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# PREPARING TECHNICIANS FOR ENGINEERING MATERIALS TECHNOLOGY

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Materials science and engineering is definitely among the worlds hottest technologies; the other two being biotechnology and communication technology.

> Every expert interviewed [deans of engineering schools, school placement directors for engineering and heads of firms that emphasize advanced technology and employ significant numbers of engineers] had materials at or near the top of the list [top 10 careers for 1990s]. The burgeoning need for new materials stretches from high performance, specialty applications to cheap, high-volume substances for mass production. The implications for use and adaptation are unlimited... focused on developing ceramics, metal alloys, polymers, biological substances and other crystalline and amorphous materials. Beyond creation of such breakthroughs, there will be plenty of jobs in bringing these materials up to mass production and introducing them into manufacturing, processing, power systems, construction and other areas of application. (Paul Price, Graduating Engineer, March, 1988.)

A long held principle is that for every engineer and scientist there is a need for ten technicians to maximize the efficiency of the technology team for meeting needs of industry and government. Developing an adequate supply of technicians to meet the requirements of the materials related industry will be a challenge and difficult to accomplish.

A variety of agencies such as the National Institute of Standards and Technology (NIST formerly NBS), NASA, ASM International and Battelle Laboratories feel the need and wish to support development of engineering materials technology programs. In a joint effort among Battelle Laboratories, Department of Energy (DOE) and Northwest College and University Association for Science (NORCUS), for development of an engineering materials technology program for vocational programs and community colleges for the Pacific Northwest Region was recently completed. This effort has implications for a national model.

Curriculum

> The increasingly interdisciplinary character of research [in materials science and engineering] has created serious problems of communication. Physicists often do not fully understand what chemists mean by terms like oxidation potential, and chemists often do not understand physicists' calculations involving path integrals and thermal Green's functions. Physicists and chemists attach different meaning to the term resonance. Electrical engineers understand logic circuits and switching devices but may know little chemistry and nothing about ceramics. Ceramicists understand materials and processes, but may not grasp electronic circuits or device physics. A period of adjustment will be needed for the different constituencies to learn to work together more effectively. (John P. McKelvey. "Understanding Superconductivity", Invention & Technology. Spring/Summer. 1989. p.56.)

The communication problem stated here involves MSE. Engineering materials technology at an associate degree level of education is even newer. A curriculum for technicians could take many forms in an attempt to meet the requirements of many areas related to materials science and engineering. Among the few programs, Erie Community College and Hocking Technical College are offering AAS degrees; the Texas State Technical Institute System is establishing a program at its Sweetwater campus.

The model Associate of Applied Science degree in Engineering Materials Technology shown on the attached sheet provides a general structure. It purposely has course titles which need delimiting while also including a core of courses necessary to develop cognitive, affective and psychomotor skills with the underlining principles of math, science and technology so students have job entry skills, and so that students can learn about and adapt to evolving technology.

Needs analyses, advisory committees and other similar input are required to delimit the program in order for it to serve specific needs. For example, two courses each are shown for materials processing and manufacturing processing. This leaves room for covering the hundreds of processes in materials technology. But community or regional needs would influence whether there was an emphasis on metal working, plastic processing or perhaps electronic materials such as semiconductors.

Many materials technologies are emerging. They will compete with established but evolving technologies which have their special interests to promote. For example, composites are being designed and promoted to replace metals. But the established metal industry is developing new alloys, more efficient processing techniques and means to keep them competitive.

Students

As mentioned above, due to a lack of public awareness about materials technology in general and of the career opportunities in MSE in particular, it may be difficult to attract students into a new program. There are on-going efforts such as the career outreach program by ASM International and the course Materials Science Technology in the Northwest Pacific that have been designed to increase awareness of MSE.

On the Virginia Peninsula a master technician program was developed with a 2 plus 2 plus 2 structure involving vocational schools, community colleges and universities. We developed two materials and processes technology curriculum guides for the Commonwealth of Virginia's Technology Education Service and have also written numerous modules on engineering materials technology which have been published in The Technology Teacher. These modules can be used to develop awareness in high school and introductory college levels of science and technology. There are other means to promote the career opportunities in materials technology including scholarships and contests that emphasize MSE.

## ENGINEERING MATERIALS TECHNOLOGY
## ASSOCIATE OF APPLIED SCIENCE DEGREE

### FIRST YEAR

#### First Semester

| | |
|---|---|
| Communication | 3 |
| Mathematics | 3 |
| Chemistry | 4 |
| Engineering Materials Technology | 3 |
| Physics | 4 |
| | 17 |

#### Second Semester

| | |
|---|---|
| Communication - Technical Reporting | 3 |
| Mathematics | 3 |
| Chemistry | 4 |
| Processing of Materials | 3 |
| Computing in Engineering Technology | 2 |
| Static & Strength of Materials | 3 |
| | 18 |

#### Summer Session

| | |
|---|---|
| Cooperative Education | 3 |

### Second Year

#### First Semester

| | |
|---|---|
| Manufacturing Processes I | 4 |
| Non-Destructive Evaluation | 3 |
| Social Science | 3 |
| Metals and Polymers | 4 |
| Materials Handling, Safety & Environment | 4 |
| | 18 |

