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ABSTRACT

This guide offers information and procedures necessary to train mechanical engineering technicians. Discussed first are the rationale and objectives of the curriculum. The occupational field of mechanical engineering technology is described. Next, a curriculum model is set forth that contains information on the standard mechanical engineering technology curriculum, electives, and related courses. Each course description contains some or all of the following: a discussion of the content of the course, a list of course prerequisites, credit hours to be awarded for completion of the course, a course outline, a list of student competencies addressed in the course, and a list of recommended texts. Course descriptions are provided for 5 courses in the social and related sciences, 6 courses in mathematics and science, and 18 technical courses. Concluding the guide is a section dealing with equipment needed to implement the curriculum. Appendixes to the guide contain guidelines for implementing a problems course, a list of technical organizations and societies, and a list of technical publications and periodicals. (MN)

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MECHANICAL ENGINEERING TECHNOLOGY CURRICULUM

**Developed and Produced
Under Contractual Agreement with**

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Office of Vocational Education
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1984**

high technology advisory council

July 3, 1984

M E M O R A N D U M

TO: The People of Georgia

FROM: R. E. Morrison, Jr., Ph.D.
High Technology Coordinator

RE: Preface to the Engineering Technology Curriculum

In the past two years, Georgia has taken the lead in human resource development of engineering technicians for the state's industry. This lead ensures that the industries locating in Georgia, or existing industries planning expansion or retooling will have a readily available supply of highly skilled, educated, and technically adaptable technicians. Over two million Georgians have been trained in the past twenty years in the state's network of thirty technical schools, junior and community colleges.

A quantum step was taken in 1982 when the General Assembly appropriated over $13 million to upgrade the technical school programs to "state-of-the-art" in the electronics, electromechanical and mechanical technologies. In that allocation were directives to develop two year engineering technology programs in the same three fields. These two year programs for a degree of Associate of Applied Technology were begun in September, 1982. The new curriculum, highly qualified technical staff, the latest in instructional equipment and a highly motivated student body are now in place. Our first graduating classes enter the "World of Work" in June 1984. The rhetoric of what should be done is behind us; high technology training for engineering technicians is a fact in Georgia.

New and expanding industries will find a new atmosphere of cooperation where the human resources required to ensure a skilled technician workforce is available. Productive and credentialed employees are available with a positive attitude toward change, adaptability, flexibility and upward mobility.

Each of the three high technology programs is based upon a solid foundation of mathematics, physics and an understanding of the fundamentals basic to the technologies. An understanding of systems, close ties to local business and industry, computer literacy, and characteristics of the high technology programs.

The Georgia "High Technology Advisory Council" was appointed by the Governor as a blue ribbon committee to advise the executive branch of government, the General Assembly, the Board of Education, the Board of Regents and the new Board on Post Secondary Vocational Education regarding high technology and engineering technology education issues. The council is composed of 12 high technology industry representatives in the state and is coordinated by the High Technology Coordinator.

Georgia's commitment to industry, "hi-tech" and quality training is now in place. Contained herein are the coordinated pieces that make up a comprehensive and viable program in the engineering technologies. It is in the basics - this is and will be the difference in Georgia's human resource development product.........the engineering technician.

MECHANICAL ENGINEERING TECHNOLOGY CURRICULUM

DEVELOPED BY

THE HIGH TECHNOLOGY CURRICULUM PROJECT

VOCATIONAL AND CAREER DEVELOPMENT DEPARTMENT

GEORGIA STATE UNIVERSITY

ATLANTA, GEORGIA

HARMON R. FOWLER, DEPARTMENT CHAIRMAN

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Education for The Technician: An Introduction

RATIONALE

Relevant education and training to prepare engineering technicians is a critical concern for the productivity needs of this nation. As new and changing technologies and processes for manufacturing, construction, communication, energy, and research and development occur with great rapidity, the need for engineering assistants who can perform the "nuts-and-bolts" problem-solving tasks associated with current technology has increased significantly. Modern industial and engineering devices that are multisystem in nature require the sort of developmental, maintenance, support, and operational personnel who can change, adjust, and adapt to new situation and utilize increasingly sophisticated hardware with a minimum of retraining. In all, this trend toward innovation as the status-quo has heightened the need for a trained technician who combines theoretical and conceptual knowledge with the manipulative, "hands-on" skill of an artisan or craftsman. It is toward this end that modern technical education must be focused. The remainder of this document offers information and procedures necessary to train engineering technicians who can make a contribution in the emerging technologies.

PURPOSE AND OBJECTIVES

PURPOSE

The purpose of the Engineering Technology Program in Georgia is to produce specialists who possess the broad base of knowledge, skill, and attitude necessary to be productive in modern technical occupations that are characterized by rapid change and highly sophisticated content.

OBJECTIVES

1. To provide basic knowledge, skill, and attitude development based on a systematic analysis of the occupational domain to be served.
2. To produce a technician who is able to deal with the complex systems interactions that characterize modern technological environments.
3. To provide program options that allow in-depth study in specialized areas of the occupational domain beyond the basic skill level.
4. To provide for awarding of credit leading to an associate degree credential, as well as options toward other degree credentials.
5. To provide instruction that maximizes the application of knowledge, skills, and attitudes to real work situations.
6. To provide instruction that prepares the student for the complex problem-solving nature of highly technical occupations.
7. To fully coordinate the high-technology program with needs of business and industry through a process of school-community-business inter-cooperation.
8. To provide a system of instruction that is fully responsive to, and perceptive of, the intrinsic nature of change and innovation in highly technical occupations and disciplines.

TECHNICIANS DEFINED

In general the work role of the engineering technician falls between that of the vocational-industrial tradesman and that of the professional engineer. This is a broad range and is ill-defined in practice, having gray areas of work requirements at either end of the continuum and at many points in between. Perhaps the best way to define a technician is by a summary of tasks performed and the accompanying skills required. This must of necessity be done in a broad and generalized fashion with provisions for more specificity left to individual job descriptions. (The basis for this description may be found in a U.S. Office of Education research report entitled Occupational Criteria and Preparatory Curriculum Patterns in Technical Education Programs.)

It is generally agreed that the engineering technician must have the following kinds of special skills and and abilities:

1. Proficiency in the use of the disciplined and objective scientific method in practical application of the basic principles, concepts, and laws of physics as they comprise the scientific base for the individual's field of technology.
2. Facility with mathematics; ability to use algebra and trignometry as problem-solving tools in the development and definition of, or to quantify, scientific phenomena or principles; and, when needed, an understanding of - though not necessarily facility in - higher mathematics through analytical geometry and some calculus according to requirements of technology.
3. A thorough understanding and facility in the use of materials, processes, apparatus, procedures, equipment, methods, and techniques commonly used in the technology.
4. An extensive knowledge of a field of specialization with an understanding of applications of the underlying physical sciences as they relate to the engineering or industrial processes, or research activities that distinguish the technology of the field. The degree of competency and depth of understanding should be sufficient to enable technicians to establish effective rapport with scientists, managers, and engineers with whom they work and to enable them to perform a variety of detailed scientific or technical work as outlined by general procedures or instructions, but requiring individual initiative, and resourcefulness in the use of techniques, handbook information, and recorded scientific data.

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

Activities Performed

Technicians are expected to perform work tasks and/or support to engineers related to any of a combination of the following kinds of activities:

1. Applies knowledge of science and mathematics extensively in rendering direct technical assistance to physical scientists or engineers engaged in scientific research and experimentation.
2. Designs, develops, or plans modifications of new products, procedures, techniques, processes, or applications under supervision of scientific or engineering personnel in applied research, design, and development.
3. Plans, supervises, or assists in installation and inspection of complex scientific apparatus, equipment, and control systems.
4. Advises regarding operation, maintenance, and repair of complex apparatus and equipment with extensive control systems.
5. Plans production or operations as a member of the management unit responsible for efficient use of manpower, materials, money, and equipment or apparatus in mass production or routine technical service.
6. Advises, plans, and estimates costs as a field representative of a manufacturer or distributor of technical appartus, equipment, services, and/or products.
7. Assumes responsibility for performance of tests of mechanical, hydraulic, pneumatic, electrical, or electronic components or systems in the physical sciences and/or for determinations, tests and/or analyses of substances in the physical and other engineering-related sciences; and/or for determinations, tests and/or analyses of substances in the physical and other engineering-related sciences; and prepares appropriate technical reports covering the tests.
8. Prepares or interprets engineering drawings and sketches, or writes detailed scientific specifications or procedures for work related to physical sciences.
9. Selects, compiles, and uses technical information from references such as engineering standards, procedural outlines, and technical digests of research findings.
10. Analyzes and interprets information obtained from precision measuring and recording instruments and/or

special procedures and techniques and makes evaluations upon which technical decisions are based.

11. Analyzes and diagnoses technical problems that involve independent decisions and and judgement that require, in addition to technical know-how, substantive experience in the occupational fields.
12. Deals with a variety of technical problems involving many factors and variables that require an understanding of applied scientific and technical understanding - the antithesis of narrow specialization.

It is recognized that no two-year technical training program will be sufficient to prepare engineering technicians for all the problems they will encounter in the workplace. The training should however be sufficient to:

1. Provide occupational skills that are compatible with at least entry-level employment in the chosen field.
2. Provide a broad base of knowledge in science, mathematics, and technical subjects that will allow the technician to progress to higher levels of job competence in an environment characterized by rapid change and innovation.

A DESCRIPTION OF MECHANICAL ENGINEERING TECHNOLOGY AND THE RELATED OCCUPATIONAL FIELD

Mechanical engineering technology is concerned with mechanical devices and systems. Mechanics is the study of physical systems under the action of forces such as gravity and friction. Mechanical systems, like all engineering systems, are designed to accomplish work with the most efficient energy use possible. The physical forces of nature have to be taken into account in the design of mechanical systems. Sometimes these forces can be employed to aid work (as in soda machines that use gravity to dispense the can or bottle), and sometimes they must be minimized (as in the lubrication of automobile wheel bearings to reduce friction). You are probably familiar with many of the elements of mechanical systems: belt drives, gear drives, cams, helical screws, pistons, linkages, bearings, fans and blowers, and valves. These and other elements are combined in various ways to create complex integrated mechanical systems.

Mechanical engineering technicians may be involved in the design, construction, maintenance, repair, quality assurance/quality control, research and development, or sales of mechanical systems.

Mechanical engineering technicians assist engineers in design and development work by making freehand sketches and rough layouts of proposed machinery and other equipment parts. This work requires knowledge of mechanical principles involving tolerance, stress, stra[illegible] [illegible]ction, and vibration factors. They analyze the co[illegible] and practical value of designs.

In planning and testing experimental machines and equipment for performance, durability, and efficiency, techicians record data, calculate the results (sometimes with the aid of computers) plot graphs, analyze results, make models, and write reports. They sometimes recommend design changes to improve performance. Their job often requires skill in the use of complex instruments, test equipment, and gauges, as well as in the preparation and interpretation of drawings.

When a product is ready for production, mechanical engineering technicians help to prepare layouts and drawings of the assembly process and of parts to be manufactured. They may prepare specifications for materials, devise tests to ensure product quality, or study ways to improve efficiency. They frequently help to estimate labor costs, equipment life, and plant life. They often supervise production workers to make sure that they follow prescribed plans and procedures. Some mechanical engineering technicians test and inspect machines and equipment in manufacturing departments or work with engineers to eliminate production problems. Automated manufacturing and industrial processes require a thorough knowledge of computer applications. This type of work often requires considerable imagination and ingenuity.

MACHINE AND TOOL DESIGN

Machine and tool designers are among the better-known specialists in mechanical engineering technology. Machine tools are stationary, power-driven devices used to shape or form metal by cutting, impact, pressure, electrical techniques, or a combination of these processes. Most machine tools are named for the way in which they shape metal. For example, commonly-used machine tools include boring machines, milling machines, lathes, drilling machines, and grinders. The most outstanding characteristic of machine tools is their precision of operation. In this century, the accuracy of machine tools has improved from a thousandth of an inch to about a millionth of an inch. This precision makes possible the production of thousands of identical parts that may be interchanged easily in the assembly or repair of final products. The interchangeability of parts, made possible by machine tools, is the most important requirement for the mass production of goods.

Common processes that mechanical engineering technicians perform, according to their specialty area, include the following:

- Analyze requirements and establish design criteria.
- Prepare sketches.
- Make or supervise the making of detailed drawings.
- Test equipment.
- Redesign existing equipment.
- Prepare reports

Technicians in the area of machine and tool design may work with the following equipment:

- Boring machines
- Milling machines
- Drilling machines
- Grinding machines
- Lathes
- Micrometers
- Verniers
- Optical measurers
- Drafting equipment
- Dies
- Presses
- Gauges
- Blueprints
- Hand tools
- Cutting oils
- Calipers
- Jigs
- Fixtures
- Lubricating oils

QUALITY ASSURANCE/QUALITY CONTROL AND NONDESTRUCTIVE TESTING

Mechanical engineering technicians in the area of quality control inspect and test incoming materials, production processes, and final products to ensure that they meet the manufacturer's specifications and quality standards. Because accuracy is important in testing, often the technician uses a wide variety of precision measuring devices to check performance parameters for a given product. Sample size, frequency, and other statistical procedures are used to ensure that products receive adequate testing.

Mechanical engineering technicians often carry out nondestructive tests on materials and products to determine whether they meet required specifications and standards. Nondestructive testing refers to any test method that does not involve damaging or destroying the test sample. With the advent of X-rays, ultrasonics, and other innovations, nondestructive testing has become widely applicable in many manufacturing processes.

Some of the basic mechanical test processes include the following:

- Tensile tests to determine proportional limit, yield points, modulus of elasticity, elongation, and reduction in area.
- Hardness tests to determine resistance to penetration.
- Bend tests to determine elasticity of a part under load.
- Notch bar, impact, or fatigue tests to determine endurance limits or the fatigue strength of a part.
- Torsion tests to determine yield strength and utlimate sheer stress of a part.
- Creep tests to determine the amount of permanent set in a given time for a given temperature.

Some of the basic types of nondestructive test processes are :

- Visual tests including optical devices.
- Penetrant tests using magnaglo and black lights.
- Penetrant tests using liquid dyes.
- Magnetic particle tests using dry or wet magnetized materials.
- Ultrasonic tests using the pulse-echo system.
- Radiographic tests using X-rays or gamma rays.

Those technicians who specialize in quality assurance/quality control, performance testing, and nondestructive testing must have a knowledge of the following equipment:

- Lenses
- Mirrors
- Microscopes
- Projectors
- Comparators
- Search coils cameras
- Magnets
- Transducers (quartz, barium titanate, and lithium sulfate crystals)
- Scintillation crystals
- Xeroradiographic equipment
- Fatigue testers
- Fluorscent materials
- Dyes
- Lights
- Television cameras
- Still and motion-picture cameras
- Fluoroscopes
- Penetrameters
- Scleroscopes
- Computers
- Holographs
- Hardness testers
- Tensile testers
- Toughness testers
- Geiger counters
- Extensometers

COMPUTER NUMERICAL CONTROL

Some mechanical engineering technicans work in close coordination with the machine tool operator, the part programmer, the production planner, and drafter in the production of machined parts in a numerically controlled tool operation. Computer numerical control (CNC) involves the use of the electronically programmed instructions through a digital computer. Simply stated, the computer directs the actions of the machine. A thorough knowledge of drafting, tooling, programming, tape programming, and inspecting is essential for the mechanical enginerring technician who is specializing in the numerical control process.

Convential machine tools are generally capable of one operation, such as drilling or milling. The metal, ceramic, or plastic piece being worked on is transferred by hand from one machine tool to the next. CNC makes possible the design of machines that can perform multiple operations. Some CNC machines can perform tasks that cannot be carried out at all on conventional machines.

The computer numerical control programming specialty area requires the use of the same equipment as the machine and tool design specialty. The major difference is that the machines are controlled by numerical controlled devices. The emphasis is then on the following equipment:

- Microprocessors
- Teletypewriters
- Punched Tape
- Punched Cards
- Light pens
- Digitizers

COMPUTER-AIDED DESIGN

The mechanical engineering technician who specializes in computer-aided design (CAD) might work with designers, engineers, drafters, or detailers in producing the engineering drawings used in manufacturing processes, particularly those that use numerical control. In computer-aided design, a computer is programmed with a set of equations that describe the structure and properities of a machine component and is able to produce perspective drawings of the component as seen from any angle. A thorough understanding of spatial relationships, the ability to visualize objects, and an understanding of physical and mathematical concepts are required to use computers in this way. Familiarity with computer capabilities, machine tools, and design parameters enables the mechanical engineering technician to define a part, shape it, and analyze stresses nad deflections. All of this can be done from the same graphics terminal of the computer-aided design system.

The mechanical engineering technician who specializes in computer-aided design uses the following equipment:

- Standard drawing equipment
- Digitizers
- Drafting Tables
- Rubber platens
- Light Pens
- Microprocessors
- Plotters
- Drums
- Punched Tapes
- Punched Cards
- Magnetic tape
- Printers

TYPICAL JOB TITLES AND WORK SETTINGS

The mechanical engineering techinician occupational area includes occupations concerned with the application of principles of physics and engineering for the generation, transmission, and the use of heat and mechanical power. Included are the design, production, installation, and maintenance of fabricated metal products, tools, machines, machinery and associated or auxiliary systems. Accessory techniques needed may be those used in electrical, metallurgical, nuclear, and civil engineering.

Job titles are determined by the function or the engineering field in which the technician works. Typical general titles are – engineering technician, laboratory-development technician, or mechanical technician. Specialized job titles relating to this course are – machine tool technician, die technician, quality-control technician, numerical control tool programmer, and computer-assisted drafter/designer.

Mechanical engineering technicians work under a wide variety of conditions. Most work regular hours in laboratories and industrial plants. Others work part of their time outdoors.

The following is a description of Mechanical Engineering technician taken from the Dictionary of Occupational Titles published by the Department of Labor:

007.161-026 MECHANICAL-ENGINEERING TECHNICIAN (PROFESSIONAL AND KINDRED)ENGINEERING TECHNICIAN; EXPERIMENTAL TECHNICIAN; LABORATORY-DEVELOPMENT TECHNICIAN; MECHANICAL TECHNICIAN

Develops and tests machinery and equipment, applying knowledge of mechanical and engineering technology, under the direction of engineering and scientific staff: Review project instructions and blueprints to ascertain test specifications, procedures, objectives, test equipment, nature of tecnical problem, and problem solutions, such as part redesign, substitution of material or parts, or rearrangement of parts of subassemblies. Drafts detail drawing or sketch for drafting room completion or to request parts fabrication by machine, sheet metal or wood shops. Devices, fabricates, and assembles new or modified mechanical components or assemblies for products, such as industrial equipment and machinery, power equipment, servosystems, machine tools, and measuring instruments. Sets up and conducts tests of complete units and components under operational conditions to investigate design proposals for improving equipment performance or other factors, or to obtain data for development, standardization, and quality control. Analyzes indicated and calculated test results in relation to design or rated specifications and test objectives, and modifies or adjusts equipment to meet specifications. Records test procedures and results, numerical and graphical data, and recommendations for changes in product or test method.

CAREER OPPORTUNITIES

In 1980 about 885,000 persons worked as engineering and science technicians. Employment opportunities are expected to be favorable through the 1980's, with employment of technicians growing faster than the average for all occupations. Graduates of a postsecondary school technician training program, particulary programs in which students gain practical work experience, are excellent candidates for employment as mechanical engineering technicians.

Industrial expansion and the increasing complexity of modern technology underline the anticipated increase in demand for technicians. Many will be in needed for work with the growing number of engineers and scientists in developing, and producing, and distributing new and technically advanced products. Automation of industrial processes and the growing importance of environmental protection, energy development, and other areas of scientific research will add to the demand for technicians.

TABLE 1. PROJECTED JOB OPENINGS IN GEORGIA FOR HIGH-TECHNOLOGY INDUSTRY

YEARS	RANK	TECHNOLOGY	"Most likely" Average Annual Job Openings
1980-1985	1	Computer/Computer Services	4,872
	2	Communications	1,884
	3	Avionics	800
	4	Robotics/Automation	643
	5	Fiber/Laser Optics	170
	6	Biology	80
	7	Solar Energy	9
1985-1990	1	Computer/Computer Services	5,472
	2	Communications	3,475
	3	Avionics	1,074
	4	Robotics/Automation	848
	5	Fiber/Laser Optics	315
	6	Biology	160
	7	Solar Energy	20
1990-2000	1	Communications	7,220
	2	Computer/Computer Services	6,222
	3	Avionics	1,713
	4	Robotics/Automation	1,244
	5	Fiber/Laser Optics	800
	6	Biology	450
	7	Solar Energy	93

Table 1. (Source - "An Advanced Technology Development Study for Georgia Vocational Technical Schools" Georgia Institute of Technology, 1981.)

