoody Industrial Institute, Southern Technical Institute, New York City Community College, DeVry Institute of Technology, and the Ward Technical Institute. They agreed to develop an Electro-Mechanical Technology oriented specifically to meet the needs of the computer and business machine industries, and used accumulated data provided by IBM, Honeywell, UNIVAC, National Cash Register Corp., Royal McBee, Underwood, and Burroughs, on which to define needs. Later incorporated as Technical Education Consortium, Inc., under the laws of the State of Connecticut, this non-profit organization developed through a systematized, coordinated approach, a frontal attack aimed at developing technicians for a field where the shortage was recognized as national in scope.

The following represents the first comprehensive "suggested curriculum guide" completed under this project. The steps leading to its development are as follows:

1. Agreement by Institute Consortium members to participate.

2. Development of individual programs of study within agreed limits.

3. Exchange of information resulting from actual experience in classrooms and laboratories.

4. Course outlines developed and exchanged.

5. Evaluation meetings on merits of separate programs.

6. Distribution of and acceptance of responsibility for each of seven segments of projected "curriculum guide" by Consortium Institute members.

7. Submission of each school's curriculum outline to proper coordinating institution accepting responsibility for every segment of projected "curriculum guide."

8. Compilation and dissemination of material by coordinating institutions.

9. Review and rewriting of all accumulated data.

10. Re-submission of completed outline to all member deans.

11. Preparation for pre-final analysis by curriculum coordinator.

This material represents the combined thinking of instructors and deans representing the Technical Education Consortium, Inc. It contains the entire data submitted for review and final approval with the exception of photographs, laboratory experiments and schematicswhich will be contained in the final "Suggested Curriculum Guide" for Electro-Mechanical Technology oriented to computer and business machine technology.

Following a meeting of Consortium deans, this material will be edited and corrected for presentation in final form. At this time the experiments, schematics, and photographs deemed most representative of the combined thinking of the schools participating, will be assembled for inclusion with the final draft. This will then be submitted to the Department of Education for final review.

Since this material does not represent the final report, some areas hereby presented may be modified, enlarged, changed, or deleted from the final document. Because it represents a composite of ideas, it is presented as a "Suggested Curriculum" only, and does not represent the precise curriculum of any of the member Consortium Institution members.

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PREFACE

The increased use of computers and business machines in all branches of industry and commerce has created an ever-growing need for electromechanical technicians. The computer industry alone estimates its manpower needs at one hundred thousand technicians by 1970. In this field, electronic circuits and mechanical actions interact.

The electromechanical technician needs a strong interrelated foundation in electronic circuits, physics and mechanics.

The following curriculum was developed at the request of the computer and business machine industry for the United States Office of Education by a technical education consortium comprising the following schools:

DeVry Institute of Technology, Chicago, Illinois;

Dunwoody Industrial Institute, Minneapolis, Minnesota;

New York City Community College, Brooklyn, New York;

Oregon Technical Institute, Klamath Falls, Oregon;

Southern Technical Institute, Marietta, Georgia;

Spring Garden Technical Institute, Philadelphia, Pennsylvania (an associate member);

Ward Technical Institute, Hartford, Connecticut.

This endeavor was jointly financed by computer industries and by a grant from USOE.

GENERAL CONSIDERATIONS

The objective of the total curriculum recommended in this guide is to produce a competent electromechanical technician. The technician must be capable of working and communicating directly with engineers and production personnel in his specialized work, of satisfactorily performing work for his employer and of growing into positions of increased responsibility. In addition, the graduate technician should be an active, well-informed member of society.

A curriculum which will produce this type of graduate must be carefully designed. Each course must be planned to develop the student's knowledge and skills in that particular area and must be integrated into the curriculum. Each course contributes uniquely in the sequence of courses which is specially planned to progress toward the final objective of producing a competent technician. A close correlation between the courses and an interdisciplinary approach within each course will assure the depth of understanding required of electromechanical technicians.

The technical content of the curriculum is intended to supply a wide background in the diverse areas of applied electromechanical technology. A firm foundation in electricity and basic electronics is planned in the first semester. The following semesters of work build directly on this background but introduce material from many subject areas, such as mechanisms, data storage and logic devices, input and output devices, and digital computing systems.

Graduates of this curriculum can expect to find employment in many areas of the electromechanical field. Each area may require somewhat different abilities and different specialized knowledge and skills for a successful career. Most of these differences will be learned by continued study on the job or in part-time study to master the details of a specific area. The following listing shows some of the major areas of job opportunities for electromechanical technicians, as described by employers:

1. "Customer engineering" or "Field engineering" in the data processing field

2. "Field engineering" for numerical control apparatus

3. Research technician

4. Quality control technician

5. Industrial control technician

6. Technical writer

7. Automation technician

8. Applications technician

9. Sales engineering

10. Teacher in industrial training programs

11. Military and civil service opportunities

12. Technical representative

13. Space technology applications

14. Medical technology applications

15. Atomic energy applications

16. Chemical technology applications

Highly skilled technicians must be capable of working closely with engineers and scientists and of supervising and coordinating the efforts of skilled craftsmen and maintenance men. These capabilities allow technicians to be effective members of the team whose work is to plan, assemble, install, calibrate, evaluate, operate and maintain computers and automated equipment.

Because electromechanical technicians are employed in varied and specialized situations, the adequately trained electromechanical technician must have attained certain abilities, scientific knowledge, and technical skills. These have been broadly defined as follows:

1. Facility with mathematics; ability to use algebra and trigonometry as tools in the development of ideas that make use of fundamental scientific and engineering principles; and an understanding of, though not necessarily facility with, higher mathematics through elements of analytical geometry and calculus.

2. Proficiency in the application of physical science principles, including the basic concepts and laws of physics that are pertinent to the individual's field of technology.

3. An understanding of the materials and processes commonly used in the technology.

4. An extensive knowledge of a field of specialization, with an understanding of the engineering and scientific activities that distinguish the technology of the field.

5. Communication skills that include the ability to interpret, analyze, and transmit facts and ideas graphically, orally, and in writing.

6. The ability to get along with people.

The electromechanical technician must blend all the foregoing abilities, knowledge, and skills as he performs several of the following general activities:

1. Applies knowledge of science and mathematics extensively in rendering direct technical assistance to scientists or engineers engaged in scientific research and experimentation.

2. Develops and plans modifications of new products and processes under the supervision of engineering personnel in research, design and development.

3. Plans and inspects the installation of complex equipment and control systems.

4. Advises, recommends, and implements procedures or programs for the maintenance and repair of complex equipment used in control systems.

5. Advises, plans, and estimates costs as a field representative of a manufacturer or distributor of technical equipment and/or products.

6. Assumes responsiblity for performance or environmental tests of mechanical, hydraulic, pneumatic, electrical, or electronic components of systems and for the preparation of appropriate technical reports covering the tests.

7. Prepares or interprets engineering drawings and sketches.

8. Selects, compiles, and uses technical information from references such as engineering standards, handbooks, and technical digests.

9. Analyzes and interprets information obtained from precision measuring and recording instruments and makes evaluations upon which technical decisions are based.

10. Analyzes and diagnoses technical problems that involve independent decisions.

11. Deals with a variety of technical problems involving many factors and variables which require an understanding of several technical fields.

A two-year curriculum must concentrate on primary or fundamental needs if it is to prepare individuals for responsible technical positions in modern industry. It must be honestly pragmatic in its approach and must involve a high order of specialization. The curriculum suggested in this bulletin has been designed to provide maximum technical instruction in the time that is scheduled.