#### Second Semester

| | |
|---|---|
| Materials Processes II | 4 |
| Ceramics and Composites | 4 |
| Manufacturing Processes II | 3 |
| Engineering Materials Technology Project | 3 |
| Elective or General Education | 3 |
| | 17 |

# TOPICAL OUTLINE

## Preparing Technicians for Engineering Materials Technology

I. History of Materials Science Department

A. 1947 - Erie County Technical Institute
1960's - Changed to Erie Community College

B. 1947 - Department of Metallurgical Technology
1960's - Changed to Materials Science Technology

II. Curriculum Requirements

| | | |
|---|---|---|
| Math | - Technical Mathematics I<br>Intermediate algebra & trigonometry. | 4.0 credits |
| Math | - Technical Mathematics II<br>Intermediate algebra & trigonometry. | 4.0 credits |
| Physics | - Technical Physics I<br>Friction, fluids, sound thermo-dynamics, heat transfer. | 4.0 credits |
| Physics Lab | - Experiments in Mechanics<br>Heat & sound. | 0 credits |
| English | - College Composition | 3.0 credits |
| English | - Composition & Reading in Science & Lit | 3.0 credits |
| Chemistry | - Introductory College Chemistry I<br>For students that require working knowledge of chemistry. Includes: chemical bonding, chemical equations, stoichiometry & gas laws. | 3.0 credits |
| Chemistry | - Chemistry I Laboratory<br>Topics covered: measurements, physical properties, specific heat, atomic weights, chemical reactions, etc. | 1.5 credits |
| Chemistry | - Introductory College Chemistry II<br>Topics covered: solutions, acidimetry & alkalimetry, oxidation-reduction, chemical equilibrium, organic chemistry, metal & polymers. | 3.0 credits |

Chemistry - Chemistry II Laboratory — 1.5 credits
Covers: solutions, acid & base titration, intro to organic compounds & qualitative analysis of transition metals.

Social Science - Macro & Microeconomics — 3.0 credits
- General Psychology

Materials Science I - Intro to Materials Science — 3.0 credits
The basic study of structures of materials and how these relate to their properties.

Materials Science II — 5.0 credits
Indepth study of all materials.

Materials Science II Laboratory — 1.5 credits
Metallurgical sample preparations and microscopic study of metallurgical specimens.

Advanced Processes & Materials — 2.0 credits
Materials joining covered in depth, as example welding and adhesive bonding. Nonmetallics as polymers, elastomers, ceramics & composites. SPC, product liability and product reliability are covered.

Advanced Processes & Materials Laboratory — 2.0 credits
Use metallographs & $MP_4$ camera used to study polymers, ceramics & composites. Join metals with several welding processes.

Strength of Materials — 3.0 credits
Study of various mechanical properties of common materials. Stress-strain relationships, yield strength, elastic limit, modulus of elasticity.

Strength of Materials Laboratory — 1.0 credit
Formal report writing on tension, compression, shear, hardness, torsion, bonding impact & fatigue experiments. Use of equipment is stressed.

Microprocessor Applications in Materials Science — 3.0 credits
It is based on the premise that computers are a useful tool for solving, evaluating & modeling problems in Materials Science Technology.

Non-Destructive Inspection — 3.0 credits
Liquid penetrant, ultrasonic, eddie current, magnetic particle, x-ray and gamma radiation techniques are studied.

Non-Destructive Inspection Laboratory — 1.0 credit
Application & operation of equipment, interpretation of results included in laboratory procedures.

Metal Casting — 1.0 credit
A course in elementary metal casting practices covering pattern design, molding processes, sand testing, gating & risering & solidification.

Metal Casting Laboratory — 2.0 credits
Many non-ferrous alloys are poured into green sand mold, ceramic molds, metal molds & graphite molds. Electric arc, induction & gas crucible furnaces are used.

Casting Processes — 1.0 credit
All the industries that are associated with the manufacturing of castings are studied. This would include refractories, ceramic, plastics, rubber, wood & cement industries.

Casting Processes Laboratory — 2.0 credits
Steel, gray iron, ductile iron & stainless steel produced & made into useful objects. The senior research project will test the resources, intelligence, ingenuity & ability of students to work as a team.

Machine Tools & Drawing — 1.0 credit
Fundamentals of mechanical drawing with emphasis on blueprint reading. Intro to basic machine tools, lathe shaper, mill, grinder & drill press.

Metallurgical Instrumentation — 3.0 credits
Indepth study of strain gages, carbon analysis, micro-hardness testing, pyrometry, creep & emission spectroscopy.

Metallurgical Instrumentation Laboratory — 1.0 credit
Perform tests on installation, calibration & operation of instruments.

Industrial Metallurgy — 1.5 credits
Visitations to materials science plants.

Manufacturing Processes I — 1.0 credit
Introductory course covering the fundamental manufacturing methods, processes & equipment.

Manufacturing Processes I Laboratory — 1.0 credit
The laboratory will afford the students hands-on experience with forging, casting, powder metallurgy, etc.

Manufacturing Processes & Materials II — 1.0 credit

An advanced course covering automated systems manufacturing, example - flexible manufacturing & computer-integrated manufacturing.

Manufacturing Processes & Materials II Laboratory — 1.0 credit

Topics in control systems, pick & place operations, automated assembly & computer-integrated manufacturing.

A Survey in Computer-Aid Design — 1.0 credit

A five-week survey of basic CAD tasks necessary to complete simple orthographic projections using micro CAD systems.