INNOVATIONS AND TRENDS

The rapid advances made in the computer industry have created a need for individuals who are familiar with the capabilities and limitations of computers. Many of the traditional processes of manufacturing are undergoing changes as a result of technological advances made, particularly in the area of electronics. The use of computers to assist in the analysis of designs, the production of visual instructions for the manufacturer, the driving of production machines, and the rapid accumulation of data used by the inspectors has resulted in the accumulation and elimination of hundreds of thousands of jobs. Significant gains in productivity resulting from automated production, improved machinery, and availability of synthetic materials and metal alloys, and other technological breakthroughs have permitted large increases in output without additional workers. This realignment of the traditional manufacturing process to automation requires production workers to who have an understanding of the entire system as opposed to an understanding of just one machine. Computer-assisted design, computer assisted drafting, and computer numerical control machines are innovations that are changing the industry at a rapid rate.

This trend toward increasing automation will continue at a rapid rate as more research and development efforts discover new and innovative ways of increasing production. There will be an increasing need to update those presently employed as well as an incresing need for technicians who are skilled in these new technologies.

COURSES FUNDAMENTAL TO MECHANICAL ENGINEERING TECHNOLOGY

Although persons can qualify for technician jobs through many combinations of work experience and education, most employers prefer those who have had some specialized training. Specialized training is available at technical institutes, junior and community colleges, area vocational-technical schools, extension divisions of colleges and universities, and vocational-technical high schools.

People who like to know how things work, who like to "tinker", with machinery, and who enjoy making and using diagrams are likely to succeed as mechanical engineering technicians. The ability to use field and office engineering dimensions, coupled with the ability to do detailed work with a high degree of accuracy, are important in this field. For design work, creative talent is also desirable. Oral and written communications skills enhance the technician's ability to work with people and communicate ideas.

Mathematics (basic computation, algebra, and introductory trigonometry) and physics are cornerstones of knowledge for the mechanical and engineering technician. An interest in and motivation for these subjects is a "plus" for anyone entering mechanical engineering technology. Fortunately, many students who have entered technical school with a "math phobia" and an aversion to physics have found these subjects much easier when they are meaningfully applied to specific technological problems.

The courses offered in the pursuit of an associate degree in mechanical engineering technology are designed to develop the skills and aptitudes that employers desire. The following courses are fundamental to all areas for the Mechanical Engineering Technology degrees:

Mathematics

Physics

English and Composition

Technical Communication

Graphics

Computer Fundamentals

Strength of Materials

Engineering Materials

DC/AC Circuits

Mechanical Devices And Systems

- Statics and Dynamics
- Electromechanical Devices
- Fluid Power
- Economics
- Industrial Relations
- Manufacturing Process

Additional courses are offered that have emphasis in specialty areas.

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CURRICULUM MODEL

MECHANICAL ENGINEERING TECHNOLOGY
STANDARD CURRICULUM - QUARTER SYSTEM
(SUGGESTED SEQUENCE)

	Class	Lab	Contact Hour	Cr
First Quarter				
D.C. Circuits	4	3	7	5
Computer Fundamentals	3	6	9	5
Algebra	5	0	5	5
Engineering Graphics I	1	6	7	3
	13	15	28	18
Second Quarter				
Physics I	4	3	7	5
Trigonmetry	5	0	5	5
A.C. Circuits	4	3	7	5
English and Composition	5	0	5	5
	18	6	24	20
Third Quarter				
Physics II	4	3	7	5
Analytic Geometry and Calculus	5	0	5	5
Mechanical Devices & Systems	1	6	7	3
Elective (Group 1)	1	6	7	3
	11	15	26	16
Fourth Quarter				
Statics	4	3	7	5
Physics III	4	3	7	5
Technical Communications	5	0	5	5
Elective (Group 2)	1	6	7	3
	14	12	26	18
Fifth Quarter				
Electromechanical Devices	4	3	7	5
Elective (Group 3)	3	4	7	5
Economics	5	0	5	5
Dynamics	4	3	7	5
	16	10	26	20
Sixth Quarter				
Elective (Group 4)	1	6	7	3
Strength of Materials	4	3	7	5
Computer Aided Manufacturing (CAM)	1	6	7	3
Machine Design	4	3	7	5
	10	18	28	16
Seventh Quarter				
Industrial Relations	5	0	5	5
Fluid Power	3	4	7	5
Elective (Any Group)	3	4	7	5
MET Problems (Elective)	0	9	9	3
	11	17	28	18

Electives - Mechanical Engineering Technology Program

Third Quarter (Group 1)

* Engineering Graphics II

Computer Aided Drafting & Design (CAD) I

Fourth Quarter (Group 2)

Computer Aided Drafting & Design (CAD) I

Manuracturing Process I

Fifth Quarter (Group 3)

Engineering Materials

Manufacturing Process I

* Computer Aided Drafting & Design (CAD) II

Sixth Quarter (Group 4)

* Manufacturing Process II
* Computer Aided Drafting & Design (CAD) II

Seventh Quarter (Group 5)

* Any of the above

* Require completion of I series

IT IS RECOMMENDED THAT A STUDENT INTERESTED IN DESIGN AS A CAREER OPTION HAVE AT LEAST THE FOLLOWING COURSES.

Communications and Social Studies	20 hrs
Math and Science	30 hrs
Computers and Graphics	17 hrs
	67 hrs
Technical Core	
A.C. Circuits	5 hrs
Computer Aided Mfg.(CAM)	5 hrs
D.C. Circuits	5 hrs
Dynamics	5 hrs
Electromechanical Devices	5 hrs
Engineering Materials	5 hrs
Fluid Power	5 hrs
Machine Design	5 hrs
Mechanical Devices and Systems	5 hrs
Statics	5 hrs
Strength of Materials	5 hrs
	55 hrs
Electives	6 hrs
TOTAL	128 hrs

IT IS RECOMMENDED THAT A STUDENT INTERESTED IN MANUFACTURING AS A CAREER OPTION HAVE AT LEAST THE FOLLOWING COURSES.

Communications and Social Studies	20 hrs
Math and Science	30 hrs
Computers and Graphics	11 hrs
	61 hrs
Technical Core	
A.C. Circuits	5 hrs
Computer Aided Mfg. (CAM)	5 hrs
D.C. Circuits	5 hrs
Dynamics	5 hrs
Electromechanical Devices	5 hrs
Engineering Materials	5 hrs
Fluid Power	5 hrs
Machine Design	5 hrs
Manufacturing Processes I	3 hrs
Manufacturing Processes II	3 hrs
Mechanical Devices and Systems	5 hrs
Statics	5 hrs
Strength of Materials	5 hrs
	59 hrs
Electives	8 hrs
TOTAL	128 hrs.

SOCIAL AND RELATED STUDIES

COMPUTER FUNDAMENTALS

COURSE DESCRIPTION

This course will provide students with knowledge, skills, and attitudes to use the microcomputer as a tool to solve engineering technology problems typically encountered throughout their programs. Topics taught will include microcomputer architecture, programming concepts, branching, looping, arrays, functions, subroutines, data files, graphics and applications.

PREREQUISITE: Admission to the Program

CREDIT HOURS: 3-6-5

COURSE OUTLINE

	Student Contact Hours Class	Laboratory
I. Introduction to the Microprocessor A. Hardware B. Terminolgy C. Execution modes D. Programs	3	6
II. Introduction to Concepts of Programming A. Flowcharting B. Variable types C. Operations and formulas D. Simple BASIC programming E. Program comments F. Storage and retrieval of programs	3	6
III. Branching and Looping A. Relational operations B. Logical operations C. Conditional branching D. Multiple branching E. The stop statement F. Loops G. Nested loops	3	6
IV. Arrays A. Lists and tables B. Subscripted variables C. Defining arrays	3	6
V. Functions and Subroutines A. Library functions B. User functions C. Defining	3	6

	Student Contact Hours Class	Laboratory
D. Random numbers		
E. Defining subroutines		
F. Referencing subroutines		
VI. Data Files	3	6
A. Creating sequential data files		
B. Using sequential data files		
VII. Engineering Applications	3	12
A. Electronic technology problems		
B. Electromechanical technology problems		
C. Mechanical technology problems		
VIII. Graphics	3	6
A. Drawing bar charts		
B. Graphing functions		
C. Computer-generated imagery		

STUDENT LABORATORIES

- Execute instructor-supplied simple programs.
- Develop, debug, and execute a simple BASIC program.
- Save, retrieve, and execute a previously developed BASIC program.
- Create a data file, develop a program that will manipulate the file, and produce an acceptable output.
- Given a typical engineering program including all necessary equations and data, develop programs that will solve the problems and produce acceptable output.
- Develop, debug, and execute a program which will produce the answers in tabular form.
- Develop, debug, and execute an interactive program.

STUDENT COMPETENCIES

Upon completion of this course the student will be able to:

- Identify microcomputer hardware and define the associated terms.
- Execute pre-written programs.
- Write, save, retrieve, and execute simple programs in BASIC.
- Write BASIC programs using branching and looping statements.
- Write BASIC programs manipulating data using arrays.
- Write BASIC programs using library functions.
- Develop functions and subroutines and incorporate them into BASIC programs.

- Write programs that use and manipulate data files.
- Solve selected technology problems using the microcomputer.
- Define and identfy microcomputer hardware (microcomputer, keyboard, CRT, disk drive, cassette, printer, floppy disk).
- List execution modes (execution, command or immediate, systems, edit).
  (These may differ according to manufacturer.)
- Execute a BASIC program which has been stored on a disk.
- Enter via keyboard and execute a program which has been supplied by the instructor.
- Discriminate between keywords and control words.
- Construct a flowchart which will display the logic of a given program or problem.
- Determine whether or not a line number is necessary in a given expression.
- Construct BASIC statements to compute given formulas.
- Write a simple BASIC program.
- List and give examples of variable types (numeric, string, constant).
- Identify symbols used for arithmetic operations (Addition, subtraction, multiplication, division, and exponentation).
- Outline correct structure for BASIC programs (identification, purpose, process).
- SAVE a BASIC program on tape or floppy disk.
- Retrieve a program which has been stored.
- Write BASIC statements using relational operators (less than,greater than, less than or equal to, greater than or equal to, less than or greater than, equal to).
- Write BASIC statements using logical operator (AND, OR NOT).
- Write BASIC programs using IF-THEN-ELSE statements.
- Demonstrate use of STOP statement to halt program and check progress.
- Identify and code algorithms involving nested loops.
- Generate lists and tables using subscripted variables.
- List examples of subscripted string and numeric variables.
- Define an array using the DIM statement.
- List keywords used as library functions (trig functions ABS, INT, RND, AQR).
- Code a DEF FN statement.
- Code algorithms using GOSUB.
- Code statements using the TAB(N) function.
- Code algorithms which will accumulate.
- Build a data file which contains at least five records.
- Access data files which have been previously created.
- Write, debug, and execute at least one program which solves a problem in the student's major area of interest.
- Plot a given point on the CRT.

RECOMMENDED TEXTS

Bent, Robert J. and Sethares, George C. Basic: An Introduction to Computer Programming. 2nd ed. Monterey, CA: Brooks/ Cole Publishing Co., 1982.

Shelly, Gary and Cashman, Thomas, Introduction to BASIC Programming. Anaheim, CA: Anaheim Publishing Co., 1982.

ECONOMICS

COURSE DESCRIPTION

Basic principles of the American economic system of free enterprise will be covered. An emphasis will be placed not only upon the classic economic principles, but upon understanding these principles as they apply to current economic trends. The role of technical/technologically-oriented industries in the economics of today to be emphasized.

PREREQUISITE: None

CREDIT HOURS: 5-0-5

COURSE OUTLINE	Student Contact Hours: Class	Laboratory
I. Introduction (Basic Economic Concepts)	1	
II. Economic Forces and Indicators A. Economics defined B. Modern specialization C. Increasing production and consumption D. Measures of economic activity 1. gross national product 2. national income 3. disposable personal income 4. industrial production 5. employment and unemployment	2	
III. Capital and Labor A. Tools (Capital) 1. the importance of saving and investment 2. the necessity for markets B. Large-scale enterprise C. Labor 1. population characteristics 2. vocational choice 3. general education 4. special training 5. management's role in maintaining labor supply	3	
IV. Business Enterprise A. Forms of business enterprise 1. individual proprietorship 2. partnership 3. corporation B. Types of corporate securities	7	

	Student Contact Hours Class	Laboratory
1. common stocks		
2. preferred stocks		
3. bonds		
C. Mechanics of financing business		
D. Plant organization and management		
V. Factors of Industrial Production Cost	10	
A. Buildings and equipment		
1. initial cost and financing		
2. repair and maintenance costs		
3. depreciation and obsolescence costs		
B. Materials		
1. initial cost and inventory value		
2. handling and storage costs		
C. Processing and production		
1. methods of cost analysis		
2. cost of labor		
3. cost of supervision and process control		
4. effect of losses in percentage of original product compared to finished product (yield)		
D. Packaging and shipping		
E. Overhead costs		
I. Profitability and business survival		
VI. Price, Competition and Monopoly	5	
A. Function of prices		
B. Price determination		
1. competitive cost of product		
3. supply		
4. interactions between supply and demand		
C. Competition, benefits and consequences		
1. monopoly and oligopoly		
2. forces that modify and reduce competition		
3. history of government regulation of competition		
D. How competitive is our economy?		

	Student Contact Hours	
	Class	Laboratory
VII. Distribution of Income	2	
VIII. Personal Income Management	2	
IX. Insurance, Personal Investments and Social Security	3	
X. Money and Banking	3	

VII. Distribution of Income — 2

- A. Increasing real income
- B. Marginal productivity
- C. Supply in relation to demand
- D. Incomes resulting from production
  1. wages
  2. interest
  3. rents
  4. profits
- E. Income distribution today

VIII. Personal Income Management — 2

- A. Consumption - the core of economics
- B. Economizing defined
- C. Personal and family budgeting
- D. Analytical buying
  1. applying quality standards
  2. consumer's research and similar aids
- E. The use of credit
- F. Housing - own or rent?

IX. Insurance, Personal Investments and Social Security — 3

- A. Insurance defined
- B. Life insurance
  1. group, industrial, ordinary
  2. type of policies - advantages and disadvantages
- C. Casualty insurance
- D. Investments
  1. savings accounts and government bonds
  2. corporation bonds
  3. corporation stocks
  4. annuities
  5. pension plans
- E. Social Security
  1. old-age survivor's insurance
  2. unemployment compensation
  3. medicare

X. Money and Banking — 3

- A. Function of money
- B. The nation's money supply

Student Contact Hours: Class | Laboratory

- C. Organization and operation of a bank
    1. sources of deposits
    2. the reserve ratio
    3. expansion of bank deposits
    4. sources of reserves
- D. The Federal Reserve System
    1. service functions
    2. control of money supply
- E. F.D.I.C.

XI. Government Expenditures, Federal and Local [Class: 3]

- A. Economic effect
- B. Functions of government
- C. Analysis of government spending
- D. Future outlook
- E. Financing government spending
    1. criteria of sound taxation
    2. tax revenues in the U.S.
    3. the federal and state personal income taxes
    4. the coporate income tax
    5. the property tax
    6. commodity taxes

XII. Fluctuations in Production, Employment and Income [Class: 5]

- A. Changes in aggregate spending
- B. Output and employment
- C. Other factors affecting economic fluctuations
    1. cost-price relationships
    2. demand for durable goods
    3. supply of commodities
    4. effects of war
    5. inflation and deflation
    6. technology and automation
- D. Government Debt
    1. purposes of government
    2. how burdensome is the debt
    3. problems of debt management

XIII. The United States Economy in Perspective [Class: 4]

- A. Recent economic changes
    1. inflation and recession
    2. effects of trade imbalance

	Student Contact Hours	
	Class	Laboratory

3. new products and industries
4. increase in governmental controls

B. Present economic problems of U.S. economy
1. the world market
2. international cooperation
3. maintenance of prosperity and progress
4. economic freedom and security

C. Communism: nature and control by Soviet State
D. Problems common to all systems
E. Special economic problems of the U.S.

STUDENT COMPETENCIES:

At the conclusion of this course, the student will be able to:

- Define what is meant by economics in the traditional sense and state the importance of economics to today's business enterprises.
- Explain the relationship of productivity, balance of trade, and gross national product.
- Explain the roles of capital and labor in the American economic system.
- Contrast individual proprietorships, partnerships, and corporations as methods of business orgranizations.
- Explain how businesses are financed.
- Define and/or explain the importance of the following terms to production cost: capital outlay, materials, direct labor, indirect labor, scrappage and efficiency, materials shipping and handling, overhead, taxation and government regulation.
- Explain how free enterprise is different from monopolistic or socialistic economies.
- Define real income.
- Compute real income given gross income and relevant variables.
- Plan a personal budget.
- Plan a projected program of personal investment, savings, and insurance.
- Explain the meaning of money in economic terms.
- Discuss orally or in writing the effects of government regulation on business and economics.
- List and briefly describe three major problems which affect the American economy today.

RECOMMENDED TEXTS

Amacher. Principles of Economics. (Second Edition). Southwestern Publishing, 1983.

Heilbraner and Thuran. The Economic Problem. Prentice-Hall, 1981.

Olsen and Kennedy. Economics: Principles and Applications (Nineth Edition). Southwestern Publishing, 1978.

Theussen, et al. Engineering Economy. (5th Edition). Prentice-Hall, 1977.

ENGLISH AND COMPOSITION

COURSE DESCRIPTION

This course is designed to enhance the student's skill in writing, grammar usage and composition. Topics for student exercises may be chosen from material discussed or experienced in technical courses. Course material will serve to integrate basic communication skills with studies in technical subject areas. Topics to be covered include grammar, writing skills and composition.

PREREQUISITE: Admission to Program

CREDIT HOURS: 5-0-5

COURSE OUTLINE

	Student Contact Hours Class	Laboratory
I. Communications and the Technician	5	
II. Composition (Emphasis on Student Writing)	47	

I. Communications and the Technician
   A. Why the technician must be proficient
   B. Importance of written communications as an essential skill
   C. Study skills
      1. notetaking skills
      2. following written and oral instructions
      3. test-taking skills

II. Composition (Emphasis on Student Writing)
   A. Diction
   B. Sentence Review
      1. review of basic parts of speech
      2. complete sentences
      3. use and placement of modifiers, phrases, clauses
      4. sentence conciseness
      5. exercises in sentence structure
   C. Grammar usage
      1. capitalization
      2. punctuation
      3. subject-verb agreement
   D. Paragraph construction
      1. topic sentence
      2. development

3. unity and coherence
4. transistional devices

E. Narration, description, and exposition

F. Theme construction
1. thesis statement
2. transitions
3. conclusions

STUDENT COMPETENCIES

At the conclusion of the course, the student will be able to:

- Explain the need for effective written communication and an appreciation for the writing process.
- Use effective techniques for taking notes, following instructions, and taking tests.
- Analyze the ideas in essays related to technology and society.
- Recognize and articulate multiple points of view.
- Use commonly misused words correctly in basic sentences.
- Punctuate, capitalize, and spell correctly.
- Recognize and write simple, complex, compound, and complex-compound sentence structures.
- Rewrite ambiguous, wordy statements into clear, terse sentences.
- Recognize and write paragraphs using varied organizational techniques (cause and effect, description, definition, and so on).
- Write paragraphs containing well-defined topic sentences and develop each paragraph into a unified whole.
- Use transitional words and paragraphs to achieve coherence and unity in writing.
- Organize thoughts during the pre-writing stage using a written outline.
- Effectively write a unified, well-developed five paragraph theme following standard English grammer usage.

RECOMMENDED TEXTS

Hodges, John C., Whiten, Mary E., Harbrace College Handbook, 9th ed., New York, Harcourt, Brace, Jovanovich, 1982.

Lynch, Robert E. and Thomas, B. Swanzey, eds. The Example of Science: An Anthology for College Composition. Englewood Cliffs, NJ: Prentice-Hall, 1981.

Watkins, Floyd C. and Martin, Edwin T., Practical English Handbook, Boston, Houghton Mifflin.

INDUSTRIAL RELATIONS

COURSE DESCRIPTION

This course includes the study of the basis of human realtions and the organization of individual and group behavior. Leadership, organizational and social environments (including labor unions), career development, communications and group processes as well as selected operating activities are covered. Appropriate case problems are reviewed and discussed. Special emphasis is placed on typical industrial and business relationships in everyday situations.