To those who are not familiar with this type of educational service (or with the goals and interests of students who elect it) the technical program often appears to be inordinately rigid and restrictive. Modifications may be necessary in individual institutions but the interdisciplinary philosophy of this curriculum should be maintained.

The specialized technical courses in electromechanical technology are laboratory-oriented. They provide application of the scientific principles concurrently being learned in the courses in physics and mathematics. For this reason, mathematics and science courses

must be coordinated carefully with technical courses throughout the program. This coordination is accomplished by scheduling mathematics, science, and technical courses concurrently during the first two terms, a curriculum principle that will be illustrated at several points.

FACULTY

The effectiveness of the curriculum depends largely upon the competence and the enthusiasm of the teaching staff. The specialized nature of the curriculum requires that the teachers of technical subjects have special abilities based on proficiency in subject matter and industrial experience. It is important also that all members of the faculty understand the philosophy, goals, and unique requirements that characterize this area of education.

To be most effective, members of the faculty responsible for this program must have interests and capabilities which transcend their area of specialization. All of the faculty members should be reasonably well oriented in the requirements for study in electromechanical science and applications so that they may use appropriate field examples or subject matter as supporting material in the teaching of their respective courses. For example, if the communications courses are to be of maximum value, the teacher should be familiar with the communications problems and demands placed on electromechanical personnel. Also, the scientific principles taught in the courses of physics, mathematics, and measurements require that the instructors emphasize and illustrate how the principles are applied in electromechanical technology.

Thus, teachers of specialized technical subjects require advanced technical training. In the past, many such teachers have been recruited from the ranks of the engineering profession. Recent experience has shown that engineering technology graduates who have acquired suitable industrial experience and who have continued their education often become excellent teachers in this type of program. Persons with this background are more likely to understand the objectives and unique instructional requirements of technical education, and often bring to the program the enthusiasm and an appreciation of the values of technical education that are essential to success.

Since the programs for highly skilled technicians must consist of a series of well-integrated courses in order to attain the scope and depth of adequate training, careful consideration must be given to when and at what level a new concept is to be introduced. This may be accomplished through "team teaching" which requires the organization of a technical staff into a coordinated teaching unit.

STUDENT SELECTION AND SERVICES

The curriculum is designed for high school graduates who have particular abilities and interests. In general, students entering the program should have completed two high school courses in mathematics, including algebra and geometry, and one year of a physical science, preferably physics.

TEXTBOOKS, REFERENCES, AND VISUAL AIDS

Textbooks, references, and visual aids for teaching any technology must be reviewed constantly and supplemented in light of (1) the rapid developments of new knowledge in the field, and (2) the results of research in methods of teaching and developing basic concepts in the physical sciences and mathematics. This is especially true in the electromechanical area. The impact of the development of whole new areas of theoretical and applied scientific knowledge is demanding fresh textbooks, references, articles in scientific and technical journals, and visual aid materials.

The suggested texts and references have been carefully chosen. From the lists presented it should be possible to select suitable ones. However, it should not be assumed that unlisted books are not suitable -- there are, no doubt, others which are excellent.

LABORATORY EQUIPMENT AND FACILITIES

Laboratories and equipment for teaching electromechanical technology programs must meet high standards of quality since the objectives and the strength of the program lie in providing valid laboratory experience, basic in nature, broad in variety, and intensive in practical experience. Well-equipped laboratories with sufficient facilities for all students to perform the laboratory work are required for these courses. The training program should include experiences which illustrate the function and application of a wide variety of electronic, mechanical, and electromechanical components devices, units and systems.

In the selection of laboratory equipment, the need for each iter should be well established. Expensive apparatus may not always be required. Many significant experiments can be built around relatively inexpensive components. In fact, in many cases they can make the principles more evident because they present only the essentials.

A recommended approach to developing laboratory work and equipping electromechanical laboratories is to determine what experiments are needed for each course and then to design these experiments as far as possible using standard components. This approach requires more time and effort on the part of the staff, but because the experimental equipment has been assembled to demonstrate some principle or to make a specific experimental determination with clarity and precision, it usually accomplishes the best teaching.

SCIENTIFIC AND TECHNICAL SOCIETIES

Scientific and technical societies are important sources for instructional materials and other potential opportunities for benefits to both staff and students. Such societies provide, in their publications and in their regularly programmed meetings, a continuing disclosure and discussion of new concepts, processes, techniques, and equipment in the science and related technologies. They are probably the greatest single device by which persons interested in a particular phase of science keep abreast of new developments. Information is presented in such a manner as to provide a "popularizing" and informative bridge between the creative theoretical scientists and the applied science practitioners, including the technicians, and usually are the first medium to announce and describe significant discoveries and applications of research in the field.

Some scientific and technical societies whose publications and services may be of interest to electromechanical technician instructors and students are:

American Institute of Aeronautics and Astronautics

American Radio Relay League, Inc.

Institute of Electrical and Electronics Engineers

Instrument Society of America

CURRICULUM CONTENT AND RELATIONSHIPS

Functional competence in a broad field such as electromechanical technology has at least three components around which a curriculum must be designed:

1. The program should prepare the graduate to enter industry with a minimum of in-plant training.

2. The broad technical training, together with a reasonable amount of experience, should enable the graduate to advance to positions of increasing responsibility.

3. The foundations provided by the training must be broad enough to allow the graduate to do further study within his field. This further study may consist of the reading of journals, new text materials, or enrolling in formal courses.

This curriculum has been developed to meet these requirements.

This electromechanical technology curriculum guide reflects three basic requirements; functional utility, units of instruction in specialized technical subjects, and provisions for the teaching of principles by application.

The sequence of courses in a two-year technical curriculum is as important as the content of the courses if the limited time available is to be used to full effectiveness. In general, the subject matter in the curriculum is carefully coordinated in groups of concurrent courses which are arranged to blend smoothly from one group of courses into the next, thus carrying the student to a deeper understanding in the many diverse areas of electromechanical technology.

The laboratory hours suggested in the curriculum outline and in the course descriptions are not necessarily intended to be in a single session, but rather as total hours of laboratory per week to be scheduled in reasonable and effective increments.

In technical curriculums, it is desirable that specialized technical course work be introduced in the first semester. Deferring this introduction even for one term imposes serious limitations on the effectiveness of the total curriculum. Several important advantages result from an early introduction of the technical specialty:

1. It helps to provide motivation.

2. It is possible to achieve greater depth of understanding in specialized subjects in the later stages of the two-year program.

3. The student sees immediate application of the principles he studies in the concurrent mathematics and physical science courses.

The course outlines in this guide are short and descriptive. The individual instructor will have to prepare complete courses of study and arrange his specific material in logical order before starting instruction. Suggested laboratory layouts and equipment in the Facilities, Equipment and Cost Section will be helpful in organizing the program.

The course outlines are intended as guides rather than as specific instructional plans to be covered in an inflexible order. It is expected that the principles outlined in these courses will be supplemented with industrial applications whenever relevant. Field trips add to the effectiveness of the instruction.

Outside study is a significant part of the student's total program. In this curriculum two hours of outside study time are suggested for each our of scheduled class time.

It should be noted that no examinations have been scheduled in the outlines. It is clearly intended that time be available for examinations. Therefore, a 16-week semester is assumed, and the outlines are designed to cover a full 15 weeks.