PREREQUISITE: None

CO-REQUISITE: None

CREDIT HOURS: 5-0-5

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Fundamentals of Organizational Behavior	4	
A. Working with people		
B. Mainsprings of motivation		
C. Social systems		
D. Morale information and its use		
E. Developing a sound behavioral climate		
II. Leadership and Its Development	6	
A. The leadership role		
B. Effective supervision		
C. Development of participation		
D. Human relations training		
III. Organizational Environment	6	
A. Organizational structures		
B. Organizational dynamics		
C. The individual in the organization		
D. Informal organization		
IV. Career Development in Organizations	6	
A. Understanding career motivation		
B. Making career choices		
C. Attitudes and advancement		
D. Career development and management practices		

	Student Contact Hours Class	Laboratory
V. Social Environment	4	
A. Labor unions		
B. Working with unions		
C. Employment discrimination		
D. Managing scientific and professional employees		
E. Managing employees in international operations		
VI. Communications and Group Processes	10	
A. Communication with employees		
B. Communication groups		
C. Counseling and interviewing		
D. Group dynamics		
E. Managing change		
VII. Operating Activities	4	
A. Appraising and rewarding performance		
B. Using economic incentive systems		
C. Integrating work systems with people		
D. Understanding automation		
E. Organizational behavior in perspective		
VIII. Case Problems in Technical Organizations	10	

STUDENT COMPETENCIES

At the conclusion of the course, the student will be able to:

- List and describe 5 fundamental componenets of a sound organizational environment.
- Explain the critical role of leadership in developing an organizational climate.
- Describe the characteristics of an effective leader.
- List 4 basic types of organizational structures.
- Diagram an organizational structure and label components.
- Develop a personal career objective and explain the rationale for the choice.
- Discuss and evaluate the impact of unionization on the U.S. economy.
- Explain the importance of interpersonal communication in an organization.
- List and describe the various types of communication that are important at work.

- Explain the possible impact of automation on the people in an organization.
- Effectively formulate solutions to organizational problems presented by the instructor.

RECOMMENDED TEXTS

Yodar and Standohar, Personnel Management and Industrial Relations, Englewood Cliffs, NJ, Prentice-Hall, 1982.

Armine et al., Manufacturing Organization and Management, Englewood Cliffs, NJ, Prentice-Hall, 1982.

Everand and Shilt, Business Principles and Management, Southwestern Publishing, 1979.

TECHNICAL COMMUNICATIONS

Technical Communications will provide the student with working knowledge of the use of communication techniques, procedures, and formats used in industry and business. The student will learn accepted methods of describing devices and processes, and of making oral and written technical presentations. Also, proper use of written manuals, guides, specifications, and vendor instructions will be reviewed.

PREREQUISITE: English and Composition

CREDIT HOURS: 5-0-5

COURSE OUTLINE	Student Contact Hours Class	Laboratory
I. Introducing Technical Communications	3	
A. Purpose of course		
B. Definition of technical writing		
C. Basic principles of technical writing		
D. Style		
1. audience		
2. purpose		
3. scientific attitude		
E. Introduction to oral communication		
II. Conducting Research	6	
A. Completing preliminary steps		
B. Assembling sources		
1. searching subject heading indexes		
2. using the card catalog		
3. consulting specialized guides		
4. locating bibliographies		
5. using indexes and abstract services		
6. using reference materials		
C. Using research results		
1. taking notes		
2. assembling an annotated bibliography		
III. Planning the report	5	
A. Outlines		
1. outlining effectively		
2. rules for formal outlines		
B. Abstracts and introductory summaries		

Student Contact Hours

Class Laboratory

1. types of abstracts
2. suggestions for writing abstracts

IV. Writing Definitions
- A. What should be defined
  1. familiar words for unfamiliar things
  2. unfamiliar words for familiar things
- B. How definitions are constructed
  1. informal
  2. formal
     - a. class
     - b. distinguishing characteristics
     - c. summary of formal usage
     - d. additional suggestions for formal usage
  3. amplified definitions
- C. Where definitions should be placed

V. Describe Mechanisms
- A. Describing mechanisms
- B. Components of the description of a mechanism
  1. some potential problems
  2. specifications
- C. Describing malfunctions of a mechanism

VI. Describing Processes
- A. Describing a process
- B. Problems encountered in describing a process
- C. Instructions in a process
- D. Describing malfunctions of a process

VII. Putting Skills into Practice: Writing a Formal Technical Report
- A. Writing the rough draft
  1. prefactory pages
  2. body of the report
  3. appendix
- B. Editing the rough draft
- C. Producing the final copy

VIII. Presenting an Oral Technical Report

A. Oral and visual aspects of technical communications
B. Oral presentations and activities
   1. oral reports and presentations
   2. leading conferences and group discussions
C. Visual illustrations
   1. what illustrations can do
   2. types of illustrations
D. Presenting the oral report

STUDENT COMPETENCIES

- Explain the importance of technical communications to the engineering technician.
- Use appropriate reference materials in preparing a technical report.
- Write a formal and an informal outline for a technical report.
- Write an abstract for a technical report.
- Write appropriate definitions of technical terminology.
- Precisely describe the characteristics and components of mechanisms.
- Precisely describe the characteristics and componenets of processes.
- Prepare a formal technical report using accepted formats and style.
- Deliver orally an informative persuasive technical presentations using supportive visual aids.

RECOMMENDED TEXTS

Brenner, Ingrid, Mathes, J. C. and Stevenson, Dwight. The Technician As Writer. Indianapolis: Bobbs Merrill, 1980.

Messer, Ronald. Style in Technical Writing. Glenview, Il: Scott-Foresman, 1982.

Sherman, Theodore and Johnson, Simon. Modern Technical Writing, 4th edition. Englewood Cliffs, NJ: Prentice Hall, 1983.

MATHEMATICS AND SCIENCE COURSES

ALGEBRA

COURSE DESCRIPTION

This course is designed to develop and update algebraic skills required for engineering technicians as applied to the solution of practical problems encountered in electrical, mechanical, thermal, hydraulic, pneumatic, and optical technolcgies. Topics to be covered include functions and graphs, linear equations, determinants, factoring, quadratics, and the solution of right triangles.

PREREQUISITES: Admission to Program

CREDIT HOURS: 5-0-5

COURSE OUTLINE	Student Contact Hours Class	Laboratory
I. Fundamental Concepts and Operations A. Numbers and literal symbols B. Fundamental laws of algebra C. The laws of exponents D. Scientific notation E. Exponents and radicals F. Addition and subtraction of algebraic expressions G. Multiplication and division of algebraic expressions H. Equations and formulas	13	
II. Functions and Graphs A. Functions B. Cartesian coordinates C. Graphing functions D. Solving equations graphically	6	
III. Linear Equations and Determinants A. Linear equations B. Graphical solution of systems of two linear equations in two unknowns C. Algebraic solution of systems D. Solution by determinants of systems of two linear equations in two unknowns E. Algebraic solutions of three linear equations in three unknowns	11	

	Student Contact Hours	
	Class	Laboratory
F. Solution by determinants of systems of three linear equations in three unknowns		
IV. Factoring and Fractions	10	
A. Special products		
B. Factoring		
C. Simplifying fractions		
D. Multiplication and division of fractions		
F. Addition and subtraction of fractions		
V. Quadratic Equations	5	
A. Quadratic equations. Solution by factoring		
B. Completing the square		
C. The quadratic formula		
VI. Variation (optional)		
A. Direct		
B. Inverse		
C. Joint		

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Write concepts mathematically using numbers and symbols.
- Perform mathematical operations using the fundamental laws of algebra and the laws of exponents and radicals.
- Make mathematical computations using scientific notation.
- Perform algebraic operations of addition, subtraction, multiplication, and division on algebraic expressions.
- Perform basic mathematical operations on equations and formulas to solve for any given variable.
- Graph relations and functions with two variables.
- Graphically solve two linear equations with two unknowns.
- Algebraically solve two linear equations with two unknowns.
- Use determinants to solve three linear equations in three unknowns.
- Identify the general form of first, second, and third degree equation products in three unknowns.
- Factor into prime factors algebraic expressions containing common monomial factors.
- Factor the difference of two squares.
- Factor trinomial expressions.
- Factor perfect square trinomials.
- Change a given algebraic fraction into a specified equivalent fraction.

- Perform operations of addition, subtraction, mu'tiplication and division on algebraic fractions.
- Solve equations containing algebraic fractions.
- Solve quadratic equations by factoring.
- Solve quadratic equations by completing the square.
- Solve quadratic equations by use of the quadratic formula.
- Define trigonometric functions using the standard triangle.
- Solve right triangles.

RECOMMENDED TEXTS

Clar and Hart. Mathematics for the Technologies. Englewood Cliff, N.J.: Pretice-Hall, Inc.

Paul and Shaevel. Essentials of Technical Mathematics with Calculus. Englewood Cliffs, NJ.: Prentice-Hall, Inc.

Washington, Allyn J. Basic Technical Mathematics with Calculus. 3rd Edition. Benjamin Cummings.

TRIGONOMETRY

COURSE DESCRIPTION

This course is designed to develop trigonometric skills required for engineering technicians as applied to the solution of practical problems encountered in electrical, mechanical, thermal, hydraulic, pneumatic and optical technologies. Topics to be covered include trigonometric functions of angles, vectors, solutions to oblique triangles, graphs of trigonometric functions, j-Operator, identities, inverse functions and logarithms, exponents and radicals and additional solutions to systems and equations.

PREREQUISITE: Algebra

CO-REQUISITE: NONE

CREDIT HOURS: 5-0-5

COURSE OUTLINE

	Student Contact Hours: Class	Student Contact Hours: Laboratory
I. Trigonometric functions of any angle	4	
A. Signs of the trigonometric function		
B. Radian		
C. Applications of the use of radian measure		
II. Vectors and triangles	7	
A. Vectors		
B. Application of vectors		
C. Oblique triangles		
D. The law of sines		
E. The law of cosines		
III. Graphs of the Trigonometric Functions		
A. Graphs of Y=A sin x and Y=A cos x		
B. Graphs of Y=A sin bx and Y=A cos bx		
C. Graphs of Y=A sin (bx+c) and Y=csc x		
D. Graphs of Y=tan x, Y= cot x, Y=sec x, Y=csc x		
E. Application of the trigonometric graphs		
F. Composite trigonometric curves		
IV. Exponents and Radicals	7	
A. Positive integers as exponents		

	Student Contact Hours Class	Laboratory
B. Zero and negative integers as exponents		
C. Fractional exponents		
D. Simplest radical form		
E. Addition and subtraction of radicals		
F. Multiplication and division of radicals		
V. The j-Operator	9	
A. Imaginary and complex numbers		
B. Operations with complex numbers		
C. Graphical representation of complex numbers		
D. Polar form of a complex number		
E. Exponential form of a complex number		
F. Products, quotients, powers and roots of complex numbers		
IV. Properties of Trigonometric Functions	4	
A. Fundamental trigonometric identities		
B. Sine and cosine of the sum and difference of two angles		
C. Double-angle formulas		
D. Half-angle formulas		
E. Trigonometric equations		
VII. The Inverse of Trigonometric Functions	2	
A. Inverse trigonometric functions		
B. Principal values		
VIII. Logarithms	5	
A. Exponential and logarithmic functions		
B. Graphs of $Y = b^x$ and $Y = \log_b x$		
C. Properties of logarithms		
D. Logarithms to the base 10		
E. Logarithms to the base e		
F. Solutions of the exponential and logarithmic equations		
IX. Additional Solutions to Equations and Systems of Equations	6	
A. Graphical solution of systems of equations		

B. Algebraic solution of systems of equations
C. Equations in the quadratic form
D. Equations with radicals

STUDENT COMPENTENCIES

At the conclusion if this course, the student will be able to:

- Define the six trigonometric functions.
- Determine the sign of the function of an angle.
- Find the value of a given function of an angle.
- Find the value of the angle of the inverse trigonometric function.
- Convert between systems of angular measurement.
- Make trigonometric computations with angles measured in radians.
- Define vector quanities and give examples.
- Graphically represent a vector.
- Graphically add and subtract vectors.
- Use vectors to solve problems by resolving vectors into rectangular components.
- Solve oblique triangles using the laws of sines.
- Solve oblique triangles using the law of cosines.
- Graph the trigonometric functions Y = A sin x and Y = A cos x.
- Graph the trigonometric functions Y =sin (bx + c) and Y = A cos (bx +C).
- Graph the trigonmetric functions Y = A sin bx and Y = A cos bx.
- Determine amplitude, period, and phase of periodic (sinusoidal) motion.
- Graph the trigonometric functions Y = tan x, Y = cot x, Y = sec x, Y = csc x.
- Describe various types of motion in terms of the sine curve.
- Graphically combine two or more trigonometric curves.
- Perform operations involving algebraic expressions containing fractional components.
- Reduce radicals to simplest form.
- Perform operations wtih algebraic expressions containing fractional components.
- Define and describe the complex number system.
- Perform complex numbers graphically.
- Represent complex numbers graphically.
- Write complex numbers in polar form.
- Write complex numbers in exponential form.
- Calculate the product, quotient, powers, and roots of complex numbers.
- Recognize and verify the basic trigonometric identities.
- Prove the vallidity of trigonometric equations by means of the trigonometric identities.

- Compute the sine and cosine of the sum and difference of two angles.
- Compute the value of the sine and cosine of the double angle.
- Compute the value of the sine and cosine of the half angle.
- Recognize and define inverse trigonometric functions.
- Compute the principal value of a given trigonometric function.
- Recognize and define an equation in exponential form.
- Recognize and define an equation in logarithmic form.
- Graph exponential and logarithmic functions.
- Perform algebraic operations with logarithmic expressions using the properties of a logarithm.
- Write a number as a logarithm to the Base 10.
- Write a number as a logarithm to the Base e.
- Solve exponenetial and logarithmic equations.
- Graphically solve systems of first and second degree equations with two variables.

RECOMMENDED TEXTS

Clar and Hart, Mathematics for the Technologies. Englewood Cliffs, NJ: Prentice-Hall.

Paul and Shaevel, Essentials of Technical Mathematics with Calculus. Englewood Cliffs, NJ: Prentice-Hall.

ANALYTIC GEOMETRY AND CALCULUS

COURSE DESCRIPTION

This course is a survey course designed to develop analytic geometry and calculus skills required for engineering technicians as applied to the solution of practical problems encountered in electrical, mechanical, thermal, hydraulic, pneumatic, and optical technologies. Topics to be covered include analytic geometry, derivatives, integrals, differentiation and integration of polynomial functions and transcendental functions and integration techniques.

PREREQUISITES: Algebra, Trigonometry

CREDIT HOURS: 5-0-5

COURSE OUTLINE	Student Contact Hours Class	Laboratory
I. Elements of Analytic Geometry	8	
A. The straight line		
B. The circle		
C. The parabola		
D. The ellipse		
E. The hyperbola		
II. Sequences and Series (optional)		2
A. Finite sequences and series		
B. Infinite sequences and series		
C. Limit of a sequence or series		
III. Derivatives and Applications	15	
A. Limits		
B. The slope of a tangent to a curve		
C. The derivative		
D. Derivatives of polynomials		
E. Derivatives of products and quotients of functions		
F. The derivative of a power of a function		
G. The derivative as a rate of change		
H. Maximum and minimum problems		
I. Implicit differentiation		
IV. Integration and Applications	15	
A. Differentials and inverse differentiation		
B. The indefinite integral		
C. The area under a curve		
D. The definite integral		

	Student Contact Hours	
	Class	Laboratory
E. Finding area by integration		
F. Volume by integration		
G. Applications for the integral		
H. Trapeziodal rule or rectangula method for approximating areas (optional)		
V. Differentiation of transcendental functions	8	
A. Derivatives of the sine and cosine functions		
B. Derivatives of the other trigonometric functions		
C. Derivatives of the inverse trigonometric functions		
D. Derivatives of the exponential and logarithmic functions		
VI. Integration Techniques (Optional)	4	
A. The genral power formula		
B. The logarithmic and exponential form		
C. Basic trigonometric forms		
D. Integration by parts		
E. Integration by substitution		
F. Use of the tables.		

STUDENT COMPENTENCIES

At the conclusion of this course, the student will be able to:

- Find the straight-line distance between two points on a graph.
- Define and find the slope of a line.
- Write the equation of a straight-line given various properties of the line such as points on the line, slope and/or intercepts.
- Define a circle and write the equation of a circle with the center at (0,0) and with the center at any coordinate (x,y).
- Define and derive the equation of a parabola given appropriate data.
- Define and derive the equation of an ellipse given the appropriate data.
- Define and derive the equation of a hyperbola given the appropriate data.
- Find the sum of a finite arithmetic or geometric series and of other finite series.
- Find the nth term of a sequence.
- Find the sum of an infinite geometric series if one exists.
- Identify convergent and divergent sequences and series.

- Find the limit of an infinite sequence or series if it exists.
- Find the limit of an infinite sequence or series if it exists.
- Determine if a function is continuous.
- Determine the limits of a function if they exist.
- Find the slope of the tangent to a curve.
- Define and find the derivative of a function.
- Derive the derivatives of products and quotients of functions.
- Derive the derivative of a power of a function.
- Use differential calculus to solve problems involving rate of change.
- Use differential calculus to solve maximum and minimum problems.
- Use implicit differentiation to solve applied problems.
- Find the differential of a function.
- Find the antiderivative of a function.
- Define and find the indefinite integral of a function.
- Find the area under a curve.
- Define the definite integral of f (n).
- Find volume by integration.
- Apply integral calculus to solve problems involving moments of inertia, work, average values, etc.
- Compute derivatives of the sine and cosine functions.
- Compute derivatives of the other trigonometric functions.
- Compute derivatives of the inverse trigonometric functions.
- Compute derivatives of the exponential logarithmic functions.
- Integrate functions by use of the general power formula.
- Integrate functions in logarithmic and exponential form.
- Integrate the trigonometric functions.
- Perform integration by parts.
- Perform integration by substitution.
- Perform integration by use of tables.

RECOMMENDED TEXTS

Clar and Hart, Mathematics for the Technologies. Englewood Cliffs, NJ: Prentice-Hall.

Paul and Shaevel, Essential of Technical Mathematics with Calculus. Englewood Cliffs, NJ: Prentice-Hall.

Washington, Allyn J., Basic Technical Mathematics with Calculus. 3rd ed., Benjamin Cummings.

PHYSICS I

COURSE DESCRIPTION

A practical approach toward the concepts of force, work, rate, and power is presented in Physics I. Students are shown, by classroom demonstration, how these four concepts are applied to the four energy systems - mechanical, fluidal, electrical, and thermal - and then will perform laboratory experiments that relate each concept to the four energy systems.

PREREQUISITE: Admission of Program

CO-REQUISITE: Algebra

CREDIT HOURS: 4-3-5

COURSE OUTLINE

	Student Contact Hours Class	Laboratory
I. Introduction	5	5
A. Identification of energy systems		
B. Review of simple mathematics		
C. Review of basic concepts of physics		
II. Force	10	10
A. Mechanical systems		
1. linear force		
2. units of mass and force		
3. forcelike quantities		
4. torque		
B. Fluidal systems		
1. pressure		
2. density/pressure relationships		
C. Electrical systems		
1. electromotive force (EMF)		
2. methods of producing an EMF		
D. Thermal systems		
1. temperature difference		
2. temperature scales		
III. Work	10	5
A. Mechanical systems		
1. mechanical work, translational		
2. mechanical work, rotational		
B. Fluidal systems		
1. pressure/volume relationships		

	Student Contact Hours	
	Class	Laboratory
2. energy considerations		
C. Electrical systems		
1. charge movement and EMF		
2. conversion factors for electrical systems		
3. current		
D. Thermal systems		
1. heat flow rate		
2. heat measure		
3. change of state		
IV. Rate	10	5
A. Mechanical system		
1. speed and velocity, linear motion		
2. acceleration, linear		
3. rotational motion, angular velocity		
4. angular acceleration		
B. Fluidal systems		
1. volume flow rate		
2. mass flow rate		
C. Electrical systems		
1. current		
2. AC/DC		
D. Thermal systems		
1. heat energy transfer		
2. heat flow rate		
V. Power	5	5
A. Power equations		
1. power defined		
2. basic equation form		
B. Efficiency		
C. Mechanical systems		
1. translational		
2. rotational		
D. Fluidal systems		
E. Electrical systems		
F. Thermal systems		

STUDENT COMPETENCIES

- Define the following physical quantities and, where applicable, state their units in both SI (International System of Units) and English System of Units:
  - Force
  - Torque
  - Pressure
  - Voltage
  - Temperature Difference
- Given two or more mechanical forces acting along the same line, determine the resultant force.

- Given two of the following quantities in a mechanical rotational system determine the third:
  - Force
  - Lever Arm
  - Torque
- Given two of the following quantities in a fluid system, determine the third:
  - Force
  - Area
  - Pressure
- Given two of the following quantities in a fluid system, determine the third:
  - Pressure
  - Height of fluid
  - Weight density
- Given two or more voltage sources connected in series, determine the resultant voltage.
- Given a temperature in either degrees Celsius or degrees Fahrenheit, determine the equivalent temperature on tha other scale.
- Describe how pressure in fluidal systems, voltage in electrical systems, and temperature difference in thermal systems are similar to force and torque in mechanical systems.
- Describe the conditions that must be met for equilibrium in each of the following energy systems:
  - Mechanical
  - Fluidal
  - Electrical
  - Thermal
- Define work and energy in general terms that apply to any energy system, and distinguish work from energy in the following systems:
  - Mechanical translational
  - Mechanical rotational
  - Fluidal
  - Electrical
  - Thermal
- Define the following units of work and energy
  - Foot-Pound
  - Calorie
  - British thermal unit
  - Joule
- Define the following terms and explain their usefulness in determining work done:
  - Radian (mechanical system)
  - Current(electrical system)
  - Specific heat (thermal system)
  - Heat capacity (thermal system)
- Given two of the following quantities in a mechanical translational system, determine the third:
  - Force
  - Displacemnt
  - Work

- Given two of the following quantities in a mechanical rotational system, determine the third:
  - Torque
  - Angular displacement
  - Work
- Given two of the following quantities in a fluidal system, determine the third:
  - Pressure differnece
  - Volume displace
  - Work
- Given two of the following quantities in an electrical system, determine the third:
  - Voltage
  - Charge transferred
  - Work
- Given the temperature difference across a uniform thickness of a substance, the dimensions of the substance, and its thermal conductivity, calculate the heat flow rate through the substance.
- Given two of the following quantities in a thermal system, determine the third:
  - Temperature change of object
  - Heat capacity of object
  - Work (heat energy transferred)
- Define and give examples of:
  - Latent heat
  - Sensible heat
- State the general equation for work, and explain how it applies to each of the following energy systems:
  - Mechanical translational
  - Mechancial rotaitonal
  - Fluidal
  - Electrical
  - Thermal
- Define the following rates and, where applicable, express their basic units both in SI and English systems of units:
  - Speed and velocity
  - Acceleration
  - Angular velocity
  - Angular acceleration
  - Volume flow rate
  - Mass flow rate
  - Electric current
  - Heat flow rate
- In a linear mechanical system, given all the quantities except one in each of the following groups, determine the unknown quantity:
  - Displacement, elasped time, velocity
  - Initial velocity, final velocity, elapsed time, acceleration
  - Mass, force, acceleration

- In a rotational mechanical system, given all the quantities except one in each of the following groups, determine the unknown quantity:
  - Angular displacement, elapsed time, angular velocity / Initial angular velocity, final angular velocity, elapsed time, angular accelaration
- In a fluidal system, given all the quantities except one in each of the following groups, determine the unknown quantity:
  - Volume of fluid moved, elapsed time volume flow rate / Mass of fluid moved ,elapsed time, mass flow rate
- Given two of the following quantities in an electrical system, determine the third:
  - Charge transferred
  - Elapsed time
  - Current
- Given two of the following quantities in a thermal system, Determine the :
  - Heat energy transferred
  - Elapsed time
  - Heat flow rate
- State the general equation for rate, and explain how it applies to each of the following energy systems:
  - Mechancial translational
  - Mechanical rotational
  - Fluidal
  - Electrical
  - Thermal
- Define "power" as it applies, in general, to all energy systems; and equations that relate work,elapsed time, force, and rate to power in these energy systems:
  - Mechanical system
  - Fluidal system
  - Electrical system
- List for each energy system the SI and English units used to define power,
- Given any two of the following quantities in any energy system, determine the third:
  - Work(or force-like quantity x displacement - like quantity)
  - Elapsed time
  - Power
- Given any two of the following quantities in any energy system, determine the third:
  - Force-like quantity
  - Rate
  - Power
- Define the following terms:
  - Input power
  - Output power
  - Efficiency

RECOMMENDED TEXTS

Cord, Unified Technical Concepts. Waco, Tx: Center for Occupational Reasearch and Development, 1980.

Dierauf, Edward J.,Jr., and Court, James E. Unified Concepts in Applied Physics. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1979.

PHYSICS II

COURSE DESCRIPTION

The second quarter of Physics builds on the foundation developed in the first quarter by presenting concepts of magnetism, resistance, energy, momentum, force transformers, and energy converters. The course balances theory related to these six concepts with practical hands-on experience in working with associated devices in the four energy systems (mechanical, fluidal, electrical, and thermal).

PREREQUISITE: Physics I

COREQUISITE: Trigonometry

CREDIT HOURS: 4-3-5

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Magnetism A. Magnetic theory B. Magnetic fields and flux C. Comparison of magnetic and electric circuits	5	5
II. Resistance A. Mechanical systems 1. dry friction 2. static and kinetic friction B. Fluidal systems 1. fluid resistance in pipes 2. viscosity C. Electrical systems 1. Ohm's Law 2. resistivity of conductors D. Thermal systems 1. thermal resistance 2. insulation	10	5
III. Potential and Kinetic Energy A. Mechanical systems 1. translational 2. rotational B. Fluidal systems 1. volume/mass conversion 2. Bernoulli's equation C. Electrical systems 1. charge relationships	10	5

	Student Contact Hours Class	Laboratory
2. capacitors		
D. Thermal systems		
IV. Momentum	5	5
A. Linear momentum		
B. Impulse and momentum change		
C. Angular momentum		
D. Momentum in fluidal systems		
E. Conservation of momentum		
V. Force Transformers	5	5
A. Principles of force transformers		
B. Mechanical systems		
1. the pulley		
2. the lever		
3. the inclined place		
4. the screw		
5. the wheel and the axle		
C. Fluidal systems		
1. the hydraulic lift		
2. mechanical advantage of a hydraulic lift		
D. Electrical systems - electrical transformers		
VI. Energy Converters	5	5
A. General considerations and background		
B. Converters of mechanical input energy		
C. Converters of fluidal input energy		
1. mechanical output energy		
2. electrical output energy		
D. Converters of electrical input energy		
1. mechanical output energy		
2. thermal output energy		
3. optical output energy		
E. Converters of thermal input energy		
1. mechanical output energy		
2. thermal output energy		
3. optical output energy		
F. Converters of optical input energy		
1. electrical output energy		
2. thermal output energy		

STUDENT COMPETENCIES

- Determine the direction and strength of a magnetic field.
- Examine how the concepts of force, parameter, rate, and resistance apply to magnetic circuits.
- List and describe different types of magnetic material.
- Calculate magnetic field strength, or magnetic flux of an area.
- Explain the effects magnetism has in each of the energy systems.
- Describe the effect of magnetic forces exerted on moving charged particles in a magnetic field.
- Compare simple magnetic and electric circuits using the unified concepts.
- Given two of the following quantities in a fluid system determine the third:
  - Pressure
  - Height of fluid
  - Weight density
- Given two or more voltage sources connected in series, determine the resultant voltage.
- Given a temperature in either degrees Celsius or degrees Fahrenheit, determine the equivalent temperature on the other scale.
- Describe how pressure in fluidal systems, voltage in electrical systems, and temperature difference in thermal systems are similar to force and torque in mechanical systems.
- Describe the conditions that must be met for equilibrium in each of the following energy systems:
  - Mechanical
  - Fluidal
  - Electrical
  - Thermal
- Define work and energy in general terms that apply to any energy system, and distinguish work from energy in the following systems:
  - Mechanical translational
  - Mechanical rotational
  - Fluidal
  - Electrical
  - Thermal
- Define the following units of work and energy
  - Foot-Pound
  - Calorie
  - British thermal unit
  - Newton-Meter Joule
- Define the following terms and explain their usefulness in determining work done:
  - Radian (mechanical system)
  - Current (electrical system)

Specific heat(thermal system)
Heat capacity(thermal system)

- Given two of the following quantities in a mechanical translational system, determine the third:
  - Force
  - Displacement
  - Work
- Given two of the following quantities in a mechanical rotational system, determine the third:
  - Torque
  - Angular displacement
  - Work
- Given two of the following quantities in a fluidal system, determine the third:
  - Torque
  - Angular displacemnt
  - Work
- Given two of the following quantities in an electrical system, determine the third:
  - Voltage
  - Charge transferred
  - Work
- Given the temperature difference across a uniform thickness of a substance, the dimensions of the substance, and its thermal conductvity, calculate the heat flow rate through the substance.
- Given two of the following quantities in a thermal system, determine the third:
  - Temperature change of object
  - Heat capacity of object
  - Work (heat energy transferred)
- Define and given examples of:
  - Latent heat
  - Sensible heat
- State the general equation for work, and explain how it applies to each of the following energy systems:
  - Mechanical translational
  - Mechanical rotational
  - Fluidal
  - Electrical
  - Thermal
- Define the following rates and , where applicable, express thier basic units both in SI and English systems of units:
  - Speed and velocity
  - Acceleration
  - Angular velocity
  - Angular acceleration
  - Volume flow rate
  - Mass flow rate
  - Electric current
  - Heat flow rate

- In a linear mechanical system, given all the quantities except one in each of the following groups, determine the unknown quantity:
  - Displacement, elapsed time, velocity
  - Initial velocity, final velocity, elapsed time, acceleration
  - Mass, force, acceleration
- In a rotational mechanical system, given all the quantities except one in each of the following groups, determine the unknow. quantity:
  - Angluar displacement, elapsed time, angular velocity/ Initial angular velocity, final angular velocity, elapsed time, angular acceleration
- In a fluidal system, given all the quantities except one in each of the following groups, determine the unknown quantity:
  - Volume of fluid moved, elapsed time volume flow rate, mass fluid moved, elapsed flow rate
- Given two of the following quantities in an electrical system, determine the third:
  - Charge transferred
  - Elapsed time
  - Current
- Given two of the following quantities in a thermal system, determine the third:
  - Heat energy transferred
  - Elasped time
  - Heat flow rate
- Define resistance in a general way, and state the final form of the energy expended when a forcelike quantity does work to overcome resistance in an energy system.
- Calculate the magnitudes of starting and sliding frictional forces, given the mass or weight of the object, the coefficients of friction, and the angle of incline.
- Given the two of the following quantities in fluidal, electrical, and thermal systems, determine the third:
  - Forcelike quantity
  - Rate
  - Resistance
- Describe the difference between laminar and turbulent flow.
- State the factors contributing to fluid resistance in pipes.
- State the factors contributing to thermal resistance of objects.
- Describe with the use of graphs the definition of resistance as the ration of forcelike quantity to rate in fluidal, electrical, and thermal systems. Include the units of forcelike quantity, rate, and resistance for each system.
- State the fundamental difference between sliding

friction and resistance as it applies to fluidal, electrical, and thermal systems.

- Define potential energy, kinetic energy, and conservation of enrgy by using examples from mechanical systems.
- Given any two of the quantities in the following groups, determine the third:

  Mass, velocity, kinetic energy
  Mass, height, potential energy
  Spring constant, spring displacement,
  potential energy / Moment of inertia, angular velocity, kinetic energy / Capacitance, voltage, potential energy
- Given Bernoulli's equation and the height of liquid in a tank, determine the exit velocity at the bottom of the tank if ther is no fluid friction.
- List and describe the three processes that transfer thermal energy.
- Discuss the conservation of energy as it applies to fluidal, electrical, and thermal systems.
- Define the following terms; state the appropriate units in the mk/s system (SI) and t cg/s system; and give the equation for each:

  Linear momentum
  Angular momentum
  Impulse
  Angular impulse
  Moment of inertia
- Given two of the following quantities, determine the third:

  Mass of an object
  Velocity of the object
  Momentum of the object
- Given all the following quanities, determine the third:

  Moment of inertia of an object
  Angular velocity of the object
  Angular momentum of the object
- Given two of the following quantities except one describing a linear collison, determine the unknown quantity:

  Mass of first object
  Initial velocity of first object
  Final velocity of first object
  Mass of second object
  Initial velocity of second object
  Final velocity of second object
- Explain the following concepts in a short paragraph each:

  Consevation of linear momentum
  Conservation of angular momentum
- Use a given equation to calcuate the force produced on one blade of a reaction turbine, given the velocity of fluid and the mass of fluid per unit time striking the blade.

- Describe specific force transformers in the mechanical translational, mechanical rotational, fluidal, and electrical systems; and discuss their fundamental similarity as transformers of forcelike quantities.
- Define the following terms:
  - Ideal mechanical advantage
  - Actual mechanical advantage
  - Efficiency
- Calculate the ideal mechanical advantage of a specific pulley, lever, screw, wheel and axle, hydraulic press or lift, and electrical transformer.
- Calculate the change in current in an ideal electrical transformer.
- Discuss how the role of resistance in a transformer dissipates energy input and reduces efficience.
- Describe the power input and power output characterisitcs of a transformer that operates continuously.
- Describe energy converters in general terms that apply to all energy-conversion devices.
- Describe the operation of the following energy converters:
  - Vane pump
  - Turbine
  - Electric generator
  - Electric motor
  - Electric heater
  - Internal combustion engine
  - Boiler
  - Solar collector
- Given two of the following quanities, determine the third:
  - Input energy
  - Output energy
  - Efficiency
- Given the efficiency of all the energy converters used in an energy conversion system, determine the overall system efficiency.

RECOMMENDED TEXTS

Cord, Unified Technical Concepts. Waco, TX: Center for Occupational Research and Development, 1980.

Dierauf, Edward J., Jr., and Court, James E. Unified Concepts in Applied Physics. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1979.

PHYSICS III

COURSE DESCRIPTION

This third quarter of Physics will provide the student with practical knowledge of sound scientific principles behind devices and components addressed in four concepts: transducers, energy transfer and storage, vibration and waves, and radiation. Practical hands-on experience with devices common to many technologies is offered in the laboratory.

PREREQUISITE: Trigonometry, Physics II

CREDIT HOURS: 4-3-5

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Transducers	5	5
II. Energy Transfer and Storage	10	5
III. Vibrations and Waves		15

I. Transducers
   - A. Basic concepts
   - B. Self excited transducers
   - C. Externally excited transducers

II. Energy Transfer and Storage
   - A. Basic considerations
     1. thermal cooling
     2. rotational
   - B. Mechanical systems
     1. translational
     2. rotational
   - C. Fluidal systems
   - D. Electrical systems
   - E. Thermal systems

III. Vibrations and Waves
   - A. Oscillating systems
     1. simple harmonic motion
     2. oscillating systems with resistance
     3. forced oscillations
     4. resonance
   - B. Types of waves
     1. transverse
     2. longitudinal
   - C. Wave characteristics
     1. wave velocity
     2. the wave equation
     3. superposition
     4. standing waves
     5. interference
   - D. Wave motion as a unifying concept
     1. mechanical systems

	Student Contact Hours	
	Class	Laboratory
2. fluidal systems		
3. electrical waves		
IV. Radiation	10	10
A. Electromagnetic radiation		
B. Light		
C. Optical instruments		
D. Waves and particles		
E. particle radiation		

STUDENT COMPETENCIES

- In a short paragraph, define a transducer. Include a distinction between those transducers that require external ènergy sources and those that do not.
- Describe the operation of the following transducers:
  - Strain gage
  - Accelerometer
  - Microphone
  - Turbine flowmeter
  - Barometer
  - Meter movement
  - Thermocouple
  - Thermistor
  - Bimetallic strip
  - Photoconductive cell
  - Photovoltaic cell
- Define the following terms:
  - Steady state
  - Transient
  - Damping
  - Time constant
  - Half-life
  - Decay constant
- Draw and label a graph showing an exponentially-decaying function. Include on the graph the time constants T1/2 and T1/e = τ. also write an equation for the function shown on the graph.
- Given the initial temperature of a hot body, the ambient temperature of its surroundings, and the thermal time constant of the system, determine the temperature of the body after a specified time interval.
- Given the number of radioactive atoms in a sample and the decay constant, determine the number of atoms remaining after a specified time interval.
- Given the values of resistance, capacitance, and applied voltage in an RC electrical circuit, determine the time constant for the circuit, the time required for the capacitor voltage to reach 99% of the applied voltage, and the circuit current and capacitor voltage after a

specified time interval.

- Explain how the concept of time constants can be applied to the following energy systems; give a specific example in each case:
  - Mechanical translational
  - Mechanical rotational
  - Fluidal
  - Electrical
  - Thermal
  - Optical
  - Nuclear
- Solve problems involving simple harmonic motion.
- Describe damping phenomena in oscillating systems with resistance.
- Describe systems oscillating under the influence of an energy source.
- Distinguish between longitudinal and transverse waves by giving at least two examples of each types and by drawing and labeling a sketch of each.
- Define the following terms associated with waves and wave motion:
  - Propagating medium
  - Wavelength
  - Frequency
  - Period
  - Displacement
  - Amplitude
  - Phase
  - Standing wave
  - Constructive interference
  - Destructive interference
  - Beats
- Calculate the wavelength of a wave, given its velocity and frequency.
- Interpret the following equation, explaining the significance of each symbol:

  $y = A \sin 2\pi (\frac{x}{\lambda} ft)$.
- Explain the meaning of the expression, "The current leads the voltage by a given phase angle " by using sine-wave sketches of both current and voltage.

Describe the superposition principle.

- Describe wave phenomena in each of the following energy sytems:
  - Mechanical
  - Fluidal
  - Electrical
- Describe in one or two sentences the basic properties of each of the following types of radiation:
  - Sound
  - Light
  - Alpha and beta particles
- Define electromagnetic radiation (radiant energy), and describe a simple experiment that illustrates how electromagnetic radiation can be created.

- List the frequencies in the electromagnetic spectrum from wavelength Em waves of AC power (60 hertz) to gamma rays (10 hertz), including each major part - radio, FM, television, radar, microwave, infrared, visible, ultraviolet, X-ray, and gamma ray.
- Given the equation v +λf - relating wave speed, wavelength and frequency - determine the radiation frequency for any part of the electromagentic spectrum.
- Given the equation E = hf or E = h c/e, determine the energy of different waves in Em spectrum.
- Describe qualitatively the nature of an electromagnetic wave in terms of electric and magnetic fields; state what is always required to generate an EM wave; and explain how EM waves are propagated through empty space without benefit of an elastic medium.
- Describe a photon, and explain why both wave and particle-like (photon) phenomena are required to describe interaction of Em radiation with matter. Give examples in which the wave character is most useful in describing Em radiation and in which the photon character is most useful.
- Explain what is meant by the inverse square law and how this law is used to describe the fall-off of EM radiation propagating from a small source.
- Define polarization, and explain what is meant by polarized Em radiation - in particular polarized light.
- Define visible radiation, and determine it's limits numerically in terms of wavelength, frequency, and energy.
- Describe the reflection and refraction of EM radiation - especially light - and set up an experiment to verify the two laws.
- Differentiate between alpha and beta radiation and gamma radiation.
- Briefly explain each of the three parts in the symbol $_{92}U^{238}$
- Given the appropriate equipment, illustrate and verify the inverse square law of EM radiation in the visible region.
- Given the appropriate equipment, produce and detect polarized light in the microwave region.

RECOMMENDED TEXTS

CORD, Unified Technical Concepts. Waco TX: Center for Occupational Research and Development, 1980.

Dierauf, Edward J., Jr. and Court, James E. Unified Concepts in Applied Physics. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1979.

TECHNICAL COURSES

A-C CIRCUITS

COURSE DESCRIPTION

This course provides the student with the knowledge and skills to analyze basic A-C circuits. The course includes the following main topics: Magnetism, Inductance, Alternating current, Reactance, Impedance, and Admittance.

PREREQUSIITE: DC Circuits, Algebra

CO-REQUISITE: Trigonometry, Phusics I

CREDIT HOURS: 4-3-5

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Magnetism	5	3
A. Magnetization curves		
B. Permability from the BH curve		
C. Hysteresis		
D. Eddy current		
E. Magnetic shielding		
F. Magnetic circuits		
II. Inductance	6	6
A. Faraday's law		
B. Lenz's law		
C. Counter emf		
D. Time constant		
III. Alternating Current	7	6
A. The sine wave		
B. Peak values		
C. Instantaneous values of voltage and current		
D. The radian		
E. Rms Values		
F. Average values		
IV. Reactance	6	6
A. Inductive reactance		
B. Capacitive reactance		
C. Vector algebra		
V. Impedance	10	6
A. RLC series circuits		
B. RLC parallel circuits		
C. Admittance		
D. Conductance and susceptance		
E. Power factor		

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	Student Contact Hours	
	Class	Laboratory
VI. Impedance networks A. Loop equations	3	3

STUDENT LABORATORIES

- Analyze magnetic circuits.
- Operation of an oscilloscope.
- Determine the peak value , RMS value, and peak-to-peak value of a sinewave using an oscilloscope.
- Plot the response curve of a series RL and RC network.
- Plot the response curve of a parallel RC and RL network.
- Analyze A-C circuits using the Thevinin theorem.
- Determine the total current in a series RC, RL and RLC circuit.
- Determine real and apparent power in a series RLC circuit.
- Use loop equations to solve impedance networks.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Operate an oscilloscope.
- Determine peak value, instantaneous value, average value, and RMS value of a sine wave.
- Measure voltage and current in a series RLC circuit and parallel RLC circuit.
- Determine the total impedance and admittance of a series and parallel RLC circuit.
- Use loop equation to solve impedance networks.