Curriculum Outline

1st Semester	Class	Lab	Total Contact Hours
Electricity & Electronics I	3	6	9
Principles of Physics I	3	3	6
Mathematics I	4	0	4
Technical Graphics	1	3	4
English Composition	3	0	3
	14	12	26
2nd Semester			
Electricity & Electronics II	3	6	9
Introduction to Data Processing	2	0	2
Mechanisms	3	3	6
Principles of Physics II	3	3	6
Mathematics II	4	0	4
	15	12	27
3rd Semester			
Digital Computer Fundamentals	4	3	7
Electromechanical Components	3	3	6
Control Systems	3	3	6
Communications Skills	3	0	3
	13	9	22
4th Semester			
Digital Computing Systems	3	6	9
Input/Output Devices	3	3	6
Storage Principles & Devices	3	3	6
Psychology and Human Relations	3	0	3
	12	12	24

Course Title: Electricity and Electronics I

Hours Required: **Class, 3 hours; laboratory, 6 hours**

Prerequisite: **None**

Co-requisites: **Math I, Principles of Physics I**

Course Description and Objectives:

The objective of this course is to familiarize the student with the concepts of the items listed under the major divisions.

Major Divisions:

I. Voltage, Current and Resistance
II. Measuring Devices
III. Circuits
IV. Network Theorems
V. Magneto-statics
VI. Inductance
VII. Capacitance
VIII. Voltage Generators
IX. Complex Algebra Notation
X. AC Circuits
XI. Oscilloscopes
XII. Transformers

Outline of Instruction:

I. Voltage, Current and Resistance
   A. Units
   B. Ohm's Law
   C. Factors affecting resistance of conductors
   D. Wire sizes and resistances
   E. Color code for resistance
   F. Non-linear resistance
   G. Power in DC circuits

II. Measuring Devices
   A. D'Arsonval movement
   B. Electrodynamometer movement
   C. Iron vane movement
   D. Ammeters
   E. Voltmeters
   F. Ohmmeters
   G. Bridges
   H. Hall-effect devices

III. [illegible]
- A. Series and parallel circuits
- B. Voltage relationships
- C. Current relationships
- D. Resistance relationships
- E. Series-parallel combinations
- F. Kirchhoff's Laws
- G. Mesh analysis

IV. Network Theorems
- A. Current and voltage sources
- B. Transformations, Δ-Y or Y-Δ
- C. Thevenin's Theorem
- D. Norton's Theorem
- E. Node equations

V. Magneto-statics
- A. Magnets and forces
- B. Electromagnetism
- C. Flux density

VI. Inductance
- A. Induced EMF
- B. Self Induction
- C. Mutual induction
- D. Inductors
- E. Transients in the RL circuit
- F. Time constant
- G. Saturated reactors

VII. Capacitance
- A. Capacitors
- B. Charging a capacitor
- C. Permittivity
- D. Capacitors in series and parallel
- E. E and I in the RC circuit
- F. Time constant
- G. Energy storage
- H. Dielectric strength

VIII. Voltage Generators
- A. DC and AC Voltages
- B. Sine Wave
- C. Maximum, effective, average and instantaneous values
- D. Frequency and phase
- E. Average power
- F. Power in inductive circuits
- G. Power in capacitive circuits

A. J-operator or rectangular form
B. Polar form
C. Exponential form

X. AC Circuits
   A. Series
      1. R only in the circuit
      2. RC only in the circuit
      3. RL only in the circuit
      4. RLC in the circuit
      5. Power in a series circuit
   B. Parallel
      1. R only in the circuit
      2. R and C in parallel
      3. R and L in parallel
      4. R, C and L in parallel
      5. Power in parallel circuits
   C. Series-Parallel
      1. Admittance, conductance and susceptance
      2. Analysis of circuits
      3. Power in series-parallel circuits
      4. Network theorems applied to AC
   D. Resonance
      1. Series circuits
      2. Parallel circuits
      3. Effect of frequency variation
      4. Effect of L or C variation
      5. Q: effect of high or low value

XI. Oscilloscopes
   A. Electron motion in an electrostatic field
   B. Electron motion in a magnetic field
   C. Functional units
   D. Voltage measurements
   E. Phase and frequency measurements
   F. Limitations

XII. Transformers
   A. Simple Transformer
   B. Voltage and Turn Ratios
   C. Coupling coefficient
   D. Phasing
   E. Impedance ratios

Texts and References:

Lurch, Electric Circuits, John Wiley and Sons, Inc.
Romanowitz, Electrical Fundamentals, John Wiley and Sons, Inc
Cooke, Basic Mathematics for Electronics, McGraw-Hill Book Co.
Slurzberg & Osterheld, Essentials of Electricity and Electron...
   McGraw-Hill Book Company, Third Edition.
Gillie, Electrical Principles of Electronics, McGraw-Hill Book Co.

Course Title: Principles of Physics I

Hours Required: Class, 3 hours; Laboratory, 3 hours

Prerequisite: None

Corequisites: Mathematics I

Course Description and Objectives:

This two-semester sequence will equip the electromechanical technician with an understanding of the principles governing the operation of equipment he will develop and maintain. A conceptual and unified approach is presented wherein the learner is expected to understand relationships rather than perform extensive calculations. A basic introduction to Newtonian mechanics.

Major Divisions:

I. Physics and measurements
II. Vector quantities
III. Systems of forces
IV. Torque and equilibrium
V. Linear motion
VI. Force and motion
VII. Work and energy
VIII. Momentum
IX. Uniform circular motion and gravitation
X. Rotational motion
XI. Harmonic motion
XII. Elastic properties of matter
XIII. Fluids at rest
XIV. Fluids in motion

Outline of Instruction:

I. Physics and measurements
   A. The importance of physics
   B. Standards of length and mass
   C. Units of time
   D. The MKS system of units
   E. Units and their conversion
   F. Measurement of angles
   G. Force
   H. Weight and mass

II. Vector quantities
   A. Displacement
   B. Vectors and scalars
   C. The graphical addition of vectors
   D. Velocity
   E. Frame of reference
   F. Rectangular components of a vector

III. **Systems of forces**
- A. Force and motion
- B. Newton's third law
- C. Concurrent forces
- D. Equilibrium under concurrent forces
- E. Friction
- F. Kinetic friction
- G. The coefficient of static friction
- H. Friction of an inclined plane
- I. Reducing friction

IV. Torque and Equilibrium
- A. Torque
- B. Center of gravity
- C. Equilibrium
- D. The conditions for equilibrium
- E. Types of equilibrium

V. Linear motion
- A. Types of motion
- B. Instantaneous velocity
- C. Acceleration
- D. Uniformly accelerated rectilinear motion

VI. Force and motion
- A. Newton's first law of motion
- B. Inertia
- C. Newton's second law
- D. The Newton
- E. Gravitational units of force
- F. Newton's third law of motion
- G. Application of Newton's second law
- H. Momentum and Newton's second law

VII. Work and energy
- A. Work
- B. Units of work
- C. Power
- D. Energy and its conservation
- E. Potential and kinetic energy
- F. Transformation of potential and kinetic energy
- G. Simple machines
- H. Mechanical advantage and efficiency
- I. Rotating systems

VIII. Momentum
- A. Momentum and impulse
- B. The conversion of momentum
- C. Center of mass
- D. Collision phenomena
- E. Perfectly inelastic collisions

IX. Uniform circular motion and gravitation
- A. Uniform circular motion
- B. Centripetal force
- C. Newton's law of universal gravitation
- D. Variation of weight with position
- E. Gravitational potential energy
- F. Applications of centripetal forces

X. Rotational motion
- A. Rotational velocity
- B. Angular acceleration
- C. Kinetic energy of rotation
- D. Moment of inertia
- E. Newton's laws for rotational motion
- F. Angular momentum

XI. Harmonic motion
- A. Vibrations
- B. Simple harmonic motion
- C. The period of a simple harmonic motion
- D. Velocity in simple harmonic motion
- E. Force and energy relations

XII. Elastic properties of matter
- A. Molecular composition of matter
- B. Elasticity

XIII. Fluids at rest
- A. Fluids and pressure
- B. Pascal's principle
- C. Archimedes' principle
- D. Density and specific gravity

XIV. Fluids in motion
- A. Fluid friction
- B. Pressure in a moving fluid: Bernoulli's theorem

Texts and References:

Miller, College Physics,
Beiser, Basic Concepts of Physics,
Beiser, Modern Technical Physics, Addison-Wesley.
Weber, Manning, White, College Physics, McGraw-Hill Book Co.
Smith & Cooper, Elements of Physics, McGraw-Hill Book Co.