RECOMMENDED TEXTS

Boylestad, Robert D. Introductory Circuit Analysis, Fourth Edition, Indianapolis, In: Bobbs Merrill, 1981.

Jackson, Herbert W., Introductory to Electric Circuits, Fifth Edition, Englewood Cliffs, NJ: Prentice-Hall, Inc., 1981.

COMPUTER AIDED DRAFTING AND DESIGN (CAD) I

COURSE DESCRIPTION

The purpose of this course is to introduce and familiarize the student with the usage of CAD/CAM equipment, software, and terminology. The student will perform a simple two-D drafting exercise on a CAD system.

PREREQUISITES: Computer Fundamentals, Engineering Graphics I

CO-REQUISITES: None

CREDIT HOURS: 1-3

COURSE OUTLINE

	Student Contact Hours Class	Student Contact Hours Laboratory
I. Introduction to CAD A. Need for computer graphics in industry B. Present engineering methods C. Need for productivity D. Vocabulary - terms and acronyms E. Who uses CAD/CAM	1	—
II. Computer Applications in Engineering A. Computer aided drafting CAD B. Computer aided design CAD C. Computer aided engineering CAE D. Computer aided manufacturing CAM	1	
III. Computer Aided Drafting & Design A. Mechanical B. Electrical - electronic C. Architectural D. Mapping E. Miscellaneous	1	
IV. The CAD System A. Hardware 1. central processing unit 2. disk memory 3. magnetic tape 4. interactive terminals 5. plotters	2	4

	Student Contact Hours	
	Class	Laboratory
B. Software		
1. operating systems		
2. application packages		
3. language support		
C. Other standard peripheral devices		
V. Why CAD/CAM - Justification	1	
IV. CAD/CAM Usage		
A. Printed circuit board design	2	12
1. system description		
2. board geometry and component placement		
3. signal routing		
4. editing and checking		
B. Integrated circuit design		
1. I.C. fabrication		
2. the role of CAD/CAM		
C. Generating a wiring diagram database		
1. wiring diagrams/wire charts		
2. cabling diagrams		
D. Cartographic processes		
1. background		
2. using the information system in planning		
E. Mechanical design using 2D/3D CAD		
1. the role of interactive graphics		
2. drafting mechanical parts		
3. generating numerical control data		
4. tool design		
F. CAD/CAM in manufacturing processes		
1. process design applications		
2. forging, extrusion, rolling and forming		
3. machine shop application		
VII. 2D Drafting on CAD	2	42
A. Part description		
B. Orthographic projection		
C. Dimensioning the part		

STUDENT LABORATORIES

- Tour (as available) firms using CAD/CAM systems.
- Observe part being machined on CNC machine.
- Operate CAD system to reproduce a prestored drawing.
- Design/Draw a printed circuit board using CAD system.
- Design/Draw a cable diagram using CAD system.

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- Design/describe a basic part.
- Design/draw a machine part in three views.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Describe need for CAD in industry.
- Describe CAD engineering methods.
- Explain CAD's role in productivity.
- Demonstrate CAD vocabulary.
- Enumerate personnel using CAD/CAM.
- Explain Computer Aided Applications in Drafting-CAD.
- Explain Computer Aided Applications in Design-CAD.
- Explain Computer Aided Applications in Engineering-CAE.
- Explain Computer Aided Applications in Manufacturing-CAM.
- Describe capability in mechanical drafting & design.
- Describe capability in electrical/electronic drafting & design.
- Describe capability in architectural drafting and design.
- Describe capability in cartographic drafting and design.
- Describe miscellaneous capabilities.
- Describe the function of various hardware in a typical CAD system.
  - Central processing unit - CPU
  - Disc memory
  - Magnetic tape
  - Plotters
  - Operating systems
  - Application packages
  - Language support
- Describe the function of other peripheral devices.
  - Digitizers
  - Pens
- Describe the operations and functions possible in:
  - Printer ciruit design
  - Integrated circuit design
  - Generation of a wiring diagram database
  - Cartographic processes
  - Mechanical design, using 2D/3D CAD
  - Manufacturing process
- Demonstrate knowledge of all hardware/software in the system to be used.
- Demonstrate proper address and setup techniques.
- Design/describe a basic part.
- Demonstate completion of a part by generating a usable drawing (hardcopy).

RECOMMENDED TEXTS

Geotsch, David. CAD/CAM Workbook. Southwestern Publishing Company.

Computervision Corporation, CAD/CAM Handbook. Computer Vision Corporation, 210 Burlington Road, Bedford,Ma.,1980.

Ryan. Computergraphics Problems. Brooks-Cole Engineering, Delmart CA., 1983.

Volfinet. Introduction to CAD. McGraw Hill, 1983.

Angell, Ian O., A Practical Introduction to Computer Graphics. New York: John Wiley & Sons, Inc. Available from the Numerical Control Society.

Foley, James D. & Van Dam, Andries, Fundamentals of Interactive Computer Graphics. Reading, Massachusetts: Addison-Wesley Publishing Co., 1982.

Giloi, Wolfgang K., Interactive Computer Graphics. Englewood Cliffs, New Jersey: Prentice-Hall, Inc. 1978.

Machover, Carl, Understanding Computer Graphics. New York: Van Nostrand Reinhold Co.,

Newman, William & Sproull, Robert, Principles of Interactive Computer Graphics, (2nd Edition.) New York: McGraw-Hill,1979.

Nievergelt, Jurg 7 Failman, Michael, Pertinent Concepts in Computer Graphics. University of Illinois Press, 1969.

Parslow, R.D. ,Computer Graphics: Techniques and Applications. New York: Plenum Press, 1969.

Po'lack, Virginia, Becomming Comfortable with Computer Graphics. San Diego: Hewlett Packard Corp., 1980.

Scott, Joan E., Introduction to Interactive Computer Graphics. New York: John Wiley & Sons, Inc. Available from the Numerical Control Society.

Thompson, Harmon, Implementing Computer Graphics. Available from the Numerical Control Society.

COMPUTER AIDED DRAFTING AND DESIGN (CAD) II

COURSE DESCRIPTION

This course is an advanced computer design course that assumes the student has a working knowledge of the use of a CAD machine. The student is expected to demonstrate his/her working knowledge of engineering, drawing, technical report writing, and prepare a complete engineering design and proposal.

PREREQUISITE: Computer Aided Drafting & Design (CAD) I

CREDIT HOURS: 1-6-3

COURSE OUTLINE	Student Contact Hours Class	Laboratory
I. CAD/CAM Capability (relevant to equipment available)	2	
A. Scope of available graphics		
B. Analysis capability		
C. CAM capability		
D. Other CAD/CAM capabilities		
II. Engineering Design Specifications	1	6
A. Scope of project		
B. Required sketches for preliminary design		
C. Instructor/Student discussion of project		
III. Student Proposal for Design	1	6
A. 3-view sketch		
B. Preliminary calculations		
C. Project justification		
IV. CAD Drawings		
A. 3-view overall design		
B. 3 views, each part of design		
C. Sectional views		
D. Material lists		
E. Tolerancing/notes to manufacturer		
V. Technical Report	1	61
A. 8 1/2" X 11" 3-view with part numbers		
B. Parts listing		
C. Description of how parts are to be manufactured		

	Student Contact Hours	
	Class	Laboratory
D. Description of how design will work		
E. Cost estimate		
F. Load analysis		
IV. Project Check	1	6
A. Student review of another student's project		
B. Instructor review of project and grade		
C. Student corrections of drawings		

STUDENT LABORATORIES

- Produce, on CAD, all sketches needed for a preliminary design review.
- Produce, on CAD, a 3-view sketch and calculations sufficient for an engineering proposal.
- Produce, on CAD, all 3-view and 3-dimensional drawings needed for a "top" drawing.
- Produce, on CAD, all 3-view, 3 dimensional and sectional views needed for all detail drawings in a product.
- Generate, on CAD, material lists, tolerance notes and manufacturing notes for a product.
- Prepare fault analysis reports (as required) of other student's projects.
- Students correct own errors and finalize all drawings and reports.
- Machine assemble and test product generated in the project (time permitting.)

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Explain the scope of graphics available in the CAD/CAM system (as relevant to each respective institution).
- List the analysis functions which are available in the CAD/CAM system (as relevant to each respective institution).
- Enumerate the different types of CAM operations that could be performed with the CAD/CAM system (as relevant to each respective institution).
- Produce, on CAD, the necessary preliminary sketches for design definition of a student project.
- Prepare, on CAD, all sketches, calcuations and project justifications needed to produce a design proposal.
- Generate all overall drawings, detail drawings, material lists, tolerancing and manufacturing notes needed to produce the proposed project.

- Produce a comprehensive technical report on the proposed project.
- Correct all design and/or production discrepancies found in peer cross-review and instructor checks.

RECOMMENDED TEXTS

Chasen, Sylvan H., Geometric Principles and Procedures for Computer Graphic Applicaitons. Englewood Cliffs, New Jersey: Prentice-Hall, Inc. 1978.

Computervision Corporation, CAD/CAM Handbook. Computer Vision Corporation, 201 Burlington Road, Bedford, MA, 1980.

Goetsch, David. CAD/CAM Workbook. Southwestern Publishing Company.

Moore, Patricia A., Harvard Library of Computer Graphics. Cambridge: Harvard University Laboratory for Computer Graphics and Spatial Analysis, 1980.

Parslow, R.D., Advanced Computer Graphics: Economic Techniques and Applications. New York: Plenum Press, 1971.

Ryan. Computergraphics Problems. Brooks-Cole Engineering, Delmart, CA. 1983.

Sherr, S., Electronic Displays.. New York: Wiley-Interscience, 1979.

Voifinet. Introduciton to CAD. McGraw-Hill, 1983.

COMPUTER AIDED MANUFACTURING (CAM)

COURSE DESCRIPTION

Computer numerical controlled machining introduces the student to the concept of automated machining, necessary coordinate systems, manual programming, conversational programming and the actual production of parts on CNC machines.

PREREQUISITE: Manufacturing Processes II

CREDIT HOURS: 1-6-3

COURSE OUTLINE

	Student Contact Hours Class	Laboratory
I. Introduction to Numerical Control	1	
A. History		
B. Introduction terminology		
C. Economics		
II. Drafting for Numerical Control	1	3
A. Base line dimensioning		
B. Cumulative dimensioning		
III. Review of Mathematics for NC	1	3
A. Plane geometry		
B. Trigonometry		
IV. Introduction to Coordinate Systems	1	3
A. Base line		
B. Cartesian		
C. Two axis planar		
D. Workpiece location		
E. Point to point and continuous path		
F. Absolute and incremental		
V. Program Preparation	2	9
A. Planning the job for NC		
B. Fixturing		
C. Cutting tools		
D. Set-up sheet		
E. Plotting command point and cutter path		
F. Writing the part program manuscript		
VI. CNC Milling Machine	1	18
A. Machine specifications		
B. Programming format		
C. Tools and methods consideration		

D. Program entries descriptions

VII. CNC Lathe — 1 — 18
- A. Machine specifications
- B. Programming format
- C. Tools and methods considerations
- D. Program entries descriptions
- E. Operation procedure
- F. Optional equipment

VIII. Optional Support Equipment — 2 — 6
- A. Paper tape
- B. Cassette recorder
- C. Floppy disk
- D. CAD systems

STUDENT LABORATORIES

- Students will plot absolute and incremental machine cutter paths and demonstrate those paths on the CNC machines.
- Students will demonstrate correct location of zero points relative to planned cutter paths.
- Students will demonstrate correct operating procedures for the respective CNC equipment.
- Students will demonstrate correctly-written part programs on the respective CNC machines.
- Students will prepare programs off-line and on-line.
- Students will edit programs and demonstrate successful outcomes on the CNC machines.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Manually write acceptable part programs.
- Prepare acceptable tapes and other formats of programs and demonstrate correct loading into CNC machines.
- Write acceptable part programs utilizing conversational programming techniques.
- Select proper tools relative to part programs.
- Produce acceptable parts on the respective CNC machines in the laboratories.

RECOMMENDED TEXTS

Childs, James J., Principles of Numerical Control, Third Edition, Industrial Press Inc. 200 Madison Ave., N.Y., 1982.

Harrington, Joseph Jr., Computer Integrated Manufacturing. New York: Krieger. Available from the Numerical Control Society.

Nicks, J. BASIC Programming Solutions for Manufacturing. Dearborn: Society of Manufacturing Engineers.

Orr, Joes, The Complete CAD/CAM Anthology. Chestnut Hill, Massachusetts: Management Roundtable Inc., 1989.

Taraman, K., CAD/CAM: Meeting Today's Productivity Challenge. Dearborn: Society of Manufacturing Engineers, 1980.

D-C CIRCUITS

COURSE DESCRIPTION

This course provides the student with the knowledge and skills to analyze basic D-C circuits. The course includes the following main topics: Scientific notation and unit conversions, Insulators, Conductors, Sources, Resistance, Work and power, Series and parallel circuits, Series-parallel circuits, and Equivalent circuits.

PREREQUISITE: Admission to program.

CO-REQUISITE: Algebra

CREDIT HOURS: 4-3-5

COURSE OUTLINE

	Student Contact Hours Class	Laboratory
I. Introduction to Engineering Technology A. SI units B. Scientific Notation C. Unit Conversions	4	6
II. Introduction to Electricity A. Insulators B. Conductors C. Sources D. Resistance E. Work and power	9	3
III. Series and parallel circuits A. Series circuits B. Parallel circuits C. Series-parallel circuits	8	9
IV. D-C Circuit Theorems A. Thevenin's theorem B. Norton's theorem C. Superposition theorem D. Millman's theorem E. Delta-wye transformations F. Nodal analysis G. Mesh analysis	15	9
V. Capacitance A. Capacitance reactance B. Charging and discharging C. Time constants	4	3

STUDENT LABORATORIES

- Introduce the student to Engineering Technolcgy.
- Introduction to instruments, measurement procedures, and saftey precautions.
- Measure D-C voltage, current and resistance in series circuits.
- Measure D-C voltage, current, and resistance in parallel circuits.
- Measure D-C voltage, current, and resistance in series-parallel circuits.
- Design a basic voltmeter and current meter.
- Analyze series-parallel circuits using circuit theorems.
- Determine capacitance values by use of discharge times.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Convert from one unit of measurement to another.
- Express decimal numbers in scientific notation.
- Use SI units
- Determine resistor values from their color code.
- Convert mechanical power to electrical power.
- Use a digital and analog VOM.
- Measure the current and voltage in a D-C series and parallel circuit.
- Use D-C circuit theorems to determine the total resistance, current and voltage in resistance networks.
- Plot the charging curve of a capacitor.

RECOMMENDED TEXT

Boylestad, Robert D. Introductory Circuit Analysis, Fourth Edition, Indianapolis, IN: Bobbs Merrill, 1981.

Jackson, Herbert W., Introduction to Electric Circuits, Fifth Editions, Englewood Cliffs, NJ: Prentice-Hall, Inc, 1981.

DYNAMICS

COURSE DESCRIPTION

Dynamics is the study of forces on particles and bodies in motion. It is a fundamental Mechanical Engineering Technology course which supplements the knowledge acquired in Statics and allows students to apply this knowledge to dynamic systems.

PREREQUISITES: Statics, Physics II, Analytical Geometry and Calculus

CREDIT HOURS: 4-3-7

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Kinematics of Particles	6	6
A. Introduction to dynamics		
B. Description of motion		
C. Rectilinear and angular motion		
D. Plane curvilinear motion		
II. Kinetics of Particles	8	6
A. Equations of motion		
B. Work and energy		
C. Impulse and momentum		
III. Kinematics of Rigid Bodies	8	6
A. Translation		
B. Rotation about an axis		
C. General plane motion		
D. Motion about a fixed point		
IV. Kinetics of Rigid Bodies	6	6
A. Force, mass, and acceleration		
B. Impulse and momentum		

STUDENT LABORATORIES

- Student will investigate change and momentum.
- Using equations and principles of rotational motion, students will determine angular velocity and angular acceleration of a phonograph turntable.
- Students will calculate the angular momentum of a flywheel drive.

STUDENT COMPETENCIES

By the conclusion of this course students will be able to:

- Determine the position, velocity, and acceleration of a particle given set conditions.

- Determine the motion of a particle.
- Determine the acceleration of a particle.
- Determine the force acting on a particle.
- Determine the angular momentum of a particle.
- Determine the angular velocity and angular acceleration of a point on a rotating body.

RECOMMENDED TEXTS

Breneman, Mechanics, McGraw-Hill.

Jensen and Chenoweth, Applied Engineering Mechanics, McGraw-Hill.

ELECTROMECHANICAL DEVICES

COURSE DESCRIPTION

Electromechanical Devices is designed to provide the student with a working knowledge of control elements in electrical circuits, transformers, generators, motors, and synchromechanisms. Topics presented include power losses in transformers, large alternators, DC motor controls and efficiency, three-phase AC motors, synchronous motors, single and three-phase induction motors, stepper motors, and classifications and applications of synchromechanisms.

PREREQUSIITE: Circuit Analysis

CO-REQUISITE: None

CREDIT HOURS: 4-3-5

COURSE OUTLINE	Student Contact Hours Class	Laboratory
I. Electromechanical Devices An Introduction	2	
A. Magnetic forces and fields		
B. The origin of magnetism		
C. Magnetic fields of electric currents		
D. Forces of charged particles moving through magnetic fields		
E. Generator action		
F. Motor action		
G. Transformers		
II. Control Elements in Electrical Circuits	4	3
A. Switches		
B. Testing and maintenance of switches		
C. Relays		
D. Testing and maintenance of relays		
E. Relay circuits		
F. Fuses		
G. Checking and replacing fuses		
H. Checking circuit breakers		
III. Transformers	4	3
A. The basic transformer		
B. Power losses in transformers		
C. Power transformers		
D. Auto transformers		
E. Other transformers		
F. Troubleshooting transformers		

	Student Contact Hours Class	Laboratory
IV. Generators and Alternators	4	3
A. The simple DC generator		
B. Construction of DC generators		
C. Field coil connections in DC generators		
D. Operation of DC generators		
E. The alternator		
F. Automobile alternators		
G. Large alternators		
H. Operation of alternators		
I. Maintenance		
V. DC Motors and Controls	8	6
A. The simple DC motor		
B. Construction of DC motors		
C. DC motor controls		
D. Motor efficiency		
E. Motor maintenance and troubleshooting		
VI. AC Motors and Controls	10	9
A. Three-phase AC motors		
1. rotating magnetic fields		
2. synchronous motors		
3. induction motors		
4. power factor in AC motors		
B. Synchronous motors		
1. rotor construction		
2. field excitation and power factor		
3. starting synchronous motors		
4. applications of synchronous motors		
C. Three-phase induction motors		
1. rotor construction		
2. starting three-phase induction motors		
3. applications of three-phase induction motors.		
4. wound rotor motors		
D. Single-phase induction motors		
1. capacitor - start motors		
2. permanent-capacitor motors		
3. repulsion-induction motors		
4. shaded-pole motors		
5. speed control of single-phase induction motors		
E. Universal motors		
VII. Stepper Motors	4	3
A. Operation of the stepper motor		
B. Stepper motor control		

	Student Contact Hours	
	Class	Laboratory
VIII. Synchromechanisms	4	3

A. The synchro transmitter
B. The synchro receiver
C. Differential synchro transmitter and receivers
D. The synchro control transformer
E. Classification of synchromechanisms
F. Applications of synchromechanisms

STUDENT LABORATORIES

- Examine the characteristics and diagram the magnetic fields of permanent magnets and electromagnets.
- Construct common control circuits using switches and relays.
- Construct circuits and measure efficiency of a power transformer.
- Set-up a generator and an alternator and measure the output characteristics.
- Construct a motor circuit and measure the output characteristics of a shunt motor.
- Set up, operate, and determine the functioning characteristics of synchronous, induction, and universal motors.