Lab: Experimental College Physics, White and Manning, McGraw-Hill Book Co.

Course Title: Mathematics I

Hours Required: Class, 4 hours; Laboratory, 0 hours

Prerequisites: None

Course Description and Objectives:

A study which covers the concepts of basic mathematical functions; algebraic and graphic solutions of equations and systems of equations. The theory and use of the slide rule is stressed. Emphasis is placed on operational knowledge and the subject matter of trigonometry is investigated and its dependence on, and interrelationships with, algebra are utilized.

Major Divisions:

I. Fundamental qualities of, and operations with numbers
II. Properties of, and operations with polynomials
III. Solution of, and graphing of linear equations
IV. Solution of, and graphing of quadratic equations
V. Exponents, radicals and logarithms
VI. Functions and graphing
VII. Basic trigonometric functions and relations
VIII. Complex numbers and the j-operator

Outline of Instruction:

I. Fundamental qualities of, and operations with numbers
  A. Numbers, number symbols, order
  B. Fundamental operations
  C. Scientific notation
  D. Slide rule: multiplication and division

II. Properties of, and operations with polynomials
  A. Laws of exponents
  B. Grouping
  C. Operations on polynomials
  D. Factors and factoring

III. Solution of, and graphing of linear equations
  A. Algebraic solution of a linear equation
  B. Rectangular coordinate system
  C. Slope-intercept form of a linear equation
  D. Graphing the linear equation

IV. Solution of, and graphing of quadratic equations
  A. Algebraic solution
  B. Graphical solution

V. Exponents, radicals and logarithms
   A. Positive and negative exponents
   B. Laws of radicals
   C. Logarithms

VI. Functions and graphing
   A. Maxima and minima
   B. Types of variation, writing equations
   C. Graphing
   D. Application problems
      1. linear
      2. logarithmic

VII. Basic trigonometric functions and relations
   A. Angles
      1. definitions
      2. degrees
      3. radians
   B. Trigonometric functions defined
      1. limiting values
      2. signs
      3. relationships among functions
   C. Use of tables
   D. Use of slide rule

VIII. Complex numbers and the j-operator
   A. Fundamental operations
   B. Polar representation
   C. DeMoivre's theorem
   D. Roots of complex numbers

Texts and References:

Washington, Basic Technical Mathematics.

Cooke, Basic Mathematics for Electronics.

Fisher & Zieber, Integrated Algebra & Trigonometry.

Rees & Sparks, Algebra & Trigonometry.

Peterson, Intermediate Algebra for College Students.

Course Title: Technical Graphics

Hours Required: Class, 1 hour; Laboratory, 3 hours

Prerequisites: None

Course Description and Objectives:

This course is designed to instill a knowledge and understandi of the basic concepts of both mechanical and electrical drafting. Drafting is taught as a means of a communication using the tools of orthographic and isometric projection. Careful attention is paid to proper representation.

The course is designed to develop skills in the mechanical and electrical area to permit the student to read and make simple drawings. Simplified methods, free-hand sketching and the use of standard symbols will be stressed.

Throughout the course of study, emphasis will be placed on development of visualization. Whenever possible, the interdisciplinary area of electromechanical concepts will be introduced.

Major Divisions:

I. Sketching Techniques
II. Introduction to 2 view orthographic projection
III. Orthographic Projection
IV. Electrical and Electronic Drafting
V. Assembly Drawings
VI. Charts and Graphs

Outline of Instruction:

I. Sketching Techniques
   A. Purpose of course
   B. Isometric Drawing
   C. Oblique Projection
   D. Perspective Projection

II. Introduction to 2 view orthographic projection
   A. Simplified drafting
   B. Symbols
      1. threads
      2. fasteners
      3. keys
      4. gears
      5. pins
      6. springs
   C. Use of standards tables

III. Orthographic Projection
  A. Use of tools
  B. 2-view
  C. 3-view
  D. Dimensioning
  E. Sectioning

IV. Electrical and Electronic Drafting
  A. Standard symbols
    1. use of templates
  B. Block diagrams
  C. Schematics
    1. elementary
    2. ladder
  D. Wiring diagrams
    1. Tables (harness)
  E. Electromechanical components
  F. Chassis layouts

V. Assembly Drawings
  A. Purpose
  B. Standard procedures
  C. Bill of Materials

VI. Charts and Graphs
  A. Purpose
  B. Standard Practices
  C. Timing Charts and Cams

Texts and References:

Giesecke, Mitchell and Spencer, Technical Drawing,

Baer, C. J., Electrical and Electronic Drawing,

Rashnodoff, Electronic Drafting and Design,

Shiers, Electronic Drafting,

French and Vierck, Engineering Drawing,

Kirchner and Stone, Electronic Drafting Workbook,

Bishop, Electrical Drafting and Design,

Visual Aids:

Models, film strips, films, overhead projector and projectuals, motor in parts, relay, limit switch, gears, cams, resistors, capacitors, transistors, diodes and ecx.

Course Title: English Composition

Hours Required: Class, 3 hours; Laboratory, 0 hours

Prerequisites: None

Course Description and Objectives:

The student's strength and weaknesses are analyzed through the use of diagnostic tests and exercises in writing, reading, and listening. Both technical and social skills are emphasized throughout the entire course.

Major Divisions:

I. Grammar and spelling
II. Sentence structure
III. Elimination of errors in Sentence Structure
IV. Writing for Composition
V. Vocabulary Building
VI. Sentence Style
VII. Paragraph Technique
VIII. Business Correspondence

Outline of Instruction:

I. Grammar and Spelling
   A. Sentence sense
   B. Case
   C. Spelling
   D. Tense
   E. Mood

II. Sentence Structure
   A. Adjectives and Adverbs
   B. Diagramming
   C. Sentence fragments, comma splice
   D. Unity reference of pronouns

III. Elimination of errors in Sentence Structure
   A. End punctuation; internal punctuation
   B. Non restrictives; parenthetical elements
   C. Word Punctuation: Italics, capitals, apostrophe, hyphen

IV. Writing for comprehension
   A. Quoted Material
   B. The whole composition
   C. Effective paragraphs
   D. Paragraph development

V. Vocabulary Building
   A. Effective letters
   B. The whole composition; parallel structure
   C. Words and spelling
   D. Effective use of dictionary

VI. Sentence Style
- A. Effective sentence structure
- B. Jargon
- C. Parts of a sentence
- D. Form of a letter

VII. Paragraph Technique
- A. Making writing easy to read
- B. Effective paragraphs
- C. Paragraph development
- D. Effective letters and paragraphs

VIII. Business Correspondence
- A. Answers to inquiries, orders
- B. Claim letter and adjustment letters
- C. Credit letters
- D. Collection letters
- E. Sales letters
- F. Application letters

Texts and References:

Leggett, Mead and Charvat, Handbook for Writers,

Shurter, Effective Letters in Business,

American College Dictionary

Course Title: Electricity and Electronics II

Hours Required: Class, 3 hours; Laboratory, 6 hours

Prerequisites: Electricity and Electronics I

Course Description and Objectives:

The objective of this course is to familiarize the student with the concepts of the items listed under the major divisions.