STUDENT COMPETENCIES

. At the conclusion of this course, the student will be able to:

- Diagram and explain the components and relationships of basic magnetic and electromagnetic systems.
- Use the right hand rule to determine direction of force on a conductor or a current carrying a conductor in a magnetic field.
- Identify, diagram, and explain the functioning characteristics of basic types of relays used in electrical circuits.
- Identify, diagram and explain the function of basic fuses.
- Construct a relay control circuit.
- Diagram, label, and explain the functioning characteristics and the components of basic types of transformers.
- Determine primary voltage and current, secondary voltage and current, input power and efficiency of a transformer.
- Test transformers for continuity of windings, and shunted windings.
- Diagram, label, and explain the functioing characteristics of basic generators.

- Operate a DC generator and alternator and determine their operating characteristics.
- Diagram, label, and explain the components and funct' 'ing characteristics of common types of '.C Motors.
- Specify appropriate types of motors for a given mec.. cal load.
- Diagram, label, and explain the components and functioning characteristics of common AC motors.
- Construct, test, and plot the curve of a DC motor circuit.
- Diagram, label, and explain the components and functioning characteristics of common types of AC motors.
- Given necessary data, determine the number of magnetic poles, synchronous speed, operating speed, slip speed of common AC Motors.
- Operate properly universal motor, shaded pole motor, capacitor start motor.

RECOMMENDED TEXTS

Center for Occupational Research and Development. Electromechanical Devices. Waco, TX: CORD, 1981.

Alevich, Walker N. Electric Motor Control. New York: Van Nostrand Publishing Co., 1975.

Anderson, Edwin P. Electric Motors. Indianapolis, IN: Theodore Aide and Co., 1969.

Fitzgerald, A.E. and Kirply, Charles, Jr. Electric Machinery. New York: McGraw-Hill Book Co., Inc. 1952.

ENGINEERING GRAPHICS I

COURSE DESCRIPTION

An introductory course to provide the technician with basic skills and techniques used to communicate information and ideas graphically. Topics to include: an introduction to freehand sketching; graphic drafting techniques and procedures, schematic drawing; descriptive geometry; and computer graphics.

PREREQISITE: Algebra

CO-REQUISITE: Trigonometry

CREDIT HOURS: 1-6-3

COURSE OUTLINE	Student Contact Hours Class	Laboratory
I. Technical Sketching A. Sketching lines, circles, and arcs B. Using the box construction technique C. Sketching in isometric D. Sketching in oblique	1	9
II. Drafting Fundamentals A. Use of instruments B. Lettering C. Alphabet of lines D. Drawing reproduction E. Scale F. Dimensioning and tolerancing G. Geometric construction techniques	2	15
III. Orthographic Projection A. Third-angle projection in drawing B. Section drawing	2	15
IV. Pictorial Drawing A. Drawing objects in isometric	2	12
V. Schematic Drawing	1	6
VI. Descriptive Geometry A. True length, slope, and bearing B. Auxiliary views C. Developments	2	12

	Student Contact Hours Class	Laboratory
VII. Computer Graphics	1	
A. Drawing on CRT		
B. CAD introduction		
VIII. Overview of Engineering Graphics Drawing in Industry	1	

STUDENT LABORATORIES

- Make freehand sketches in isometric and oblique.
- Use drafting instruments to make simple drawings involving geometric construcion techniques.
- Make drawings of objects in orthographic.
- Make isometric drawings of simple objects.
- Make schematic drawings.
- Find true length, slope, and bearing of lines.
- Make developments of objects.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Make simple freehand sketches that will describe an object or a process in three dimensions.
- Use drafting instruments to make simple engineering drawings.
- Draw and interpret objects in orthographic projection.
- Draw and interpret simple objects in isometric.
- Prepare and interpret schematic drawings.
- Graphically find the true length, slope, and bearing of a line.
- Determine true shapes and sizes of surfaces from alternative vies utilizing the line and plan methods of descriptive geometry.
- Discuss the use of computer as a graphics tool.

RECOMMENDED TEXT

Luadder, Warren J., Fundamentals of Engineering Drawing. Englewood Cliff, N.J.: Prentice-Hall, 1981.

ENGINEERING GRAPHICS II

COURSE DESCRIPTION

This course is designed to further the student's knowledge and skills necessary to communicate information and ideas graphically. Topics to include: advanced sketching, advanced orthographic projection techniques, advanced pictorial techniques, industrial graphics applications and, an introduction to computer graphics.

PREREQUISITE: Engineering Graphics I.

CREDIT HOURS: 1-6-3

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Technical Sketching A. Sketching in isometric B. Sketching in oblique C. Sketching in orthographic	1	6
II. Lettering		4
III. Advanced Orthographic Projection and Dimensioning A. Auxiliary views B. Points, lines and planes C Skew lines D. Piercing points and plane intersections E. Dihedral angles F. Intersection and development	3	18
IV. Advanced Pictorial Techniques A. Isometric techniques B. Oblique techniques	3	18
V. Industrial Graphics Applications and An Introduction to Computer Graphics	3	14

STUDENT LABORATORIES

- Make freehand sketches in isometric and oblique.
- Letter exercises using single-stroke Gothic letters.
- Make advanced drawings in orthographic.
- Make advanced drawings in isometric and oblique.
- Make drawings relating to industrial applications.
- Make basic drawings using 2-D comptuer graphics.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Make detailed freehand sketches in isometric and oblique.
- Letter notes and dimensions on drawings using single-stroke Gothic letters.
- Make detailed drawings in orthographic projection utilizing standard dimensioning procedures.
- Make detailed drawings in isometric and oblique utilizing standard dimensioning procedures.
- Make working drawings utilizing industrial applications.
- Make basic computer drawings utilizing 2-D graphics.

RECOMMENDED TEXTS

Luzadder, Warren J. Fundamentals of Engineering Drawing. Englewood Cliffs, NJ: Prentice-Hall, 1981.

Luadder, Warren J. Problems in Engineering Drawing, Volumes I and II. Englewood Cliffs, NJ: Prentice-Hall (workbook).

ENGINEERING MATERIALS

COURSE DESCRIPTION

The purpose of the course is to provide the student with the knowledge of the more important physical properties, limitations, and processing of metals, plastics, and ceramics so that he will be able to select materials to use in engineering designs.

PREREQUISITE: Statics, Dynamics

CREDIT HOURS: 3-4-5

COURSE OUTLINE

	Student Contact Hours Class	Laboratory
I. Materials of Engineering A. Materials in Industry B. Types of materials	1	
II. Properties A. Mechanical properties 1. stress 2. strain 3. hardness 4. toughness B. Thermal properties 1. thermal conductivity 2. expansion	4	12
III. Steel Products A. Making of steel B. Steel terminology	2	2
IV. Heat Treatment of Steels A. Equilibrium diagrams B. Microstructure of steel C. Reasons for heat treating D. Heat treat cycles	3	4
V. Surface and Local Hardening A. Mechanisms B. Processes	3	4
VI. Carbon and Alloy Steels A. Alloy designations B. Carbon steels C. Alloy steels	2	4
VII. Tool Steel	1	

		Student Contact Hours	
		Class	Laboratory
VIII.	Cast Iron	2	
IX.	Corrosion A. Nature of corrosion B. Factors affecting corrosion C. Types of corrosion	3	4
X.	Aluminus and Its Alloys A. General characteristics B. Alloy designations	2	4
XI.	Copper and Its Alloys A. Properties B. Alloys	2	
XII.	Polymer Materials A. Types B. Strengthening mechanisms C. Polymer systems D. Uses of plastics 1. structural components 2. friction & wear	3	4
XIII.	Ceramics A. Types B. Applications		2

STUDENT LABORATORIES

- Determine and compare the tensile properties of various materials.
- Measure the compressive stress and strain of metal or ceramic samples.
- Polish a metal specimen furnished by the instructor and observe the specimen in a microscope and sketch the observed surface, each the surface and sketch the etched surface.
- Measure the hardness of metal samples with either the Brinell, Rockwell, or Vickers hardness test.
- Perform a Charpy impact test on metal specimens and measure the energy absorbed and determine whether the fracture was ductile or brittle.
- Determine the effect of cold working and annealing on the structure and properties of metal samples.
- Determine the increase of hardness of the metal as a function of cold work and the determination of the annealing rate as a function of time and temperature.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Discuss the production of iron and steel.
- Explain atomic and molecular structure of metals, polymers and ceramics.
- Discuss plastic deformation, annealing and hot working.
- Work binary phase diagram problems.
- Prepare metallogrpahic specimens.
- Discuss various heat treatments on carbon steel.
- Discuss surfact hardening treatments.
- Explain the nature and use of alloy steels, cast itons, nonferrous metals, plastics and ceramics.
- Discuss the effect of wear and corrosion.

RECOMMENDED TEXTS

Budinski, Kenneth. Engineering Material Properties and Selection (Second ed.,). Reston, VA; Reston Publishing Co, 1983.

Van Vlack, L.H. A Textbook of Material Technology. Reading, MA: Addison-Wesley Publishing Co.

FLUID POWER

COURSE DESCRIPTION

Fluid Power is designed to give the student an overview of fluid power technology and a working knowledge of each of the componenets used in fluid circuits. Hydraulic and pneumatic systems are covered. Topics include fundamentals of fluid dynamics, coventional fluid circuits, and fluid power components.

PREREQUISITE: Physics III

CREDIT HOURS: 4-3-5

COURSE OUTLINE:

	Student Contact Hours Class	Laboratory
I. Introduction and Fundamentals of Fluid Power	5	6

- A. Introduction of fluid power
  1. background and applications of fluid power.
  2. advantages and disadvantages of fluid power
  3. capabilities
  4. how fluid power works
- B. Basic fluid power systems
  1. hydraulic systems
  2. pneumatic systems
- C. Review of physics fundamentals
  1. forms of energy
  2. force and pressure
  3. work done by a fluid
  4. power in fluid power systems
- D. Basic principles of fluid behavior
  1. the continuity equation
  2. Bernoulli's theorem
  3. Torricelli's theorem
  4. Gas Laws
  5. Pascal's Law
  6. Charles's Law
- E. Basic fluid symbols
- F. Summary

II. Fluid Power Properties and Characteristics

- A. Properties of hydraulic fluids
  1. viscosity
  2. viscosity index
  3. lubricating ability

	Student Contact Hours Class	Labortory
4. rust and corrosion prevention		
5. oxidation stability		
6. resistance to foaming		
7. flash and fire points		
B. Types of hydraulic fluids		
1. water		
2. petroleum oils		
3. water-oil emulsions		
4. water-glycol fluids		
5. synthetic fluids		
C. Replacing hydraulic oil		
III. Fluid Storage, Conditioning Maintenance	6	3
A. Reserviors and tanks		
1. hydraulic reservoirs		
2. pneumatic tanks		
B. Temperature Control		
1. cooling in hydraulic systems		
2. cooling in pneumatic systems.		
C. Filters and strainers		
1. types of hydraulic filters		
2. location of hydraulic filters		
3. pneumatic filters		
4. air pressure regulators		
5. air-line lubricators		
6. FRL units		
D. Sealing devices		
1. compression packings		
2. O-rings		
3. V-rings		
4. piston cup packings		
5. piston rings		
6. water rings		
7. seal materials		
E. Summary		
IV. Pumps and Compressors		
A. Theory of pumps	6	3
1. positive-displacememt pumps		
2. characteristics of positive displacement liquid pumps		
3. nonpositive-displacement pumps		

	Student Contact Hours	
	Class	Laboratory
B. Hydraulic Pumps		
1. vane pumps		
2. piston pumps		
3. selection of hydraulic pumps		
4. pump maintenance		
C. Pressure boosters		
D. Air compressors		
1. reciprocating compressors		
2. rotary compressors		
3. compressor maintenance		
E. Vacuum pumps		
F. Summary		
V. Actuators and Fluid Motors	6	3
A. Fluid power actuators		
1. constructon of hydraulic cylinders		
2. cylinder operating characteristics		
3. construction of air cylinders		
4. mounting and application of cylinders		
5. special cylinder types		
6. rotary actuators		
7. causes of cylinder failure		
8. cylinder maintenance		
B. Fluid motors		
1. hydraulic motor tyopes		
2. hydraulic motor performance		
C. Summary		
VI. Fluid Distribution and Control Devices	6	3
A. Accumulators		
1. accumulator types		
2. accumulator applications		
B. Pressure intensifiers		
C. Fluid conductors and connectors		
1. rigid pipes		
2. semirigid tubing		
3. flexible hoses		
4. plastic tubing		
D. Fluid control devices		
1. directional control valves		
2. servo valves		
3. pressure control valves		
4. flow control valves		

	Student Contact Hours	
	Class	Laboratory
5. other control valves		
E. Summary		
VII. Fluid Circuits	6	6

A. Fluid power symbols
B. Basic hydraulic circuits
   1. cylinder circuits
   2. motor circuits
   3. speed control
C. Basic pneumatic circuits
   1. cylinder circuits
   2. motor circuits
   3. speed control
   4. multi-pressure circuits
D. Synchronous motion
   1. hydraulic cylinders in series
   2. fluid motors as synchronizers
   3. air cylinders
   4. hydraulic motors
E. Acutator speed
   1. pneumatic circuits
   2. hydraulic circuits

STUDENT LABORTORIES

- Construct and operate fluid circuits for single-acting hydraulic, and double-acting cylinders.
- Compare characteristics and operation of the cylinders.
- Measure volumetric efficiency of a hydraulic pump, overall efficiency of a hydraulic power system, and delivery rate of an air compressor.
- Construct and operate fluid power circuits for operation of single-acting, hydraulic and double-acting cylinders, and for operation of hydraulic and pneumatic motors.
- Construct and operate a circuit using an accumulator to power a pressure intensifier and a circuit to sequence the operation of hydraulic cylinders.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able

- Identify components and describe the function of basic hydraulic and pneumatic power systems; show all connections for operating a single-acting cylinder.
- Calcuate quantities for a fluid power system.
- Construct and operate fluid circuits for single-acting cylinder.
- Describe principles of fluid behavior and explain how they

relate to fluid power systems.

- Explain hydraulic system problems(rust, corrosion, oil viscosity too high or low, oil oxidation).
- Describe and list characteristics of hydraulic fluids.
- Construct fluid power circuits, comparing characteristics and operation of each.
- List characteristics and function of each major part of a hudraulic reservior.
- Explain the role of a compressed-air tank in fluid conditioning in a pneumatic system.
- Explain importance and methods of controlling temperature of fluid in hydraulic and pneumatic systems.
- Explain operation, advantages, and disadvantages of various hydraulic filters, and filter locations.
- Explain operation of each element in a pneumatic filter-regulator-lubricator unit.
- Draw diagrams of and list applications, and approximate operating temperature ranges of various seal materials.
- List characteristics, applications, and approximate operating temperature ranges of various types of pumps.
- Calculate delivery rate of a compressor.
- Explain importance of cooling and how cooling is accomplished with air and water in a multistage piston compressor.
- Explain operation of reciprocating compressors and of positive -displacement and nonpositive-displacement rotary air comporessors.
- Explain types of damage and maintenance to prevent these damages to pump and hydraulic compressors.
- Measure volumetric efficiency of hydraulic pump,overall efficiency of a hydraulic power system, and a delivery rate of an air compressor.
- Contrast differences in the construction components and functioning capabilities of hydraulic versus pneumatic cylinders.
- Sketch disgrams and explain operation of common types of actuators. . Describe common causes for actuator failure and malfunction.
- List procedures for troubleshooting damaged cylinders.
- Compare operating characteristics of basic hydraulic motors(gear, vane, axial piston, radial piston).
- Construct fluid circuits for operation of hydraulic and pneumatic motors and compare operating characteristics.
- List and describe the functioning of basic types of accumulators.
- Explain the importance of common types of conductors and their applications.
- List common types of control valves, their importance, and their operating characteristics.
- Construct and operate a circuit using an accumulator to power a pressure intensifier and a circuit for sequencing the operating of hydraulic cylinders.

- Explain design demands and control characteristics important in construction of fluid circuits, including actuator speed limits, slow control characteristics, synchronous motion, cylinder speed.

RECOMMENDED TEXTS

Fluid Power Systems. Waco, TX: Center for Occupational Research and Development, 1980.

Sullivan, James A. Fluid Power Theory and Application. Reston Publishing Company, Inc. 1982.

Vickers. Mobil Hydraulic Manual.

Henke. Introduction to Fluid Mechanics. Addison-Wesley.

MACHINE DESIGN

COURSE DESCRIPTION

The purpose of the course is to provide the basic theories and techniques in analysis of machine parts such as gears, belts, shafting, clutches, and other machine elements. Solutions to the design process includes the sue of applied engineering mechanics and strength of materials. Some of the designs will be based on the methods of failures due to static loads, fatigue loads, and rigidity. Some problems are based on actual installations with emphasis on both design and analysis. The designer gets experience in making assumptions and decisions, which give an opportunity to exercise his ingenuity and creative ability.

PREREQUISITES: Strength of Materials, Mechanical Devices and Systems.

CREDIT HOUTS: 4-3-7

COURSE OUTLINE	Student Contact Hours Class	Laboratory
I. Introduction	2	
A. Computation and precision		
B. Stress		
C. Deformaton		
II. Shafting	4	3
A. Stress concentration		
B. Keyways		
III. Gears	6	3
A. Types		
B. Strength		
C. Use of catalogues		
IV. Mechanical Fabrication	8	6
A. Rivets		
B. Welds		
C. Bolts and screws		
D. Knuckle and cotter joints		
V. Belts and Chains	4	3
A. Flat belts		
B. V belts		
C. Roller chains		
VI. Clutches and Brakes	8	9
A. Plate type		
B. Cone type		
C. Block type		

	Student Contact Hours	
	Class	Laboratory
VII. Springs	8	6

A. Helical
B. Torsion
C. Disk

STUDENT LABORATORIES

- Determine size of a shaft based on strength.
- Determine size of a shaft based on deflection.
- Calculate strength of gear teeth.
- List types of gear failures.
- Determine the stresses in a knuckle and cotter joint.
- Size a knuckle and cotter joint.
- Determine loads on the rivets of an eccentrically loaded connection.
- Calculate the length and contact angle of a belt or chain.
- Find the allowable horsepower for a flat belt.
- COmputer the number of V belts required in a drive.
- Design a plate or block type brake.
- Find the torque transmitted by a cone clutch.
- Compute the spring rate of a coil spring.
- Analyze a spring for torsional stresses.
- Compute the deflection of a spring.
- Design a simple mechanical device.

STUDENT COMPETENCIES

- Design a shaft, taking into consideration stress concentration.
- Calculate the required dimension of a shaft key.
- Describe the terminology used in gear design.
- Classify the types of gears.
- Use catalogues to select gears.
- Design a rivet or bolt connection.
- Determine the strength of a weld joint.
- Describe the different types of chains.
- Classify the categories of clutches and brakes.
- Analyze torque or force requirements for a clutch or brake.
- Know the purpose of different types of springs.
- Select a coil spring for a given deflection and load.
- Calculate wire size of a coil spring.

RECOMMENDED TEXTS

Machine Design: Black; McGraw-Hill

Machine Design: Myatt; McGraw-Hill

Machine Design: Levision; Reston

Design of Machine Elements: Spotts; Prentice-Hall

MANUFACTURING PROCESSES I

COURSE DESCRIPTION

This course is designed to provide a background of knowledge covering various manufacturing materials and fundamental types of manufacturing methods as employed in cold working processes. Through lecture, demonstration, familiar with the various types of machine tools, tooling, measuring, and inspection procedures. Automation is introduced and information is presented to aquaint the student with the practices of numerical control for machine tools and the uses of special machines.

PREREQUISITE: Engineering Graphics

CREDIT HOURS: 1-6-7

COURSE OUTLINE

	Student Contact Hours Class	Laboratory
I. Introduction to Production Processes	2	
A. Course objectives		
B. Production design and process selection		
1. product specifications		
2. production design		
3. production process		
4. inspection		
5. marketing		
II. Principles of Metal Cutting	1	
A. Mechanics of metal cutting		
B. Metal cutting tools		
III. Metal Cutting Tools	1	30
A. Turning lathes		
1. types		
2. construction and design		
3. operation		
B. Turret and automatic lathes		
1. types		
2. construction and design		
3. operations		
4. multiple toolings		
C. Screw machines		
1. types		
2. construction and design		
3. operations		
D. Drilling machines		
1. types		
2. construction and design		
3. operations		
E. Boring machines		
1. types		
2. construction and design		
3. operation		

	Student Contact Hours Class	Laboratory
F. Planers and shapers 1. types 2. construction and design 3. operation G. Milling Machines 1. types 2. construction and design 3. operation H. Broaching machines 1. types 2. construction and design 3. operation I. Sawing machines 1. types 2. construction and design 3. operation J. Grinding machines 1. types 2. construction and design 3. operation K. Gear cutter machines 1. types 2. construction and design 3. operation		
IV. Special Cutting Tools A. Chemical milling machines 1. processes 2. applications 3. operation B. Electrical discharge machines 1. processes 2. applications 3. operation C. Electrochemical machines 1. processes 2. applications 3. operation D. Laser bean machines 1. processes 2. applications 3. operation E. Ultrasonic machines 1. processes 2. applications 3. operation F. Electron beam machines 1. processes 2. applications 3. operation	1	18

	Student Contact Hours	
	Class	Laboratory
G. Automatic machines		
1. definition		
2. application		
H. Numerical control machines		
1. definition		
2. computers		
3. control concepts		
4. application		
5. operation		
V. Metal Forming Machines	2	
A. Processes		
B. Operations		
1. stamping		
2. piercing		
3. bending		
4. drawing		
5. rolling		
6. squeezing		
VI. Measuring, Gaging, and Inspection Techniques	1	6
A. Visual inspection		
B. Direct measurement		
C. Comparative measurement		
D. Precision measurement		
E. Measuring standards		
F. Tolerances		
G. Optical measuring		
VII. Finishing	2	6
A. Surface finishing		
1. types		
2. processes		
B. Cleaning and coating		
1. mechanical cleaning		
2. chemical cleaning		
3. organic coating		
4. inorganic coating		
5. metallic coating		
6. conversion coating		

STUDENT LABORATORIES

- Conduct a tour of the school facilities to include machine shop, tool and die shop and welding shop.
- Conduct tour of local manufacturing industry which would include machine ships, foundries, fabrication shops, etc.
- Observe machine operations in local industries.
- Show film of different forms of metal cutting procedures.