Major Divisions:

I. Balanced polyphase circuits
II. Power Supplies
III. Semi-Conductor Devices
IV. Electron Tube Characteristics
V. Amplifiers
VI. Feedback
VII. Oscillators
VIII. Pulse, Digital and Switching Circuits

Outline of Instruction:

I. Balanced polyphase circuits
  A. Two-phase
  B. Current and voltage relationships
  C. Three-phase
  D. Current and voltage relationships

II. Power Supplies
  A. Two terminal rectifiers
    1. Vacuum diode characteristics
    2. Gas diode characteristics
    3. Semiconductor diode characteristics
  B. Half-wave rectifier
  C. Full-wave rectifier
  D. Bridge rectifier
  E. Three phase rectification
  F. Voltage regulation

III. Semi-Conductor Devices
  A. Basic physics
  B. Ratings and limitations
  C. Graphical analysis
  D. Biasing methods
  E. Bias stability
  F. Field-effect transistor
  G. Other semiconductor devices - SCR's

IV. Electron Tube Characteristics
- A. Triodes
- B. Tetrodes
- C. Pentodes
- D. Thyratrons
- E. Special Tubes

V. Amplifiers
- A. Triode
  1. Load line analysis
  2. Bias circuits
  3. Equivalent circuit analysis
- B. Pentode
  1. Characteristics
  2. Operating potentials
  3. Equivalent circuit analysis
- C. Transistor
  1. Characteristics
  2. Operating potentials
  3. Equivalent circuit analysis
- D. Classes of Operation
  1. Class A, B, and C
  2. Operating point
- E. Coupling
  1. Direct
  2. RC
  3. Transformer
  4. Frequency response
  5. Photoelectric
  6. Decoupling
- F. Large signal
  1. Single ended
  2. Harmonic distortion
  3. Power output
  4. Push-pull

VI. Feedback
- A. Voltage feedback
- B. Gain
- C. Noise and distortion
- D. Input impedance
- E. Output impedance
- F. Current feedback
- G. Oscillation
- H. Selective feedback

VII. Oscillators
- A. Phase shift oscillators
- B. Feedback oscillators
- C. Negative feedback
- D. Bridge Oscillators
- E. Crystal Oscillators

VIII. Pulse, Digital, and Switching Circuits
- A. RC and RL Circuits
- B. Switches
- C. Clippers, limiters, and clamps
- D. Time base generators
- E. Blocking oscillators
- F. Multivibrators
- G. Scalers and counters

Texts and References:

Romanowitz, Electrical Fundamentals, McGraw-Hill Book Co.

DeFrance, Electron Tubes and Semiconductors, Prentice Hall.

Shrader, Electronic Communication, McGraw-Hill Book Co., Second Edition.

Cutler, Active Networks, Vol. II, McGraw Hill Book Co.

Course Title: Introduction to Data Processing

Hours Required: Class, 2 hours, Laboratory, 0 hours

Prerequisites: None

Course Description and Objectives:

The intent of this course is to develop knowledge and understanding of data processing as a tool of society which can be beneficial in numerous areas of employment.

Major Divisions:

I. Introduction to data Processing
II. Keypunching
III. Sorter: IBM Model 82
IV. Collator: IBM Model 85
V. Card Reproducing Machine: IBM Model 519
VI. Computer Operation
VII. The Console
VIII. Conversing with a computer
IX. Problem Solving Using Symbolic Language
X. Problem Solving Using a Problem-Oriented Language

Outline of Instruction:

I. Introduction to Data Processing
   A. Manual methods
   B. Electromechanical methods
   C. Electronic data processing
   D. Recent developments in electronic data processing
   E. Uses and applications of the computer
   F. Capabilities and limitations

II. Keypunching
   A. Orientation: Card Code
   B. The keyboard: "alpha" and "numeric" shift
   C. The program-control card

III. Sorter: IBM Model 82
   A. The logic of sorting
   B. The controls of the sorter

IV. Collator: IBM Model 85
   A. Merging and selection logic
   B. Wiring the control panel

V. Card Reproducing Machine: IBM Model 519
   A. Gangpunching, in-line and offset
   B. Duplicating, in-line and offset
   C. Comparing
   D. Major-minor gangpunching

VI. Computer Operation
- A. Number systems
- B. Functional units
  1. Input and output
  2. Memory
  3. Arithmetic-logic
  4. Central processing unit - control

VII. The Console
- A. Associated equipment
- B. Demonstration problem

VIII. Conversing with a computer
- A. Conversation difficulties
- B. Machine language
- C. Symbolic language (machine oriented)
- D. The assembly process (symbolic to machine language)
- E. The source and object deck
- F. Problem-oriented languages (Autocoder, FORTRAN, COBOL, etc.)
- G. Automatic programming - the compiler

IX. Problem Solving Using Symbolic Language
- A. Flow charting
- B. Introduction to mnemonics (limited)
- C. Coding in symbolic language
- D. Execution of program from flow chart, to card punching, to computer execution, through debugging (correction) phase

X. Problem Solving Using a Problem-Oriented Language
- A. Flow charting
- B. Introduction to basic Autocoder (limited)
- C. Coding in Autocoder
- D. Execution of program from flow chart, to computer execution, through debugging (correction) phase

Texts and References:

Note: While no formal texts are assigned for this course, library assignments should be made which support lecture presentations. Also, excerpts from the following manuals should be available:

Manual of Instruction:	26 Keypunch.	IBM Form #223-8319-9
Manual of Instruction:	82 Sorter.	IBM Form #
Manual of Instruction:	85 Collator.	IBM Form #231-0001
Reference Manual:	85 Collator.	IBM Form #A24-1005-2
Manual of Instruction:	519 Document Originating Machine	IBM Form #225-6320-1
Reference Manual:	519 Document Originating Machine	IBM Form #A24-1017-1
System Operation Reference Manual:	1401 DPS	IBM Form #A24-3067-1

Course Title: Mechanisms

Hours Required: Class, 3 hours; Laboratory, 3 hours

Prerequisites: Mathematics I, Principles of Physics I

Course Description and Objectives:

The study of fundamental concepts as found in basic mechanical and electromechanical mechanisms. These mechanisms will be studied in terms of their function, specifications and operating characteristics. Emphasis will be placed on the use of these mechanisms in integrated electromechanical systems as found in business machines and data processing equipment.

In the laboratory these mechanisms will be studied in an electromechanical system with respect to their input and output characteristics. Emphasis will be placed on methods of controlling and analyzing the systems and analyzing malfunctions. All laboratory projects will be designed and then constructed using breadboard techniques.

Major Divisions:

I. Fundamental Units
II. Levers and Linkages
III. Gears
IV. Transmission Components
V. Electric Controls

Outline of Instruction:

I. Fundamental Units
   A. Concepts of work
   B. Torque and torque measurement
   C. Velocity and Acceleration
   D. Inertia (F=Ma)
   E. Horsepower
   F. Efficiency
   G. Timing charts - concepts and construction

II. Levers and Linkages
   A. Levers - analysis of load
   B. Linkages - 3 bar and 4 bar
   C. Velocity, acceleration and force transmission
   D. Laboratory projects
      1. Intermittent feeding through linkages
      2. Slider ceramic linkage mechanisms
      3. Quick return linkage mechanisms

III. Gears
- A. Rack and spur gear - fundamentals and nomenclature
- B. Gear train ratios
- C. Torque and speed - ratio concepts
- D. Sources of power
- E. Power transmission
- F. Bevel gears
- G. Worm and worm wheel
- H. Spiroid
- I. Discussion of meaning of errors (actual vs. theoretical) - (fixed, cumulative and intermittent)
- J. Variable speed drives - epicyclic gear train, differential and integrator (friction drive)

IV. Transmission Components
- A. Belts and chains
- B. Shafting
- C. Keys, set screws, pins and splines
- D. Couplings
- E. Flexible shafts
- F. Clutches
- G. Brakes
- H. Cams
- I. Intermittent drives - geneva and ratchet
- J. Bearings

V. Electric Controls
- A. Magnetism
- B. Electromagnetism
- C. Solenoids
- D. Switches
- E. Relays - introduction

Texts and References:

Greenwood, Manual of Electromechanical Devices,

Workman, Mechanisms Laboratory Manual,

Penton Publishers, Mechanical Drives; Machine Design,

Penton Publishers, Electric Controls; Machine Design,

Pic Gear - catalog,

Browning Transmission - Catalog,

Faires and Keown, Mechanism,

Phelan, Fundamentals of Mechanical Design,

Kepler, Basic Graphical Kinematics,

Lent, Analysis and Design of Mechanisms,

Berg, Theory and Application of Precision Mechanical Components,

Boggs, Mechanisms,

Wenton, Mechanisms,

Visual Aids:

Appropriate Pic Kit - Pic Gear, N. Y.
Linkage Kit - Techmation, Conn.
Switches and Relays

Course Title: Principles of Physics II

Hours Required: Class, 3 hours; Laboratory, 3 hours

Prerequisites: Mathematics I, Principles of Physics I

Course Description and Objectives:

An introduction to the principles of heat, sound, light, electricity and magnetism and their simpler applications.

Major Divisions:

I. Temperature, heat and thermal expansion
II. Kinetic theory
III. Heat Transfer
IV. Wave motion and sound sources
V. Light and Illumination
VI. Reflection, refraction and dispersion of light
VII. Lenses and optical instruments
VIII. Electric charges and fields
IX. Electric energy
X. Electromagnetism
XI. Relativity
XII. Electrons and the Bohr atom
XIII. Conductors, Semiconductors, and non-conductors

Outline of Instruction:

I. Temperature, heat and thermal expansion
   A. Temperature Scales
   B. Heat as a form of energy
   C. Heat units
   D. Expansion of solids
   E. The general gas law

II. Kinetic Theory
   A. Kinetic theory of gas pressure
   B. Dalton's law of partial pressure
   C. Work done by an expanding gas
   D. Diffusion

III. Heat transfer
   A. Change of phase
   B. Conduction
   C. Convection
   D. Radiation

IV. Wave motion and sound sources
   A. Transverse and longitudinal
   B. Wavelength, frequency, and velocity
   C. Superposition of waves

D. The reflection of waves
E. Refraction of waves
F. Standing waves
G. The nature of sound
H. Pitch, Loudness, and quality
I. Reflection of sound
J. Refraction of sound
K. Interference of sound waves
L. Harmonics of a string
M. Resonance, and the doppler effect

V. Light and Illumination
A. The nature of light
B. Standard sources and luminous flux
C. Illuminance
D. The photometer
E. The velocity of light
F. Frequency and wavelength

VI. Reflection, refraction and dispersion of light
A. Laws of reflection
B. The plane mirror
C. The concave spherical mirror
D. The convex mirror
E. Refraction

VII. Lenses and optical instruments
A. Simple lenses
B. Single lenses
C. Combination of lenses

VIII. Electric charges and fields
A. Electric and magnetic forces
B. Conductors and insulators
C. Coulomb's law; conservation of charge
D. Electric field; concept and models
E. Potential difference
F. Capacitance
G. Inductance

IX. Electric energy
A. Electromotive force
B. Joule's law
C. Current and resistance
D. Motors
E. Motors and generators
F. Back emf and back torque; eddy currents
G. Transformers

X. Electromagnetism
A. Magnetism and the magnetic field
B. Induction, magnetic flux
C. Magnetic dipoles and poles
D. Magnetic force that acts on a moving charge
E. Force on a current carrying conductor
F. Force and torque on a current loop

XI. Relativity
- A. Postulates
- B. Relativistic mass
- C. The mass of the electron
- D. General relativity

XII. Electrons and the Bohr atom
- A. Cathode rays
- B. The Bohr atom
- C. Energy levels
- D. The atomic number

XIII. Conductors, Semiconductors and non-conductors
- A. Types of Conductors
- B. The nature of semi-conductors
- C. The nature of insulators

Texts and References:

Miller, College Physics.

Beiser, Basic Concepts of Physics.

Beiser, Modern Technical Physics.

Smith & Cooper, Elements of Physics.

Weber Manning & White, College Physics.

Lab: White & Manning, Experimental College Physics.

Course Title: Mathematics II

Hours Required: Class, 4 hours; Laboratory, 0 hours

Prerequisites: Mathematics I

Course Description and Objectives:

The emphasis of this course is placed on analytic geometry with a study of lines and conic sections. A brief introduction of the concept of the limit of a function is presented. Integration of simple functions is covered. The course is solution oriented with applications in applied engineering.

Major Divisions:

I. Analytic Geometry
II. Variables, Functions and Limits
III. Differentiation and Applications
IV. Integration and Applications

Outline of Instruction:

I. Analytic Geometry
   A. Introduction to Curves and Equations
   B. The Straight line
   C. The Circle
   D. The Parabola
   E. The Ellipse
   F. The Hyperbola

II. Variables, Functions, and Limits
   A. Variables and constants
   B. Continuous variation
   C. Limit of a variable
   D. Limiting value of a function
   E. Theorems of limits

III. Differentiation and Applications
   A. Increments
   B. Derivative of a function of one variable
   C. Differentiable functions
   D. General rule for differentiation
   E. Geometric intrepretation

IV. Integration and Applications
   A. Basic rules for integration
   B. Area calculation
   C. Mean value of a function

Texts and References:

Steen and Ballou, Analytic Geometry,

Peterson, Calculus with Analytic Geometry,

Course Title: Digital Computer Fundamentals

Hours Required: Class, 4 hours; Laboratory, 3 hours

Prerequisites: Introduction to Data Processing

Course Description and Objectives:

The fundamentals of digital computers are studied from a non-mathematical approach. The student is first introduced to general purpose computing systems and the concept of a stored program computer.

The basic ideas of programming are presented to develop an understanding of the logical organization of a digital system.

The study of peripheral equipment touches upon card readers and punches, printers, tape and disk drives.

Major Divisions:

I. Introduction
II. Computer Programming
III. Computer Software
IV. Peripheral Equipment
V. Number Systems and Boolean Algebra
VI. Computer Components
VII. Computer Units
VIII. Computer Applications

Outline of Instruction:

I. Introduction*
   A. Historical background
   B. Types of Computers
      1. Digital
      2. Analog
   C. General Block Diagram

II. Computer Programming
   A. Typical computer problems
   B. Problem analysis and flow charts
   C. Instructions
   D. Subroutines
   E. Load routines

III. Computer Software
   A. Automatic programming
   B. Symbolic programming system
   C. Fortran
   D. Cobol

* Although the IBM 1401 System is used in this program, any other system could be substituted.