- Give a hypothetical piece part, have the student design and describe a manufacturing process to produce it, to include the overall system, the necessary equipment, and processses performed.
- Have student assist in performing proper metal cutting procedures on selected piece parts on the following metal cutting tools:
  - Lathe
  - Milling machine
  - Drill press
  - Saw
  - Grinder
- Show a film on as many processes as possible.
- Instructor will demonstrate common measuring devices to class. Student will then practice measurements with each of the devices, and will report results.
- Given selected machine parts, student will select the proper measuring device, perform and report measurements for each.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Discuss elements used in selection and design of the processes used in manufacturing.
- Describe what takes place when metal is cut.
- Name and describe principal cutting tools.
- Explain the purpose of cutting fluids.
- Define the terms "speed" and "feed" and explain how they are related to lathe work.
- Define the following lathe terms:
  - Plane or straight turning
  - Facing
  - Parting
  - Chamfering
  - Knurling
  - Swing
  - Headstock
  - Tailstock
  - Coinage
  - Bed
- Explain operation of an engine lathe.
- Describe the most common lathe accessories and attachments.
- List ways to cut tapers on a lathe.
- Constrast major differences among a bench lathe, a tool lathe, and a speed lathe.
- Discuss important features of a horizontal turret lathe and describe the nature of work performed.
- Define the following terms:
  - Drilling
  - Core drilling

Counterdrilling
Step drilling
Boring
Counterboring
Spot-facing
Countersinking
Reaming

- Name the two types of boring machines.
- Contrast important similarities and differences between shaping and planing.
- Describe the difference between peripheral milling and face milling.
- Describe a hole broach and name its principal operations.
- List important advantages.
- Give a practical tolerance for production grinding operations.
- Name the three classes of gear cutting methods.
- Prepare a brief outline showing the sequence of operations involved in:
    - Chemical blanking
    - Contour machining
- Explain why EDM is not classified as a high-volume production proces.
- Compare similarities and differences of ECM and EDM.
- Discuss reasons that a CO2 laser is particularly effective for machining nonmetals.
- List important factors that control the quality of surface finish obtained by ultrasonic machines.
- Define an electron beam.
- Given certain production criteria, make an analysis to determine whether to auotmate an operation.
- Prepare a sketch illusrating how five axes of machine motion might be applied to manufacturing operations on a machine part.
- Define the following forming operations:
    - Stamping
    - Piercing
    - Bending
    - Drawing
    - Rolling
    - Squeezing
- Give an example of the machines and tools used for those operations listed above.
- Explain differences between inspection, quality control, and statistical quality control.
- Define the following measurement terms:
    - Tolerance
    - Allowance
    - Clearance
    - Basic size
    - Standard size
    - Nominal size

- Given a number of direct measurement, comparative measurement, and precision measurement instruments, perform and record results of an inspection of various parts to determine if the parts conform to appropriate measuring standards.
- Using a table of typical surface finish values, compare the ranges of surface-roughness-height values of drilling, grinding, and polishing.
- Explain why honing cannot be used as a method to improve errors of hole location or alignment on a workpiece.
- List some limitations of abrasive blasting.
- Discuss the major advantages of ultrasonic cleaning.
- Explain why alkaline cleaning of aluminum, zinc, brass, or tin workpieces is not recommended.
- Explain the function of organic coating and inorganic coating.
- Compare metallic coating with conversion coating.
- List advantages of vibratory finishing.

RECOMMENDED TEXTS

Doyle, L.E., Manufacturing Processes and Materials for Engineers, 2nd Edition. Englewood Cliffs, NJ: Prentice-Hall Inc., 1969.

Yankee, H.W., Manufacturing Processes, Englewood Cliffs, NJ: Prentice-Hall Inc., 1979.

MANUFACTURING PROCESSES II

COURSE DESCRIPTION

This course is designed to provide a background of knowledge primarily covering the various hot working processes. Through lecture, demonstration, and discussion the student becomes familiar with the various methods of welding and their applications, casting machinery and methods, and special machining operations such as ultrasonic, electrolytic grinding and chemical milling.

PREREQUISITE: Manufacturing Processes I

CREDIT HOURS: 1-6-3

COURSE OUTLINE

	Student Contact Hours Class	Student Contact Hours Laboratory
I. Introduction to Hot Working Processes	1	
A. Course objectives		
B. Class procedures		
C. History of welding processes		
D. Welding processes & nomenclature		
1. arc		
2. gas		
3. inert gas		
4. brazing		
5. forge		
6. carbon arc		
7. submerged arc		
8. laser beam		
9. various automated processes		
II. Welding Procedures- Arc		12
A. Safety		
B. Machines & accessories		
1. electrodes		
2. base materials		
C. Types of welds		
D. Applications		
III. Welding Procedures- Oxyacetylene		12
A. Saftey		
B. Equipment & materials		
1. rods		
2. base materials		
C. Types of welds & brazing		
D. Applications		

		Student Contact Hours Class	Laboratory
IV.	Welding Procedures - Inert Gas		12
	A. Saftey		
	B. Equipment & materials		
	1. gases		
	2. rods		
	3. base materials		
	C. Types of welds		
	D. Applications		
V.	Welding Design Considerations	1	
	A. Appropriate types of joints		
	B. Symbols		
	C. Casting vs. weld fabrication		
	D. Weld testing		
	E. Economy considerations		
	F. Other		
VI.	Introduction to Metal Casting	1	
	A. Ferrous metals		
	1. historical development		
	2. modern processing (production of metals)		
	B. Nonferrous metals		
	1. historical development		
	2. modern processing (production of metals)		
VII.	Foundry Practices		2
	A. Patterns - construction		
	B. Molding considerations		
	1. sand casting		
	2. sandless casting		
	C. Coring considerations		
	D. Gating and risering		
VIII.	Foundry Equipment & materials		4
	A. Melting equipment		
	B. Molding equipment		
	C. Casting equipment		
	D. Foundry accessories		
	E. Foundry materials		
IX.	Types of molds	1	2
	A. Classification		
	B. Application and use		
X.	Types of cores	1	2
	A. Classification		
	B. Mixtures and binders		
	C. Core finishing		

		Student Contact Hours Class	Laboratory
XI.	Foundry Sands A. Natural types and uses B. Synthetic sands and uses C. Foundry sand preparation	1	2
XII.	Sand Testing A. Types B. Purposes of sand control tests C. Sand preparation D. Equipment used		6
XIII.	Molding Machines A. Types B. Applications	1	
XIV.	Permanent Molding A. Design B. Types C. Uses	1	
XV.	Die Casting and Investment Casting A. Types of equipment B. Applications C. Advantages and limitations		6
XVI.	Casting Design and Economy A. Shapes B. Types of metals used C. Economy of foundry practices	1	
XVII.	Special Processes A. Electroforming B. Electrolytic grinding C. Chemical milling D. Ultrasonic machining E. Electric-discharge machining F. Electron beam welding G. Electron beam machining	1	

STUDENT LABORATORIES

- Set up range compatible with rod & material to be welded.
- Select correct rod for material and weld position.
- Correctly prepare material for welding.
- Perform satisfactory down-hand butt weld.
- Perform in other positions as time permits.

- Safely set up torch to cut.
- Cut or level specimans.
- Safely and properly set up torch for brazing.
- Perform satisfactory brazing on light metal.
- Safely and properly set up torch for welding.
- Satisfactorily weld light metal.
- Safely and correctly set up equipment for light metal.
- Choose correct heat and rod for material to be welded and satisfactorily weld light metal.

STUDENT COMPETENCIES

At the conclusion to this course, the student will be able to:

- Briefly trace the history of welding.
- Describe all major welding processes.
- Demonstrate basic welding vocabulary.
- Demonstrate correct set up of machine vs. material & rod to be used.
- Produce acceptable butt weld in down-hand position.
- Perform safe, proper set up and cut light plate.
- Perform safe, proper set up and produce acceptable brazed joint.
- Perform safe, proper set up and produce an acceptable butt weld on light metal.
- Demonstrate safe, proper set up vs. metal and rod to be used.
- Describe some considerations favorable to welded assemblies vs. cast assemblies.
- Briefly trace the history of ferrous metals.
- Briefly trace the history of non-ferrous metals.
- Describe basic casting from pattern to part.
- Describe current equipment and materials.
- Describe types of molds and applications.
- Define a core and describe types and applications.
- Decribe types and preparation of foundry sands.
- Explain reasons for testing & types of tests on sand.
- Describe the major types of molding machines.
- Define the concept, types, and uses of permanent molding.
- Define the concept of die casting.
- Describe types of equipment used in casting.
- Explain advantages and disadvantages of casting.
- Explain what shapes are feasible to cast.
- Explain what shapes are economical to cast.
- Explain some factors affecting the casting economy.
- Describe the following processes:
  a. Electroforming
  b. Electrolytic grinding
  c. Chemical milling
  d. Ultrasonic machining
  e. Electric-discharge machining(EDM)
  f. Electron beam welding
  g. Electron beam machining

RECOMMENDED TEXTS

Doyle, L.E., Manufacturing Processes and Materials for Engineers, 2nd ed., Englewood Cliffs, NJ, Prentice-Hall, Inc., 1969.

Yankee, H.W., Manufacturing Processes, Englewood Cliffs, NJ, Prentice-Hall, Inc., 1979.

MECHANICAL DEVICES AND SYSTEMS

COURSE DESCRIPTION

Mechanical Devices is an introductory treatment of modern mechanical drives, combining the elements of mechanical theory with those of practicality. The topics treated includes: various gear drive configurations employing spur, bevel and helical gears, friction drives, and some selected special topics such as cams and universal joints. An attempt has been made to expose the student to a practical skill of mechanical assembly.

PREREQUISITES: Dynamics

CREDIT HOURS: 4-3-7

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Spur Gear	7	21
A. Velocity ratio		
B. Torque ratio		
C. Simple trains		
D. Compound trains		
E. Reverted gears		
F. Internal gears		
II. Special Gears	4	12
A. Helical gears		
B. Bevel gears		
C. Worm gears		
D. Cross-helical		
III. Special Applications	3	9
A. Rack and pinion		
B. Counter rotaters		
C. Combined mechanisms		
D. Differentials		
IV. Linkages	2	6
A. Terms and definitions		
B. Types of linkages		
C. Linkage analysis		
V. Miscellaneous Drives	4	12
A. Disk drive		
B. Cams		
C. Universal joints		

STUDENT LABORATORIES

- Assemble a gear and pinion.
- Compute the velocity and torque ratio.

- Construct a simple and compound gear train.
- Measure the velocity ratio of bevel and worm gear.
- Solve for the displacement in a rack and pinion set up.
- Make a counter rotater drive.
- Set up a mechanical differential and measure its speed ratio.
- Measure and calculate the mechanical properties of disk drives and rotary cams.
- Upon examination of two or more of various list of mechines, identify type of linkages used. Sketch and describe each mechanism movement using arrows to show force input and output.

STUDENT COMPETENCIES

- Computer gear speed ratios.
- Calculate torque and displacement.
- Identify types of gears.
- Explain the advantages of a worm gear.
- Discuss the purpose of bevel and helical gears.
- Sketch a simple and compund gear train.
- Analyze the angular displacement of a differential.
- Describe the operation of disk drives.
- Interpret the effects of the angle of a universal joint on its velocity output.
- Name and explain the operational characteristics and major components of common mechancal linkages.
- List and describe the used and operational characteristics of common cams and cam sytems.

RECOMMENDED TEXT

Drives: Center for Occupational Research and Development; Waco, Texas

Mechanical Devices and Systems: Center for Occupational Research and Development; Waco, Texas.

Millwright and Mechanics Guide: Audel

Machinery Handbook

MET PROBLEMS

COURSE DESCRIPTION

The problems course in mechanical engineering technology, as outlined here, puts the design and production students together in a simulated engineering/manufacturing situation. Additionally, it is recommended that the electromechanical technology students join with the mechanical technology classes to combine all the resources needed to address a complex project such as designing and building equipment needed in a robotic cell.

The production student can gain from involvement in the design, the design student can gain from the manufacturing aspect and the electromechanical student can benefit from both, which adding the expertise needed to connect and checkout the system.

It is recommended that the project(s) present as complete a CAD/CAM path as possible; i.e., design, drawing, tooling and machining. Additionally, it would be desirable to incorporate an adequate electric/electronic component to assure a challenge to the electromechanical student.

PREREQUISITE: Consent of Instructor

CO-REQUISITE: None

CREDIT HOURS: 0-9-3

COURSE OUTLINE	Student Contact Hours Class	Laboratory
I. Assignment and Clarification of Projects	2	

I. Assignment and Clarification of Projects
   A. Instructor suggests one or more of the following (or similar):
      1. end effector(s) for robot(s)
      2. pick and place station(s) for robot(s)
      3. interface devices for robot cell(s) in conjunction with electromechanical students
         a. conveyor(s)
         b. holding devices for drilling
         c. turning & "flipping" devices
         d. feed devices (move roll of sheet metal, advance

	Student Contact Hours	
	Class	Laboratory

for stock, etc.)

e. brackets for robot arms (to hold sight devices, etc.)

4. duplicate, machine and assemble structural parts of robots in conjunction with electromechanical tech
5. design, machine and assemble simple robots (pick & place) in conjunction with electromechanical tech
6. design tools for the CNC mill
7. design tools for the CNC lathe
8. others

	Class	Laboratory
II. Produce Preliminary Sketches		7
III. Generate Total Design and Make Database		47

A. Overall drawing and detail database
B. All tolerancing and production notes
C. All tooling data needed for fixtures
D. Generate part programs & machine
E. Measure on 3-axis validator
F. Assemble projects

IV. Test and Evaluate Product

A. Run as complete engineering test as practical
B. Write test report and/or failure analysis
C. Prepare and publish corrections (may be used for the next problem class)

STUDENT LABORATORIES

- Students will develop preliminary design sketches on CAD.
- Students will create a total CAD/CAM project, from design to machining.
- Students will develop and conduct engineering test(s) on product.

STUDENT COMPETENCIES

- Demonstrate ability to convert engineering parameters to mechanical design.

- Create a total CAD/CAM design/manufacture program and produce a product.
- Design and conduct an engineering test for the product created.
- Prepare and publish results of the engineering test.

STATICS

COURSE DESCRIPTION

Statics, a branch of mechanics, is the study of force and their effects on bodies at rest. This study provides a fundamental background for the mechanical engineering technician to be able to analyze problems in a logical manner. Students will apply these principles in understanding structural systems.

PRERFQUISITES: Physics II, Analytical Geometry, anc Calculus

CRLDIT HOURS: 4-3-7

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Introoduction to Statics A. Definitions B. Fundamentals concepts and principles C. Units	4	3
II. Basic Principles A. Scalars and vectors B. Newtons's laws C. Description of statics problems D. Free body diagram	8	6
III. Forces and Equilibrium A. Introduction B. Forces C. Moments and couples D. Resultant of force systems E. Equilibrium	12	9
IV. Center of Gravity and Moment of Inertia A. Center of Gravity 1. parallel force systems 2. irregular areas 3. composite areas B. Moment of Inertia 1. parallel axis theorems 2. composite areas 3. radius of gyration	8	6
V. Truss Analyis A. Concurrent force systems B. Non-concurrent force systems	8	6

Student Laboratories

- Students will solve a series of force problems with multiple forces.
- Students will measure the forces at different points within a truss.
- Students will extend their experience with force problems through an investigation of moments.

Student Competencies

By the conclusion of this course, the student will be able to:

- Define statics.
- Define scalar and vector, and position vector.
- Add and subtract vectors.
- Multiply vectors by scalars.
- Find the dot product and cross product of 2 vectors.
- Draw a free body diagram for a problem showing all of the forces acting on the body.
- Determine the resultant of 2 forces graphically and by trigonmetry.
- Find the resultant of 2 forces by adding x and y components.
- Resolve a force into two components.
- Find the moment of a force about a point.
- Find the addition of 2 couples.
- Reduce a system of forces to one force and a couple.
- Define center of gravity, and moment of inertia.
- Calculate the center of gravity of discrete weights, irregular areas and composite areas.
- Explain the parallel axis theorem.
- Calculate the moment of inertia of composite area.
- Calculate the radius of gyration.
- Find the addition of 2 couples.

Recommended Texts

Brannernan, Mechanics. McGraw-Hill Book Company

Jensen & Chenoweth, Applied Engineering Mechanics. McGraw-Hill Book Company.

STRENGTH OF MATERIALS

COURSE DESCRIPTION

Strength of materials is designed to give the student an overview of how materials behave when subjected to different loadings and restraints and for the student to predict this behavior in a given situation. Topics presented will include concepts of stress, strain, torsion, center of gravity and moments of inertia. The course is intended for students who have successfully completed courses in Statics and Dynamics.

PREREQUSITES: Statics and Dynamics, Calculus

CREDIT HOURS: 4-3-7

COURSE OUTLINE:

	Student Contact Hours	
	Class	Laboratory
I. Simple Stress and Strain	8	6
A. Normal stresses		
B. Shearing stresses		
C. Ultimate stresses		
D. Allowable stress		
E. Factor of safety		
F. The direct-stress formula		
G. Axial deformation (strain)		
H. Elasticity-elastic limit		
I. Hook's Law		
J. Shearing deformation and Poisson's Ratio		
K. The stress-strain diagram		
L. Stress concentration		
M. Axial stresses in members of two materials		
II. Torsion		
A. The torsion formula	4	3
B. Analysis and design of circular shafts		
C. Shaft couplings		
D. Angle of twist		
E. Power transmission of shafts		
III. Beams	12	9
A. Beam loading conditions		
B. Shear and shear diagrams		
C. Bending moments and moment diagrams		
D. Bending stress, the flexure formula and section modulus		
E. Shearing stresses in standard sections		
F. Designing beams of standard sections		

	Student Contact Hours Class	Laboratory
G. Calculating the Deflection of Beams		
H. Statically Indeterminate Beams		
IV. Bending Combined With Tension or Compression	4	3
A. Combined axial and bending stresses		
B. Combined stresses caused by eccentric axial loading		
V. Compression Members	4	3
A. Types of compression members and loading		
B. Radius of gyration and slenderness ratio		
C. Euler's formula for column design		
D. Gordon-Rankin formula for column design		
VI. Bolted, Riveted and Welded Connections	8	6
A. Types of failures in riveted and bolted connections		
B. Calculating shearing strasses in rivets and bolts		
C. Calculating bearing stresses in rivetsand bolts		
D. Designing simple riveted and bolted joints		
E. Designing simple welded connections		

STUDENT LABORATORIES

- Research the availability of steel structural shapes according to ASTM standards from the AISC handbook. .
- Identify structural shapes (W, M, S, HP, C, L, BAK,) (AISC handbook)
- Research dimensions for detailing from the AISC handbook.
- Research data of allowable stress for structural cross sections.
- Explore applications of composite materials in industry (graphite, fiberglass, etc.)
- Identify beam types and loading conditions.
- Identify failures in riveted, bolted and welded connections.
- Prepare a stress-strain diagram.
- Construct free body diagrams.
- Construct shear and moment diagrams.
- Perform a tensile test.
- Perform a hardness test.
- Explore applications of aluminum, copper, titanium, cobalt, brass,tin,lead,nickel in industry.