IV. Peripheral Equipment
- A. On-line and off-line operation
- B. Card and tape punches
- C. Magnetic tape drives
- D. Printers
- E. Card handling machines

V. Number Systems and Boolean Algebra
- A. Decimal
- B. Binary
- C. Octal
- D. Hexadecimal
- E. Binary coded decimal
- F. Binary arithmetic
- G. Basic ideas of Boolean algebra
- H. Boolean equations to logic diagrams
- I. Truth tables
- J. Karnaugh maps

VI. Computer components
- A. Digital logic concepts
- B. Counters and decoders, coincidence detectors
- C. Storage registers
- D. Shift registers
- E. Adders and subtracters
- F. Timing generators

VII. Computer Units
- A. Input and output
- B. Memory systems
- C. Arithmetic unit
- D. Control logic

VIII. Computer Applications
- A. Applications in business and commerce
- B. Applications in applied science
- C. Military applications
- D. Industrial control by computer
- E. Computers in education

Texts and References:

Burroughs Corp., Digital Computer Principles,

Bartee, Digital Computer Fundamentals,

Phister, Logical Design of Digital Computers,

Scott, Analog and Digital Computer Techniques,

Course Title: Electromechanical Components

Hours Required: Class, 3 hours; Laboratory, 3 hours

Prerequisites: Mechanisms

Course Description and Objectives:

An in-depth study of mechanisms as they are specifically related to use in business machines and data processing machines. It will apply the principles and concepts learned in the course in mechanisms.

Laboratory projects will give the student "hands on" knowledge of these mechanisms as individual units and as part of an overall electromechanical system.

Major Divisions:

I. Drives
II. Relays
III. Cam Operated Switches
IV. Electromechanical clutches
V. Feeding Mechanisms
VI. Sensing - Reading Mechanisms
VII. Recording - Writing Mechanisms
VIII. Accumulating Mechanisms
IX. Control and Timing of Electromechanical Systems

Outline of Instruction:

I. Drives
   A. Motors
      1. DC
      2. Single phase
      3. Multiphase
   B. Comparitive characteristics
   C. Applications
   D. Maintenance

II. Relays
   A. Terminology and Nomenclature
   B. Characteristics - Electrical and Mechanical
   C. Different types of relays
   D. Application
   E. Protection for arcing, noise and surge
   F. Maintenance

III. Cam Operated Switches
   A. Characteristics - Electrical and Mechanical
   B. Types of breakers
   C. Application
   D. Maintenance

IV. Electromechanical Clutches
   A. Types of clutches
      1. Positive
      2. friction
      3. magnetic
      4. magnetic particle
      5. overrunning
   B. Characteristics
   C. Application
   D. Maintenance

V. Feeding Mechanisms
   A. Basic feeding concepts
   B. Parts feeding
   C. Card feeding
   D. Tape feeding
   E. Loose paper feeding

VI. Sensing - Reading Mechanisms
   A. Basic sensing concepts
   B. Basic reading concepts
   C. Card reading - static, dynamic, mechanical, optical
   D. Paper tape reading - static, dynamic, mechanical, optical
   E. Magnetic tape reading
   F. Print reading - optical and magnetic

VII. Recording - Writing Mechanisms
   A. Card Punching
   B. Tape punching
   C. Card printing
   D. Paper printing
   E. Magnetic tape recording

VIII. Accumulating Mechanisms
   A. Basic concepts of accumulating
   B. Mechanical accumulators
   C. Electrical accumulators
   D. Electromechanical accumulators

IX. Control and Timing of Electromechanical systems
   A. Clocks
   B. Timing devices
   C. Programmers
   D. Timing charts
   E. Flow charts
   F. Component and sub-assembly integration

Texts and References:

IBM Customer Engineering Manuals of Instruction:
   Functional Units
   1403 Printer
   1402 Card Read Punch
   519 Reproducer Punch
   1311 Disk Storage Drive

Bartee, Digital Computer Fundamentals,

Greenwood, Manual of Electromechanical Devices,

Wertman, Mechanisms Laboratory Manual,

Penton Publishers, Mechanical Drives; Machine Design,

Penton Publishers, Electric Controls; Machine Design,

Pic Gear - Catalog.

Browning Transmission - Catalog.

Faires and Keown, Mechanism,

Phelan, Fundamentals of Mechanical Design,

Kepler, Basic Graphical Kinematics,

Lent, Analysis and Design of Mechanisms,

Berg, Theory and Application of Precision Mechanical Components,

Beggs, Mechanisms,

Winston, Mechanisms,

Course Title: Control Systems

Hours Required: Class, 3 hours; Laboratory, 3 hours

Prerequisites: Mathematics II, Principles of Physics II, Electricity and Electronics II

Course Description and Objectives:

This course is designed to assist the student to gain an understanding of the basic systems and the devices used in these systems. In class the systems and devices will be discussed and in the laboratory the student will connect, operate, adjust, and test the various devices individually and in simple systems.

Major Divisions:

I. Motor and Generator Characteristics
II. Motor Controls
III. Automatic Control Systems
IV. Sensing Devices (Transducers)
V. Measuring Devices
VI. Actuating Devices
VII. Control Devices
VIII. Applications

Outline of Instruction:

I. Motor and Generator Characteristics
   A. Shunt motors
   B. Series motors
   C. Compound motors
   D. Induction motors
   E. Split phase motors
   F. DC Generators

II. Motor Controls
   A. Control-circuit functions
      1. Acceleration
      2. Control of speed
      3. Stopping
      4. Overload
   B. Control Devices
      1. Resistors
      2. Reactors
      3. Autotransformers
      4. Magnetic amplifiers
      5. SCRs and Thyratrons

III. Automatic Control Systems
- A. Open Loop
- B. Closed Loop
- C. Control Loop
- D. Time Response
- E. Frequency Response
- F. Stability
- G. Analog and digital

IV. Sensing Devices (Transducers)
- A. Motion
  1. Linear
  2. Angular
  3. Speed of Rotation
- B. Force
  1. Pressure
  2. Tension
  3. Torque
- C. Temperature
  1. Fluid
  2. Resistive
  3. Bimetallic
  4. Thermocouple
- D. Radiation
  1. Light
  2. X-Ray
  3. Radioactive

V. Measurement
- A. Electrical Quantities
  1. Voltage
  2. Current
  3. Resistance
  4. Frequency
  5. Inductance
  6. Capacitance
  7. Pulse Rate
- B. Counters
  1. Mechanical
  2. Electrical
  3. Electronic
- C. Time
  1. Clock
  2. Electronic
     a. Time Delay
     b. Time Interval

VI. Actuating Devices
- A. Solenoids
  1. AC, DC
  2. Pull, Push, Rotary
- B. Relays
  1. Electromechanical
  2. Stepping
  3. Latching
  4. Meter
  5. Thermal
  6. Electronic

C. Synchros
   1. Transmitters
   2. Receivers
   3. Differential
   4. Control Transformer
   5. Circuits

D. Servomotors
   1. Electric
   2. Hydraulic

E. Fluid (Gas or liquid)
   1. Cylinder
   2. Rotary
   3. Diaphram
   4. Valves

F. Miscellaneous Devices
   1. Saturable Reactors
   2. Magnetic Amplifiers
   3. Fluidic Amplifiers
   4. Variable Transformers

VII. Control Devices
   A. Pneumatic
   B. Hydraulic
   C. Electric

VIII. Applications *
   A. Analysis of Servomechanisms
   B. Air conditioning system
   C. Speed Control for Paper Making or Tin Plating of steel

* See References below for information.