STUDENT COMPETENCIES

- Define terms as; normal shearing, ultimate and allowable stress, factor of safety, axial deformation, elasticity, Poisson's Ratio, modulus of elasticity.
- Solve problems in stress and strain.
- Identify points on the stress-strain diagram.
- Solve axial stresses in members of two materials.
- Solve problems involving Poisson's Ratio.
- Solve problems in temperature stresses.
- Solve problems in shearing deformation.
- Solve problems in torsion.
- Solve problems in power transmission on shafts.
- Calculate shear in beams and draw shear diagrams.
- Calculate bending moments and draw moment diagrams.
- Design beams if standard section.
- Calculate deflections in beams.
- Design simple statically indeterminate beams (beams over 3 or 4 spans).
- Define radius of gyration and slenderness ratio.
- Identify types of compression members and loading conditions. . Design compression members using Euler's Formula and the Gordon-Rankin Formula.
- Calculate problems involved with bending combined with tension.
- Design simple riveted, bolted and welded connections.

RECOMMENDED TEXTS

Granet, Irving, Strength of Materials for Engineering Technology. Reston, VA Prentice-Hall Co., 1980.

Materials. Waco, TX Center for Occupational Research and Development, 1980.

PILOT LEVEL TEACHING EQUIPMENT INFORMATION

FOR MECHANICAL TECHNOLOGY

Note: This is a suggested equipment list which is considered to be a minimum requirement for carrying out pilot level programs.

MECHANICAL ENGINEERING TECHNOLOGY PROGRAMS - SUGGESTED EQUIPMENT INFORMATION

Equipment/ Instrumentation	Training Devices/ Systems	Qty. Per School	Approximate Unit Cost	Extension
Basic Courses				
These items may be used jointly with mechanical and electromechanical technology	Drafting Tables	20	500	10,000
	Track Drafters	20	350	7,000
	Diazo Printer	1	1,500	1,500
	Hardening Furnace	1	10,000	10,000
	Tempering Furnace	1	9,000	9,000
	Polishing Table	2	2,000	4,000
	Grinding Table	2	2,000	4,000
	Cut-off Machine	1	6,000	6,000
	Mold Press	3	1,500	4,500
	Belt Surfacer	2	3,000	6,000
	Metallurgical Microscope	4	3,000	12,000
	Metallograph	1	30,000	30,000

MECHANICAL ENGINEERING TECHNOLOGY PROGRAMS - SUGGESTED EQUIPMENT INFORMATION

Basic Courses

Equipment/ Instrumentation		Training Devices/ Systems	Qty. Per School	Approximate Unit Cost	Extension
CNC Milling Machine			1		
Drill Press	Sharing		3	10,000	30,000
Surface Grinder	Possible with		3	20,000	60,000
Lathes, 145"	Electro-		3	8,000	24,000
Vertical Mill	Mechanical Program		3	30,000	90,000
Horizontal Mill			12	500	6,000
Tool Sets and Gauges		Mechanical Drives Trainers Belt Drives Chain Drives Mechanical Linkages Trainers			
	Shared with Other Programs	Levers, Followers Rocker Arms, Geneva Mechanism Cranks, Sliding Links Drag links, Ratchets Cams, Toggles			

MECHANICAL ENGINEERING TECHNOLOGY PROGRAMS - SUGGESTED EQUIPMENT INFORMATION

Basic Courses

Equipment/ Instrumentation	Training Devices/ Systems	Qty. Per School	Approximate Unit Cost	Extension
CNC Coordinate Measuring Machine		1	75,000	75,000
CNC Machine Tuning Center		1	100,000	100,000
CNC Wire Feed EDM		1	75,000	75,000
CNC Floppy Disk Programming Center		1	20,000	20,000
Atmospheric Controlled Heat Treatment Center		1	25,000	25,000
Hardness Tester		1	10,000	10,000
Tensile Testing Machine		1	15,000	15,000
Digital Optical Comparator		1	30,000	30,000
Electronic Microscope		1	20,000	20,000
Computer Assisted Drafting System		1	97,000	97,000
				$467,000

APPENDIX A

SUGGESTIONS FOR
IMPLEMENTING A
PROBLEMS COURSE

SUGGESTIONS FOR IMPLEMENTING A PROBLEMS COURSE

I. INTRODUCTION

The problems course is intended to be the capstone of the two years a student spends in the technical school. It should be problem/project centered and attempt to synthesize everything that has occurred throughout the curriculum. It is also possible to broaden the student's areas of understanding during this time and to cover topics not covered because of time or other constraints. An excellent strategy is to pair students from different disciplines, EMT/EET, Robotics/CAD et., just as might happen in industry. A great deal of learning and sharing can take place through this arrangement and the experiences should as closely as possible approximate the conditions of the "real" high tech world.

II. POSSIBLE PROBLEMS TO BE ENCOUNTERED

Too often, curriculum designers suggest problems courses which sound ideal on paper, but are impossible to implement. This is due, in the final analysis, to widely uppredictable factors discovered at the time the problems course is to come togeher, such as:

A. Student numbers and distribution

The M.E./E.M.T. combination, for example, could arrive at the proper quarter for "problems" without a design student or a production student. What then?

Obviously, adjustments would need to be made. If a mechanical design student were lacking, then a on-design project should be picked - - such as replication an electromechanical device (which would increase the number of devices available for future learning labs.).

Invaluable experience would be gained in measuring the parts to be replicated, then describing them accurately on CAD. If a production student were then available, he/she could translate the CAD data into CAM operations to make the parts. In the absence of a production student, a machine student could complete the CAM cycle.

Finally, the electromechanical technology students could assemble and check out the product. If no electromechanical technology students were available, it is conceivable that the mechanical technology students could complete the project in cooperation with the electronic/electric technology students.

Chances are good that, in combining classes, numbers will seem too large and unmanageable for a single, coordinated project. In this case there are reasonable options:

1. Assign small individual projects concurrently with a coordinated, or group project.
2. Assign a group project large enough so that all students can work on a sub-assembly or detail part of the whole. (Beware of a "log jam" at test and checkout!)
3. Assign two or more group projects.

The above examples of "what-ifs" are intented to serve as a model to stimulate thinking of ways to solve number and distribution problems.

B. <u>Student progress and distribution</u>
Occasionally students arrive at the "problems" area somewhat weak in an area of knowledge. Seldom is distribution of this weakness such that all students have the subject deficiency. In the case of a reasonable number having a well-rounded grasp of the technology, "pairing" of the lesser skilled students with the stronger students can be beneficial.

In a case where the distribution runs to a majority weakness in an area of knowledge, the curriculum should be examined. However, to proceed with the subject group, the staff should steer the projects in such a way that they tend to remediate the lack.

C. <u>Student creativity</u>
It is desirable to draw first from the ideas of the student body in putting together "problems" projects. Often it is possible to assign small projects that were originated individually by the students themselves. Or, students may suggest a coordinated, or group, project that is very worthy. It is an excellent idea to work closely with local firms having tool design needs. Simple tools and equipment can be designed and built for these companies (to the great benefit of both parties). Occasionally, however, solicitation of proposals for projects produces a low number of useable ideas. It is wise to have on hand a number of both individual and group projects from which the students may choose to their liking.

III. PLANNING A PROBLEMS COURSE

A "problems" course can linger in a student's mind as the high-water mark of technical education, or be remembered as waste of time. The difference usually is in the planning done by the school staff.

A. Interdiscipline staff coordination

If "problems" are to be attempted which simulate an engineering / manufacturing environment, an interdiscipline approach should be taken (such as a problem involving M.E. and E.M.T.). The first step is for the staff in these disciplines to meet and address the following minimum issues.

1. What roles each staff member would assume.
2. What laboratories will be needed.
3. What scope of project (s) is reasonable,
4. Maximum material costs affordable.
5. General learning objectives desired.
6. Estimated number of students per group project.

B. Formulating student entry

Many approaches are possible to enlist and assign students to projects, but the staff should have planned in detail how the student be assigned to a "problems" project.

A suggested method follows:

1. Staff and students need to discuss thoroughly the rules regarding time, cost, scope, and grading.
   Give handouts.
2. Students receive a form for proposal and deadline.
3. Students submit proposals.
4. Instructors evaluate proposals, suggest changes and deadline.
5. Instructors assign individual projects and group projects.

C. Formulate engineering coordination methods

Students sharing a group design/make project across 2 or 3 disciplines will need an organized way to coordinate their design and build efforts.

They need to learn the methods employed by industry

1. Suggest that the groups elect a "project" engineer who will be responsible for total coordination of the project. Elect assistant for backup.

2. Suggest that each discipline elect a "group" engineer; i.e., a single point of contact for that group.
3. Suggest that each "group" engineer assign tasks within his/her group.
4. Establish regular coordination meetings (usually with basically a fixed format to prevent digression).
5. Empower "project" engineer to call special meetings as required.
6. Suggest weekly progress reports by "group" engineer to the "project" and a composite weekly report from the "project" engineer.
7. Suggest that "project", in conjunction with "group", prepare a master schedule and keep it current. Off-schedule reports must be accompanied by "make-up" plans and newly scheduled target dates.
8. Suggest that "group" prepare all the input data as they go to allow revision and prompt compilation of the final engineering and cost report.
9. Suggest that "project" demand as we go data to allow compilation of the final engineering and cost reports in a timely manner (project status, man hours, span time and cost, etc.)
10. Suggest that a file be set up for drawings and that it be handled professionally. Changes should be documented and routed to "group" and "project" leaders.

D. Plan the physical details

Often all the people and procedural plans are in order, but the physical and logistical plans are sketchy. They staff should give considerable thought to the following:

1. Materials. Are there adequate materials for student projects?
   Have plans been laid for timely puchases of special needs?

2. Special processes. Some special needs, such as heat-treating, may be generated in the projects. Have plans been laid to handle these needs?

3. Equipment availablity. If the project is large, or if there are multiple projects, access to machines and equipment can become a problem. Considerable thought must be given to availability and scheduling of CAD and CAM

equipment, as well as utilizing non-CAM machines.

4. Space. It is desirable to set up a simulated engineering/produciton setting. Is space available? Can "group" and "project" leaders set up a simulateed office (or work stations with pigeonholes and baskets for report and change notices)?

E. Formulate progress reviews

Obviously the coordinated, or group, project described in c above, will be supplying weekly reports at both group and project levels. They will also maintain a master schedule as well, so progress will be well documented.

It is possible, however, to have a group project going concurrently with small individual projects. The individual should learn the same discipline of reporting that is legislated for the group.

Following is a suggested method:

1. Prepare a "contract" with the student relative to completion of design, build, test and final engineering reports.
2. Discuss the progress reports and format to preclude any misunderstanding. Explain weight of progress reviews in final grade.

3. Follow up! The instructor must call for progress reviews, look at them and return them as quickly as possible.

F. Formulate a grade system
Since student projects have disinct phases it is suggested that some method be designed to grade accoridngly. Additionally, it is sometimes case that a project cannot be completed in the allotted time. If grading is done by phases in these cases, a base exists for formulating a final score.

Phases of a project and grading could be as follows:

1. Organization of the engineering/producion groups.
2. Design of engineering checkoints and controls, including forms and paperwork.
3. How effective group coordinaton actually is.
4. Aptness of the design vs. the oparameters.
5. Producability of the product.

6. How well the design fulfills the original parameters.
7. How well schedules are met
8. The test procedures

APPENDIX B

TECHNICAL SOCIETIES

TECHNICAL PUBLICATIONS OF

INTEREST

TECHNICAL SOCIETIES AND ORGANIATIONS

American Automatic Control Council (AACC)
P.O. Box 12277, Research Triangle Park, NC 27709
919/549-0600

Numerical Control Society (Automatic Control) (NCS)
519 Zenith Drive, Glanview, IL 60025
312/297-5010 Responsibility for the application of numerical control techniques.

Institute of Electrical and Electronics Engineers (IEEE)
345 East 47th Street, New York City, NY 10017
212/644-7910

International Society for Hybrid Microelectronics (ISHM)
P.O. Box 3255, Montgomery, AL 36109 205/272-3191
Ceramics, thick/thin films, semiconductor packaging, discrete semiconductor devices, and monolithic circuits. Bimonthly newsletter.

National Engineering Consortium (NECO (Not an association)
1211 West 22nd Street, Oak Brook, IL 60521 312/325-5700
Provides fellowships, scholarships, grants, and endowments to engineering students for furthering electronic training.

Accreditation Board for Engineering and Technology (ABET)
345 East 47th Street, New York City, NY 10017 312/644-7685
Accredits college engineering curricula and engineering technology programs.

American Association of Engineering Societies (AAES)
345 East 47th Street, New York City, NY 10017
212/686-5676
Advance the science and practice of engineering in the public interest.

American Institute of Industrial Engineers (AIIE)
25 Technology Park, Norcross, GA 30092 404/449-0460
Design, improvement, and installation of integrated systems of people, materials, equipment, and energy.

American Institue of Plant Engineers (AIPE)
3975 Erie Avenue, Cincinnati, OH 45208
Newsletter 8 times/year; journal quarterly.

American Society for Certified Engineering Technicians (ASCET)
4450 West 109th Street, Overland Park, KS 66211 913/341-5669
Skilled technicians whose training and experience qualify them to provide technical support and assistance to registered professional engineers. Certified Engineering Technician, bimonthly.

Automated Procedures and Engineering Consultants (APEC)
Miami Valley Tower, Suite 2100, Dayton, OH 45402
513/228-2602
Application of up-to-date computer technology to building design. Journal, bimonthly.

Engineering Technologist Certification Institute (ETCI)
2029 K Street, NW< Washington, DC 20006 202/659-5773
Not a membership organization. Issues certificates for Associate Technologists and Engineers.

American Institute for Design and Drafting (AIDD)
3119 Prince Road, Bartlesville, OK 74003 918/333-1053
Design and Drafting News, monthly.

Design and Drafting Management Council (DDMC)
P.O. Box 11811, Santa Ana, Ca 92711 714/838-5800
Computer-assisted drafting. Library. Commentary, monthly.

Engineering Reprographic Society (ERS)
P.O. Box 5805, St. Louis, MO 63134 314/232-7386

American Federation of Information Processing Societies (AFIPS)
1825 North Lynn Street, Suite 800, Arlington,VA 22209
703/558-3600
Serves as national voice for the computing field, advanced knowledge of the information processing sciences.

Association for Computing Machinery (ACM)
1133 Avenue of Americas, New York City, NY 10036
212/265-6300

Computer and Automated Systems Association of the Society of Manufacturing Engineers (CASA/SME)
Box 930, One SME Drive, Dearborn, MI 48128 313/271-1500

Instrument Society of America (ESA)
P.O. Box 1227, Research Triangle Park, NC 27709
919/549-8411
Instruments and controls in science and industry. Instrumentation Technology, monthly.

Society of Manufacturing Engineers (SME)
P.O. Box 930, Dearbor, MI 48128 313/271-1500
Library. Manufacturing Engineering, monthly.

American Society for Mechanical Engineers (ASME)
345 East 47th Street, New York City, NY 10017 212/644-7722
Sponsor for ANSI. Library. Applied Mechanics Review, monthly. Mechanical Engineering, monthly.

American Institute of Physics (AIP)
335 East 45th Street, New York City, NY 10017
212/661-9404

American Physical Society
335 East 45th Street, New York City, NY 10017
212/682-7341

American Society for Quality Control (ASQC)
161 West Wisconsin Avenue, Milwaukee, WI 53227
414/272-8575
Quality Progress, monthly.

International Institute for Robotics (IIR)
Box 21078, Dallas, TX 75211
Small library. Robotics Newsletter, monthly.

Robot Institute of America (RIA)
P.O. Box 930, Dearborn, MI 48128 313/271-1500
Robotics Today, quarterly.

Robotics International (RI/SME)
P.O. Box 930, Dearborn, MI 48128 313/271-1500
Library. Robotics Today, bimonthly.

American National Standards Institute
1430 Broadway, New York City, NY 10018 212/354-3300

JOURNALS AND OTHER PUBLICATIONS OF INTEREST TO THE ENGINEERING TECHNICIAN

American Journal of Physics, monthly $25
335 East 45th Street, New York City, NY 10017

American Machinist, biweekly, $25
1221 Avenue of the Americas, New York City, NY 10020

Canadian Controls and Instrumentation, monthly, $10/12
481 University Avenue, Toronto, Ontario, Canada M52 1A7

Canadian Datasystems, monthly $10/12
481 University Avenue, Toronto, Ontario, Canada M52 1A7

Canadian Electronics Engineering, monthly, $10/12
481 University Avenue, Toronto, Ontario, Canada M52 1A7

Computer, monthly, $30
5855 Naples Marine Plaza, Suite 301, Long Beach, CA 90803

Computer Decisions, monthly, $15
50 Essex Street, Rochelle Park, NJ 07662

Computers and Automation, 13 times/year, $18.50
815 Washington Street, Newtonville, MA 02160

Computerworld, weekly, $12
797 Washington Street, Newtonville, MA 02160

Data Management, monthly, $8
505 Busse Highway, Park Ridge, IL 60068

Datamation, monthly, $18
35 Mason Street, Greenwich, CT 06830

Design Engineering, monthly, $12/15
481 University Avenue, Toronto, Ontario, Canada M52 1A7

Design News, biweekly, $20
221 Columbus Avenue, Boston, MA 02116

EE - Electrical Equipment, monthly, no price listed
172 South Broadway, White Plains, NY 10605
(Instrument Society of America)

Electromechanical Design, monthly, $20
167 Corey Road, Brookline, MA 02146

Electronic Design, biweekly, $25
50 Essex Street, Rockelle Park, NJ 07662

Electronic Engineering Times, 26 times/year, $8
280 Community Drive, Great Neck, NY 11030

Electronic News, weekly, $9.50
7 East 12th Street, New York City, NY 10003

Electronic Technician/Dealer, monthly, $6
757 Third Avenue, New York City, NY 10017

Electronics, biweekly, $12
1221 Avenue of the Americas, New York City, NY 10020

Engineering Education, 8 times/year, $20
One duPont Circle, Suite 400, Washington, DC 20036
(American Society for Engineering Education)

IEEE Spectrum, monthly, $3
345 East 47th Street, New York City, NY 10017
(Institute of Electrical and Electronics Engineers)

Instrumentation Technology, monthly, $7
400 Stanwix Street, Pittsburge, PA 15222

Instruments and Control Systems, monthly, $25
P.O. Box 2025, Radnor, PA 19089

Journal of the Association for Computing Machinery, quarterly,
$30 ,1133 Avenue of the Americas, New York City, NY 10036

Machine and Tool Blue Book, monthly, no price listed
Hitchcock Building, Wheaton, IL 60187

Machine Design, 31 times/year, $20
Penton Plaza, 1111 Chester Avenue, Cleveland, Oh 44114

Manufacturing Engineering and Management, monthly, $8.50
20501 Ford Road, Dearborn, MI 48128

Mechanical Engineering, monthly, $10
345 East 47th Street, New York City, NY 10017

Physics Today, monthly, $12
335 East 45th Street, New York City, NY 10017

Process Design, monthly, no price listed
221 Columbus Avenue, Boston, MA 02116

Production, monthly, no price listed
P.O. Box 101, Bloomfield Hills, MI 48013

Tooling and Production, monthly, $10
5821 Harper Road, Solon, OH 44139

Hewlett-Packard Journal
3000 Hanover Street, Palo Alto, CA 94303

Technology, bimonthly, $24
Technology Information Corporation, 2200 Central Avenue, Suite F, Boulder, CO 80301

Tekscope - Tektronix, Inc. (customer information)
P.O. Box 500, Beaverton, OR 97077

Federal law prohibits discrimination on the basis of race, color or national origin (Title VI of the Civil Rights Act of 1964); sex (Title IX of the Educational Amendments of 1972 and Title II of the Vocational Education Amendments of 1976); or handicap (Section 504 of the Rehabilitation Act of 1973) in educational programs or activities receiving federal financial assistance.

Employees, students and the general public are hereby notified that the Georgia Department of Education does not discriminate in any educational programs or activities or in employment policies.

The following individuals have been designated as the employees responsible for coordinating the department's effort to implement this nondiscriminatory policy.

Title II - Ann Lary, Vocational Equity Coordinator
Title VI - Peyton Williams Jr., Associate Superintendent of State Schools and Special Services
Title IX - Myra Tolbert, Coordinator
Section 504 - Jane Lee, Coordinator of Special Education

Inquiries concerning the application of Title II, Title VI, Title IX or Section 504 to the policies and practices of the department may be addressed to the persons listed above at the Georgia Department of Education, Twin Towers East, Atlanta 30334; to the Regional Office for Civil Rights, Atlanta 30323; or to the Director, Office for Civil Rights, Education Department, Washington, D.C. 20201.

Program Improvement and Evaluation
Office of Vocational Education
Georgia Department of Education
Atlanta, Georgia 30334
Charles McDaniel, State Superintendent of Schools
1984