Texts and References:

Holzbock, Automatic Control, Reinhold Publishing Corp.

Marcus, Automatic Industrial Controls, Prentice-Hall Pub. Co.

Bulliet, Servomechanisms, Addison-Wesley.

Haines, Automatic Control of Heating and Air Conditioning, McGraw-Hill Book Co., Second Edition.

*Zoss and Delahooke, Theory and Applications of Industrial Process Control, Delmar.

*Siskind, Electrical Control Systems in Industry, McGraw Hill Book Co.

Tucker and Wills, Simplified Technique of Control System Engineering, Minneapolis-Honeywell Regulator Co., Brown Instruments Div.

Ruiter and Murphy, Basic Industrial Electronic Controls, Holt, Rinehart and Winston, Inc.

Considine, Process Control Instruments, McGraw-Hill Book Co.

Sipkind, Electrical Machines, McGraw-Hill Book Co., Second Ed.

Course Title: Communication Skills

Hours Required: Class, 3 hours; Laboratory, 0 hours

Prerequisites: English Composition

Course Description and Objectives:

A study of the fundamentals of public speaking including topic selection, organization, and effective speaking. The methodology of technical writing will be included and laboratory reports will be graded on their structure and grammar as well as the technical content.

Major Divisions:

I. Organizing a Speech
II. Presenting Speeches Effectively
III. Techniques of Technical writing
IV. Transitions, Introductions, and Conclusions
V. Report Layout

Outline of Instruction:

I. Organizing a Speech
   A. Selecting a topic
   B. Library research
   C. Organizing material
   D. Organizing notes
   E. Arranging visual aids

II. Presenting Speeches Effectively
   A. Reading the speech
   B. Making a speech
   C. Conferences
   D. Graphic Aids

III. Techniques of Technical Writing
   A. Definitions
   B. Descriptions
   C. Classification and Partition
   D. Interpretation

IV. Transitions, Introductions, and Conclusions
   A. How to write a transition
   B. Where to put transitions
   C. Introductions
   D. Conclusions and summaries

V. Report Layout
   A. Introduction
   B. Elements of the formal report
   C. Relation of format and style
   D. Graphic aids

Texts and References:

Weiss and McGrath, *Technically Speaking*,

Hays, *Principles of Technical Writing*,

Selected reports from industrial organizations.

Course Title: **Digital Computing Systems**

Hours Required: **Class, 3 hours; Laboratory, 6 hours**

Prerequisites: Digital Computer Fundamentals

Course Description and Objectives:

A study of the computer as a system: Its external data forms and functions; data input, program flow charts, instructions, programs.

The use of the digital computer and its peripheral equipment as a total system requires an understanding of man-to-computer communication, thus 1401 machine language, SPS, and AUTOCODER are presented in some depth. Other languages are considered.

The course will:

1. Provide the student with basic understanding and with practical applications of software and hardware data processing system concepts, and to introduce SPS, Autocoder, Fortran and other data processing languages.

2. Foster in the student a deeper understanding of the ways in which data processing systems can be utilized in modern scientific, commercial and industrial endeavors.

3. Promote an appreciation by the student of his place in the rapidly changing world of computers, automation and data processing systems.

Major Divisions:

I. The Nature and Challenge of Data Processing
II. Input Means and Methods
III. The Coding of Information: Machine Oriented Languages
IV. Miscellaneous Systems Operations
V. Procedure Oriented Languages
VI. A Specific Data Processing Application: Admissions/Registrar
VII. Other Hardware Systems
VIII. Data Processing Systems Using Other Techniques

Outline of Instruction:

I. The Nature and Challenge of Data Processing
   A. Basic ideas
   B. Data processing: Hardware systems
   C. Data Processing: Software applications to the hardware
   D. Sequential file processing

II. Input Means and Methods
   A. The presentation of information to the computer
   B. Punched cards, layout and format
   C. Punched tape, layout and format
   D. Document readers
   E. Tape, disk and drum as input media

III. The Coding of Information: Machine Oriented Languages
- A. Addressing core memory
- B. Instructions versus data in core memory
- C. Simple arithmetic instructions and data
- D. Comparisons of coding: Cards, punched tape, magnetic tape, disk, drum
- E. Comparisons of accessing different media
- F. Branching; Loops and Address Modification
  1. Flexibility of the branching idea
  2. Applications and operations involving branching
  3. A practical case study: Calculation of GPA
  4. Computations for varying addresses
  5. Counting and comparisons: Loops
  6. Modifying addresses via loops
  7. Indexing and index registers
  8. A practical case study: Table of square roots
- G. Symbolic Programming System
  1. Flowcharting - the outlining of programs
  2. Machine versus symbolic languages
  3. SPS language and the need for an SPS processor
  4. Limitations of the simple SPS approach
  5. A practical case study: Payroll

IV. Miscellaneous Systems Operations
- A. Editing and Tabulating
- B. Carriage Control
- C. Timing of input and output operations
- D. Calculations of the time required by a whole program
- E. Subroutines and utility programs
- F. A practical subroutine development: Multiply

V. Procedure Oriented Languages
- A. The Autocoder
  1. Basic concepts - importance and applications
  2. Constants, instructions and data
  3. Arithmetic operations
  4. Logic operations
  5. Data moving operations
  6. Miscellaneous: Clear storage, set or clear word marks, halt, etc.
  7. Input-output operations
- B. Autocoder Practice Problems
  1. "Employee Fund" program
  2. "Charge Account" program
  3. "Payroll" program
- C. Advanced Proceedures
  1. Program flowcharts and work flowcharts
  2. Sequential data handling via magnetic tape
  3. Reading and writing tape check procedure
  4. Random access data handling via magnetic disks
  5. Disk checking procedures

D. FORTRAN Language
   1. Special needs for scientific programming languages
   2. What is a "more powerful" language or system?
   3. Fortran coding: Control instructions
   4. Fortran coding: Input-output instructions
   5. Fortran coding: Indexing, counting and loops
   6. Fortran subroutines and their applications
   7. Variations in Fortran for various data processing systems

E. COBOL and ALGOL Languages
   1. Special needs for business oriented languages
   2. Forms and formats
   3. COBOL instructions
   4. Example of program using COBOL
   5. ALGOL: Description, applications and example

VI. Specific Data Processing Application: Admissions/Registrar
   A. The total problem
   B. Information flow and data formats
   C. Intermediate outputs
   D. Sequence of reports and other output data
   E. The team approach to coding the program
   F. Tests and checks

VII. Other Hardware Systems
   A. Comparative listings and how to read them
   B. Shared time and real time systems
   C. Computer Systems
      1. Various manufacturers

VIII. Data Processing Systems Using Other Techniques
   A. Automatic programmed tooling (APT)
   B. Remote terminals, their problems and applications
   C. Computer-controlled machines
   D. Programmed pipelines
   E. Space flights and computers

Texts and References:

Leeds, Herbert D., and Gerald M. [illegible]g, Computer Programming Fundamentals, Second Edition, McGraw-Hill Book Co.

McCracken, Daniel D., A Guide to IBM 1401 Programming, John Wiley and Sons, Inc.

Bartee, Thomas C., Digital Computer Fundamentals, Second Ed., McGraw-Hill Book Co.

Benrey, Ronald M., Understanding Digital Computers, John F. Rider Pub. Co.

Burroughs Corporation, Digital Computer Principles, McGraw-Hill Book Co.